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DALL SHEEP

Susan M. Abbott, Editor

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STATE OF ALASKA
Walter J. Hickel, Governor

DEPARTMENT OF FISH AND GAME
Carl L. Rosier, Commissioner

DIVISION OF WILDLIFE CONSERVATION
David G. Kelleyhouse, Director
Wayne L. Regelin, Deputy Director

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(907) 465-4190

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LOCATION

Game Management Units: 7 and 15 (8,397 mi^2)

Geographic Description: Kenai Mountains

BACKGROUND

U.S. Fish and Wildlife Service (USFWS) reports indicate aerial sheep surveys were initiated on the Refuge portion of the Kenai Mountains in 1949. Records after statehood (ADF&G and USFWS files) suggest the Kenai Mountains sheep population steadily increased in size from 1949 to 1968, before sharply declining until 1977 and 1978, when the lowest counts were recorded.

Since the late-1970s the sheep population has been rebuilding from its previous low levels; impacts of weather and habitat were the controlling factors. Predation, regulated hunting, natural and disease related mortalities also played a part in controlling the sheep population size in the Kenai Mountains; however, they were not significant factors.

MANAGEMENT DIRECTION

Management Objectives

The sheep management objective for Units 7 and 15 is to maintain a population of sheep that will sustain an annual harvest of 25 rams.

METHODS

Biologists used a Piper PA-18, flown at 200-400 feet above ground level, to count, sex, and age sheep during summer in selected count areas of the Kenai Mountains sheep habitat. Surveys were conducted during early morning or late-evening hours to avoid midday increases in wind speed and turbulence. Sheep were classified into categories of lambs, sublegal rams (7/8-curl or less), legal rams (full-curl or larger) and unidentified sheep. The unidentified sheep category was comprised primarily of ewes and a low number of yearling and 2-year-old rams. In addition to counting selected count areas, three count areas from Skilak Glacier to Fox River were designated in 1987 to be used as areas to assess sheep population trends.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: In 1991, 9 of 12 count areas were counted and 926 sheep were classified (Table 1). Using the 1991 count plus an estimate from previous year's surveys for areas not counted, resulted in an estimate for the Kenai Mountains of 1,200-1,500 sheep. This estimate included 300 sheep in the Unit 7, Cooper Landing Closed Area. In 1991, it appeared the sheep population was increasing slightly compared with counts during the early-1980s.

A complete census of the Kenai Mountain sheep habitat has not been conducted since 1968 when observers counted 2,121 sheep and estimated the population at 2,200 to 2,500 sheep. The population declined sharply during the early-1970s because of overpopulation and severe winters then started to rebuild during the late-1970s and 1980s.

Population Composition: Aerial surveys conducted during 1989-1990 and 1990-1991, resulted in 224 and 926 sheep classified, respectively (Table 1). The 1990-91 data was the most complete with 9 of the 12 count areas surveyed. A total of 926 sheep was classified comprised of 40 (4%) legal rams (full-curl or larger), 201 (22%) sublegal rams, 173 (19%) lambs and 512 (55%) ewes, yearlings and 2-year-old rams.

Distribution and Movements: We found sheep throughout the central portion of the Kenai Mountains, north of Sheep Creek in Unit 15 and north of Snow River in Unit 7. The highest density of sheep ($6/mi^2$) was found on Round Mountain in Subunit 15A.

The count area containing the highest number of sheep (438) was between Killey Glacier and Tustumena Glacier. This area has traditionally supported the highest number of animals because of its size and available habitat. Sheep were not found along the coast of Unit 7 or the southern coast of Unit 15. Seasonal movement data is not available for sheep in the Kenai Mountains.

Mortality

Harvest:

Season and Bag Limit. The sheep season for resident, subsistence, and nonresident hunters was 10 August through 20 September, and the bag limit was 1 ram with full-curl horn or larger.

Board of Game Actions and Emergency Orders. The Board of Game changed the size of a legal ram from 7/8-curl to full-curl for the 1989 season. No emergency orders were issued during this report period.

Hunter Harvest. As a result of the change in legal horn size, the sheep harvest declined from 42 in 1988, to 8 in 1989 (Table 2). The 1990 harvest increased to 33 rams, matching the 3-year mean harvest, from 1986 to 1988, of 32, 7/8-curl rams.

Mean horn size of rams increased with the full-curl regulation in 1989 (34.6 inches) and in 1990 (35.5 inches). Compared to mean horn size from 1986 to 1988, the new regulation yielded a 6% increase (33.0 to 35.1 inches) in horn size for 1989 and 1990. Horn size ranged from 32.0 to 39.4 inches and mean age of harvested rams was 7.4 years during 1989 and 1990.

Hunting effort declined 28%, from 184 hunters in 1988 to 132 in 1989, probably a result of the new regulation (Table 3). Comparing the mean number of hunters from 1986 to 1988 (158), the 1990 hunting effort increased by 5%, to 167.

Hunter Residency and Success. Seven (88%) of the successful hunters in 1989 and all of the successful hunters in 1990 were Alaska residents (Table 3). One successful hunter in 1989 did not report residency. Unsuccessful hunters were comprised of 112 residents, 1 nonresident (12 unknown residency) in 1989 and 125 residents and 4 nonresidents (5 unknown residency) in 1990.

Harvest Chronology. Chronology of harvest followed similar patterns over the past 2 years (Table 4). Most of the harvest occurred during the first week of the season and few animals were taken during the last two weeks of September.

Transport Methods. During 1989 successful hunters reported using boats (75%), highway vehicles (13%), and aircraft 13% for transportation in their hunts (Table 5). In 1990, successful hunters reported using boats (36%), highway vehicles (27%), aircraft (27%), horses and ATVs (3% each).

Habitat Assessment

According to Culbertson et al. (1980) the only significant sheep habitat enhancement documented for the Kenai Mountains resulted from the 1974 wildfire on Round Mountain in Subunit 15A. This fire burned 50 acres from 2,500 to 3,500 feet altitude on the south-facing slopes from the alder-brush zone through the alpine-tundra zone. Culbertson (ibid.) recorded 40% more sheep observations per acre in the burned versus the adjacent unburned area. Two grasses important to sheep, *Trisetum spicatum* and *Festuca rubra*, were more abundant and vigorous in burned areas when compared to nearby unburned areas. They concluded that sheep made equal or more use of the 1974 burn than the adjacent unburned alpine habitat in mid-summer.

CONCLUSIONS AND RECOMMENDATIONS

A primary objective of the sheep management program for the Kenai Mountains should be to develop a population data base which reflects accurate changes in sex and age composition, relative abundance, and changes among areas during the same time period. The three trend areas should be expanded to include three additional areas to more accurately assess population changes. Bear and Russian mountains (Area 853) and Sheep Creek (Area 858) should be included as trend areas representing areas hunted. The Cooper Landing Closed Area should be counted annually to sample an unhunted area. Areas on the "edge" of suitable sheep range, Mills Creek (Area 834), and Snow River (Area 844), should be included in surveys to serve as early indicators of weather or range related population changes.

Data collected during 1989/90 and 1990/91 indicated the Kenai Mountains sheep population was increasing in most count areas. Although insufficient data were collected to determine population size, an estimated 1,200 to 1,500 sheep existed in the Kenai Mountains. The reduced effort and reported harvest of 8 rams in 1989 suggested that sheep hunters felt the increase in legal horn size reduced their chances to harvest a sheep. The increased effort in 1990 indicated the change in regulations only reduced hunting effort for one year. The harvest of 33 rams in 1990 was 2-3% of the estimated population. This level of harvest met the management objective for the sheep population in the Kenai Mountains. I recommend no change in season or bag limit.

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Prepared by:

Ted H. Spraker
Wildlife Biologist

Submitted by:

Jeff Hughes
Wildlife Biologist

Table 1. Kenai Mountains, Units 7 and 15 summer aerial sheep composition counts and estimated population size, 1986-91.

Regulatory year	Rams				Ewes[a]	Lambs (%)	Sheep/ hour	Total Sheep observed	Estimated population size
	Full-curl(%)	3/4 to full-curl	1/2 to 3/4-curl	<1/2-curl					
1986/87[a]	19 (4)	100[b]	--	--	276	104 (21)	--	499	1,200-1,500
1987/88[a]	19 (5)	172	--	--	534	174 (19)	--	923	1,200-1,500
1988/89	No Data available		--	--	--	---	--	--	1,200-1,500
1989/90	5 (2)	44[d]	--	--	121	54 (24)	--	224	1,200-1,500
1990/91[c]	40 (4)	201[d]	--	--	512	173 (19)	--	926	1,200-1,500

[a] Legal ram 7/8-curl or larger.
[b] Sublegal rams 3/4-curl or smaller.
[c] Legal ram full-curl.
[d] Sublegal rams 7/8-curl or smaller.

Table 2. Kenai Mountains Units 7 and 15 sheep harvest[a], 1986-91.

Regulatory Year	Rams	$\bar{x}$ Horn Length (in)	% ≥ 40 in	Ewes	Total sheep
1986/87	25	33.4	0	0	25
1987/88	30	33.5	3.3	0	30
1988/89	42	32.1	0	0	42
1989/90	8	34.6	0	0	8[a]
1990/91	33	35.5	0	0	33

[a] Reduced effort and harvest due to increased horn size of legal rams.

Table 3. Kenai Mountains, Units 7 and 15, sheep hunter[a] residency and success, 1986-90.

	Successful				Unsuccessful				
Regulatory year	Local[b] resident	Nonlocal resident	Nonresident	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Total (%)	Total hunters
1986/87	10	12	0	25[c] (19)	--	--	0	107 (81)	132
1987/88	15	11	4	30 (19)	--	--	6	129 (81)	159
1988/89	22	12	6	42 (23)	64	70	0	142 (77)	184
1989/90	6	2	0	8 (6)	46	66	1	125 (95)	132
1990/91	23	10	--	33 (20)	72	53	4	134 (80)	167

[a] Excludes hunters in permit hunts.
[b] Residents of Units 7 and 15.
[c] Three successful hunters failed to report residency.

Table 4. Kenai Mountains, Units 7 and 15 sheep harvest chronology percent by time period, 1986-91.

Regulatory year	Harvest periods 8/10-8/16	8/17-8/23	8/24-8/30	8/31-9/6	9/7-9/13	9/14-9/20	n
1986/87	No Data Available		--	--	--	--	--
1987/88	No Data Available		--	--	--	--	--
1988/89	53	21	11	8	0	8	38
1989/90	75	0	13	13	0	--	8
1990/91	56	3	13	19	3	6	32

Table 5. Kenai Mountains, Units 7 and 15 sheep harvest[a] percent by transport method 1986-91.

Regulatory year	Percent of harvest Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	n
1986/87	32	0	28	0	0	0	36	4	25
1987/88	33	3	17	0	0	0	43	3	30
1988/89	26	10	38	0	0	0	19	7	42
1989/90	13	0	75	0	0	0	13	0	8
1990/91	27	3	36	3	0	0	27	3	33

LOCATION

Game Management Units: 9, 16, 17, 19 (approximately 4,600 mi^2)

Geographical Description: Alaska Range west and south of Denali National Park and Preserve

BACKGROUND

The Alaska Department of Fish and Game (ADF&G) management plans for Dall sheep (ADF&G 1976, Bos 1988) define the sheep management goals in Alaska. These goals include protection and maintenance, scientific and educational study, diversified recreational use, and commercial and subsistence uses. Federal and state subsistence laws mandate subsistence use as the highest priority for fish and wildlife when harvest is allowable. However, the Alaska Board of Game, acting in compliance with these subsistence laws, has found that historic human use of Dall sheep rarely meets present definitions of subsistence use. Consequently, diversified human recreation is the predominant use of Dall sheep in Alaska.

The ADF&G revised management plans (Bos 1988) recognize that diversified human recreational uses of Dall sheep include consumptive and nonconsumptive uses. Non-consumptive uses include viewing and photography. The consumptive use objectives for this species include 1) maximum opportunity to hunt, 2) opportunity to hunt under aesthetically pleasing conditions, and 3) opportunity to harvest unusually large rams as trophies.

MANAGEMENT DIRECTION

The major management objective for the Alaska Range West (ARW) is to provide the opportunity to harvest Dall rams under aesthetically pleasing conditions. This objective can be attained if the following goals are met.

1. Manage to maintain the existing Dall sheep populations at recorded levels of abundance and productivity.

2. Manage for sustained uncrowded hunting conditions by monitoring hunter participation and location and assessing hunter satisfaction with hunting experiences in the ARW.

3. Manage for a sustained harvest of more than 100 legal rams per year with a mean horn length of more than 34 inches and a mean age exceeding 8 years.

METHODS

No herd management activities were performed in the ARW during this report period. We based conclusions about human use on analyses of hunter harvest reports.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

Because no systematic aerial or ground survey program has been established in the ARW, no reliable information on population trend is available. However, reports from guides and hunters in the area indicate that sheep populations do not differ greatly from past years.

Population status may be superficially inferred from harvest data. Sheep harvests in the ARW were relatively light before the mid-1960s. The mean reported harvest from 1962 to 1967 was 60 rams. From 1968 through 1991, the mean number of rams reported harvested was 110. This mean has varied considerably (low of 71, high of 157) depending on weather and regulations (i.e., changing definitions of what constitutes a "legal" sheep). During the past 5 years annual harvest averaged 145 rams (range 139-157). Based on hunter success rates and numbers of rams harvested, sheep populations appeared relatively stable during the past decade.

No recent sheep surveys have been conducted in the ARW. In 1974, an estimated 3,200 sheep inhabited the area. In 1978, following a more comprehensive survey, Shepherd (1979) estimated the sheep population at 4,000-5,000. In 1984 and 1985 (Pegau 1985, 1986, respectively) the sheep population was thought to be about 4,000 animals. I suspect that the increases noted between 1974 and 1978 were a result of more comprehensive surveys and not because of any significant changes in the sheep population.

If there are 4,000-5,000 sheep in the population, the harvest rate is about 3% and should be easily sustainable. If this is the case, present harvest levels may be maintained indefinitely without depleting the population.

Population Composition:

No recent survey data are available regarding sex and age ratios of the ARW sheep population. Data from 5 aerial surveys of various portions of the range from 1972 to 1984 indicate relative lamb production averaged 38 lambs:100 ewes (range 25-45). Data from these flights also indicated a legal ram ("legal" = 7/8 curl or better) percentage averaging 10% (range = 9-11%).

If survival in the ARW is similar to that projected from Murie's (1944) data from Denali Park, a population of 4,000 Dall sheep could be expected to produce about 850 lambs annually. These lambs should provide a 222 ram increment at age 7 years if survival is not greatly different than in Denali Park. The recent harvest average of 145 rams per year would come to approximately 65% of the anticipated increment under these conditions.

Distribution and Movements:

We did not survey the ARW sheep during this report period. However, incidental observations and analyses of kill locations reported by hunters indicate that no significant shifts have apparently occurred in sheep harvest distribution within the ARW. The north side of the Alaska Range from Denali Park west to Big River produces most of the harvest. From Big River south, the Lake Clark National Park sheep habitat appears less than optimum.

Mortality

Harvest:

Season and Bag Limit. The Alaska Range west of Denali Park in Units 9, 16, 17, and 19 has had an open season from 10 August through 20 September for over 20 years. Bag limit for the area during this report period was one ram having full-curl or larger horns. Historically, the bag limit was one ram with 3/4-curl or larger horns until 1979, when it was changed to a 7/8-curl minimum that was in effect until 1989.

Board of Game Actions and Emergency Orders. The Board of Game made no changes to sheep hunting regulations during this report period. No emergency orders were issued.

Hunter Harvest. The reported sheep harvest within the ARW probably comes close to the actual harvest. Few illegal or unreported harvests are thought to occur. During the last 5 years harvest was stable with a reported average harvest of 145 sheep (Table 1).

During the previous 5 years, mean reported horn length in the harvested segment of ARW rams did not change significantly and remained near 36 inches (Table 1). During the 1991 season, mean reported horn length was 36.0 $\pm$ 0.4 inches (90% CI). Reported ages of harvested rams averaged 8.9 years, which did not differ significantly from the age data for the previous 5 years.

Hunter Residency and Success. A significant proportion of hunters using the ARW sheep population are nonresidents. During the 1991-92 regulatory year 44% of the hunters were not Alaskan residents (Table 2). Because these hunters were generally guided by licensed guides, their success rates were significantly higher than resident hunters; during 1991, 40% of resident hunters were successful while nonresidents had a 70% success rate. Reported success rates have been at least 50% since 1977.

Harvest Chronology. Chronology of sheep harvest in the ARW depends somewhat on weather conditions during the season. As a general rule, over half the harvest occurs during the first 2 weeks of the 6-week season, when weather is less likely to restrict access (Table 3).

Transport Methods. Since the late 1970s, aircraft have provided 80-90% of the access to the ARW for sheep hunters. No occupied villages exist within or adjacent to sheep habitat; no roads bisect the area; and drainages generally are not conducive to boat travel. Other access means are minor compared with that provided by aircraft (Table 4).

Other Mortality:

Natural mortality among ARW sheep is considered typical. Winters within most of the Alaska Range were moderate during the last 5 years. I suspect that wolf predation effects will become more pronounced in the future with the current changes in land-and-shoot harvest methods, and that mortality factor should be investigated.

Nonregulatory Management Problems/Needs

The unregulated guide/outfitter industry in the ARW is presently suspected to negatively impact sheep in readily accessible drainages. Along the Windy Fork of the Kuskokwim River at least 13 different guide/outfitters operated during the 1992 season. Unless restrictions are forthcoming, I suspect that area ram populations will decline to the point that only marginally legal sheep will be harvested. The Big Game Commercial Services Board should be encouraged to adopt guide/outfitter regulations soon.

CONCLUSIONS AND RECOMMENDATIONS

The management objective of providing an aesthetically pleasing hunting opportunity is apparently being met in the ARW at present except for a few problem areas with easy access and unlimited guiding activity. To better respond to changes in demographic parameters of the sheep population, we should collect annual productivity, population status, and population trend data.

Currently, full-curl restrictions apparently regulate harvest of rams within the ARW. Unless weather, disease, or predation effects become prevalent, current regulations can sustain the Dall sheep population in the ARW. I recommend no regulation changes.

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Prepared by:

Jackson S. Whitman
Wildlife Biologist III

Submitted by:

Kenton P. Taylor
Management Coordinator

Reviewed by:

Kenneth R. Whitten
Wildlife Biologist III

Table 1. Alaska Range West Mountains reported sheep harvest, 1987-91.

Regulatory year	Rams	$\bar{x}$ horn length (inches)	% >40"	Ewes	Total sheep
1987-88	139	35.5	5.7	0	139
1988-89	157	35.9	6.5	0	157
1989-90	141	35.8	5.0	0	141
1990-91	151	36.1	7.8	0	151
1991-92	139	36.0	5.8	0	139

Table 2. Alaska Range West Mountains reported sheep hunter residency and success, 1987-91.

	Successful				Unsuccessful				
Regulatory year	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	Total hunters
1987-88	4	58	77	139 (63)	11	58	12	81 (37)	220
1988-89	2	70	85	157 (71)	0	47	18	65 (29)	222
1989-90	4	57	80	141 (59)	5	64	29	98 (41)	239
1990-91	0	49	102	151 (55)	9	70	44	123 (45)	274
1991-92	1	53	80	134 (54)	1	81	34	116 (46)	250

[a] Local hunters are those residing in Units 9, 17, or 19.

Table 3. Alaska Range West Mountains reported sheep harvest[a] chronology percent by time period, 1987-91.

Regulatory year	Harvest periods							n
	8/10-8/16	8/17-8/23	8/24-8/30	8/31-9/6	9/7-9/13	9/14-9/20	Unk	
1987-88	30	20	20	8	4	14	3	139
1988-89	36	17	16	7	15	9	1	157
1989-90	37	22	17	7	7	9	1	141
1990-91	46	12	10	14	9	8	2	151
1991-92	42	9	16	14	6	12	1	139

[a] No permit hunts in Alaska Range West Mountains.

Table 4. Alaska Range West Mountains reported sheep harvest percent by transport method, 1987-91.

Regulatory year	Percent of harvest								n
	Airplane	Horse	Boat	3-or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	
1987-88	81	5	1	< 1	0	3	< 1	8	220
1988-89	79	7	1	4	0	1	2	5	222
1989-90	83	6	2	3	0	3	< 1	3	239
1990-91	86	6	2	2	0	0	< 1	4	265
1991-92	79	5	2	5	0	1	< 1	8	258

LOCATION

Game Management Unit: 11 (13,300 mi^2)
South Wrangell Mountains

Geographical Description: Chitina Valley and the eastern half of the Copper River Basin

BACKGROUND

Dall sheep inhabit most alpine and subalpine areas of the Wrangell Mountains, and have long been hunted for sport and subsistence purposes. The Wrangell Mountains are famous for trophy-sized rams. Little information is available on the number of sheep harvested before 1962 because harvest data were not collected. Since 1962, harvest reports have provided managers with numbers and locations of harvests.

In late 1978 the Wrangell Mountains, including all of Unit 11, was designated as a National Monument. During the 1979 hunting season only subsistence hunting by local rural residents was allowed under National Monument regulations.

Wrangell-St. Elias National Park and Preserve was established by the Alaska National Interest Lands and Conservation Act (ANILCA) in 1980. Harvest of sheep in the portion designated as Park was limited to subsistence hunting by rural residents of designated communities within Units 11, 12 and 13. Sport hunting for sheep in the Preserve areas was open to residents and nonresidents. Effective 1 July 1990, all Alaska residents were considered subsistence hunters under state law. However, subsistence hunting in the Park was still limited to local residents under federal regulations.

Estimates of historical sheep numbers in the Wrangell Mountains are unavailable. Sheep surveys flown during the late 1950s and 1960s are not comparable because survey intensity and specific areas counted are unknown. Specific count areas and techniques for aerial surveys were established in 1973 when sex and age composition surveys were flown over large portions of the Wrangell and Chugach mountains. Additional surveys to census sheep and determine sex and age composition have continued.

MANAGEMENT DIRECTION

Management Objective

The management objective for South Wrangell Mountains Dall sheep is to maintain a sheep population that will sustain an annual harvest of 60 rams.

METHODS

An aerial survey was conducted in 1990 to determine sex and age composition and population trends of sheep in Count Area 11 (between Long Glacier and Dadina River) in Unit 11. We monitored harvests and hunting pressure by requiring harvest ticket reports from all hunters.

RESULTS AND DISCUSSION

Population Status and Trend

Before 1985, aerial surveys for sheep were conducted periodically on established count areas in the southern Wrangell Mountains (Table 1). Since 1985, budgetary constraints have curtailed annual surveys.

The most recent survey covered Count Area 11, located between the Dadina River and Long Glacier. This 1990 survey resulted in a count of 361 sheep, down 35% from the 1987 tally of 559 (Table 1). The 1990 count was 24% below the average (mean = 473, range = 361-559) of the 1982, 1984, 1987, and 1990 surveys.

Population Size: Information on size of the Unit 11 sheep population is limited. Maximum historical counts from established count areas indicate at least 4,000 sheep inhabited the Wrangell Mountains from Mount Drum, southeast to the Canada border (Table 1). Areas in Unit 11 that were not surveyed, but are inhabited by sheep include the Mount Sanford area, the Copper River drainage above Copper Lake, and the Chugach Mountains south of the Chitina River.

The National Park Service (NPS) conducted sheep surveys in Wrangell-St. Elias National Park and Preserve during 1990 and 1991 (McDonald et al. 1990; 1991). NPS estimated 25,972 sheep ± 6,233 (95% CI) in 1990, and 27,972 sheep ± 6,448 (95% CI) in 1991. Areas counted in the NPS surveys included the northern Wrangell Mountains (Unit 12), and the eastern Chugach Mountains. An estimate of the size of the sheep population for the Wrangell Mountains, within Unit 11 has not been completed.

Population Composition: The percentage of lambs in the population during 1990 in Count Area 11 was 22%. Lambs have averaged 19% of the population since 1982 (range = 14-23%; Table 1). The number of lambs classified in 1990 was the second lowest of the four counts, but total numbers have fluctuated considerably (range = 60-126). The percentage of rams in the 1990 population in Count Area 11 was 14%. Rams have averaged 16.5% of the population since 1982 (range = 13-22%). The number of rams classified in Count Area 11 during 1990, 52, was also the lowest of the four counts (range=52-123).

Distribution and Movement: Information on movements of sheep inhabiting Unit 11 is limited. Studies of sheep have not been conducted in this area. Field observations suggest that sheep move to wind-blown, snow-free areas during winter, and to areas of new growth in spring.

Mortality

Harvest:

Seasons and Bag Limit. The open season for resident and nonresident sheep hunters was 10 August through 20 September, and the bag limit was 1 sheep for resident (subsistence) hunters and 1 ram with full-curl horn or larger for nonresident hunters. Guides were required for nonresident sheep hunters.

Board of Game Actions and Emergency Orders. Before 1978, the season and bag limit for sheep in the Wrangell Mountains of Unit 11 was 10 August through 20 September and the bag limit was 1 ram with 3/4-curl or larger horns. Beginning in 1978, the minimum horn size was increased to 7/8-curl or larger with bag and season dates remaining the same. In 1989, the bag limit was changed to 1 sheep (any size or sex) for subsistence hunters and 1 ram with full-curl or larger horns for sport hunters. Subsistence hunters were defined as any Alaska resident. No emergency orders restricting the take or season on sheep in this portion of Unit 11 have been issued during this report period.

Hunter Harvest. Hunters reported killing 101, 138, and 163 sheep during the 1989, 1990, and 1991 seasons, respectively (Table 2). Subsistence hunting regulations for the 1989 season allowed resident hunters to take any sheep, however there were not any ewes or rams with horns less than 7/8-curl harvested. Hunters harvested 101 legal rams during 1989. The take of 114 legal rams in 1990 and 111 in 1991 was similar to 1986-89 average of 110.5. Eleven rams with less than full-curl horns (i.e., less than 28 in horn measurement) and 13 ewes were harvested during the 1990 season. Eighteen rams with less than full-curl horns and 24 ewes were taken during the 1991 season.

Harvest reporting requirements provided horn measurements of sheep harvested from Unit 11 (Table 3). Average horn size data from specific areas in the unit were compared from year-to-year and within the unit. Table 3 details average horn size in the harvest by harvest location. The Eastern Region includes the area from the Nizina River to the Canada border. The Mid Region includes the area from the Dadina River to west of the Nizina River. The Western Region includes the northern and western Wrangell Mountains from Jack Creek to the Dadina River.

Average horn size varied annually from within each of the regions. Historically, sheep horn size has decreased from east, to west and north. Contributing factors suspected include favorable habitat, weather conditions, and genetic influence. The world record sheep came from the Eastern Region of the Wrangell Mountains.

Hunter Residency and Success. The number of people hunting sheep in the Wrangell Mountains in Unit 11 from 1986-91 was lowest in 1988 and highest in 1991 (Table 4). The regulation change allowing resident hunters to take any sheep was probably responsible for the observed increase in hunting pressure in 1990 and 1991.

The percentage of the annual sheep harvest from 1986-91 by local Alaska residents, nonlocal Alaska residents, and nonresidents averaged 19%, 51%, and 30%, respectively (Table 4). The average annual success rate from 1986-91 for local hunters was 36% (range = 31-42%), for nonlocal hunters was 42% (range = 38-48%), and for nonresidents was 81% (range = 70-93%). Annual success rates for all hunters from 1986-91 averaged 48% (range = 43- 54%).

The average number of days hunted annually by successful hunters ranged from 4.7 to 6.0 days between 1986 and 1991 (Table 5). The average number of days hunted annually reported by unsuccessful sheep hunters for the same period ranged from 4.8 to 5.6 days. Successful sheep hunters in 1990 (the first year sublegal rams and ewes were taken for subsistence) reported an average hunt of 5.3 days, similar to the 1986-91 average of 5.1 days. Unsuccessful sheep hunters in 1990 reported an average hunt of 5.6 days, slightly more than the 1986-91 average of 5.4 days. Successful sheep hunters in 1991 reported an average hunt of 4.7 days and unsuccessful sheep hunters in 1991 reported an average hunt of 4.8, both less than the 1986-91 average of 5.1 and 5.4 respectively.

The decrease in average hunt length was probably because of the increased number of sublegal rams and ewes taken for subsistence considering the average hunter success rate in 1991 and increased number of sheep taken. Young rams and ewes were more accessible than large mature rams.

Harvest Chronology. During the early part of this report period, most sheep harvested each year were taken during the initial weeks of the season (Table 6). Although one-half of the annual sheep harvests were taken in the first three weeks of sheep season in 1990 and 1991, the harvest appears to have been spread throughout more of the season.

Transportation Methods. Aircraft were the primary mode of transportation for both successful and unsuccessful sheep hunters in Unit 11 (Table 7). The percentage of successful hunters using aircraft decreased in the last few years because of increased use of 3- or 4-wheelers and highway vehicles. This change was attributed to resident hunters taking small rams and ewes for subsistence.

Other Mortality: Studies of natural mortality of sheep in the area have not been conducted in recent years. Sources of natural mortality common to sheep populations include accidents and starvation during periods of deep snow and icing. Wolf predation has also been observed in portions of Unit 11. Reports by trappers and local residents suggested wolf predation may be an important mortality factor, however, predation rates have not been determined.

One observation of wolves killing a group of adult rams was documented in 1989. Remains of 22 rams were located on a mountain ridge between the Dadina and Chetaslina rivers. Tracks indicated a pack of wolves came upon the rams away from escape cover and killed the entire group.

Habitat Assessment

Studies of sheep habitat assessment or carrying capacity have not been conducted in the Wrangell Mountains. A subjective evaluation based on sheep numbers and horn growth indicated most of the area consists of quality sheep habitat. The area between the Sanford River and Copper Lake contained fewer sheep than similarly sized areas in the unit, possibly because of a lack of escape cover.

CONCLUSION AND RECOMMENDATIONS

The Dall sheep population in the Wrangell Mountains has been productive and abundant. Local fluctuations in abundance have been noted in the past, but widespread declines in sheep numbers have not been documented. We attributed small fluctuations in census data to survey technique, conditions, and sheep visibility.

Annual surveys of count areas ended in 1985. Surveys in Count Area 11 have been conducted on alternating years depending on fiscal constraints. Incidental observations of sheep made over the past few years in Unit 11 indicated sheep numbers have declined, however, counts from Count Area 11 were the only empirical data that indicated a change in sheep abundance. The observed decline could be because of survey technique, seasonal movements, or other factors. Any unitwide conclusions should await NPS sheep surveys.

The observed decline in Count Area 11 was in all sex and age classes and was not attributed to overhunting. The number of rams taken by hunters in Count Area 11 has steadily declined since 1987. Annual harvests from Count Area 11 averaged 17 rams between 1982 and 1989 (range = 11-24). Ram harvests from Count Area 11 in 1990 and 1991 were 5 and 7, respectively.

Annual unitwide harvests of adult rams remained consistent and account for approximately 10% of the annual statewide harvest. The effect of sport hunting on the unit's sheep population was negligible given the level of sport hunting for mature rams and restrictions on nonresidents to take full-curl rams.

The distinction between sport and subsistence sheep hunters in Unit 11 is obscure. While nonresidents are restricted to taking full-curl rams, any Alaska resident is considered a subsistence hunter and can take one sheep per year of either sex with no horn size restriction. Many resident hunters take large, mature rams despite the presence and

opportunity to take smaller rams or ewes. Hunters spending large amounts of time and money to reach remote hunting areas generally take only mature rams.

There is some question about the effect of a ewe harvest on a sheep population. Heimer (1986) stated a ewe harvest greater than 2% could lead to a population decline. The present subsistence harvest of ewes and small rams is widely dispersed and occurs in the more accessible locations. Data collected in subsequent years will reveal the effect of ewe and small ram harvests on the population. I recommend an evaluation of the effects of ewe harvests on the unit's sheep population.

The level of wolf predation and other natural mortality factors is unknown. Repeated incidental observations of wolf predation on sheep in the area indicate it is relatively common. The effects of predation on the unit's sheep population will remain unknown until directed research is conducted.

ADF&G should continue to oversee sport and subsistence sheep harvests, monitor harvested horn measurements, and check legal ram abundance to prevent depletion of mature ram numbers should hunting pressure or other factors change. I recommend no changes in season or bag limits. Significant increases of either sport or subsistence harvests may require reevaluation of present regulations.

The entire unit is open to any sheep and some consideration should be given to creating a trophy management area where all but very large rams are protected. Such an area would allow for a high quality sheep hunt for very large rams. The area between the Nizina and Chitina rivers (Unit 11) should be considered in this regard. Management options for this area should include harvest limited to full-curl rams only, or a drawing for a limited number of permits for full-curl rams.

Management objectives need to be revised. Population objectives should be changed to allow the population to fluctuate as dictated by climatic conditions and predation. Human use objectives should be adopted to provide for the opportunity to harvest mature rams as they are available in the population and to provide a limited harvest of other sex and age classes for subsistence use on a sustained yield basis.

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Prepared by:

James D. Woolington
Wildlife Biologist

and

Robert W. Tobey
Wildlife Biologist

Submitted by:

Jeff Hughes
Wildlife Biologist

Table 1. Unit 11 summer aerial sheep composition counts and estimated population size, 1981-90.

Regulatory year	Rams[a]				Ewes[b]	Lambs(%)	Sheep/ hour	Total sheep observed	Estimated population size[c]
	full curl (%)	3/4 to full-curl	1/2 to 3/4-curl	<1/2-curl					
Count Area 10									
1980/81	4 (2)	31	---	---	107	59 (29)	52	201	201
Count Area 11									
1981/82	24 (4)	48	---	---	359	126 (23)	169	557	559
1983/84	12 (3)	59	---	---	283	60 (14)	118	414	559
1986/87	52 (9)	71	---	---	330	106 (19)	193	559	559
1989/90	28 (8)	24	---	---	231	78 (22)	109	361	559
Count Area 12									
1982/83	60 (12)	49	---	---	341	64 (12)	112	514	514
1983/84	65 (13)	67	---	---	290	68 (14)	123	490	514
Count Area 13									
1983/84	27 (18)	19	---	---	85	19 (13)	65	150	150
Count Area 14									
1980/81	2 (1)	5	---	---	142	60 (29)	91	209	209
Count Area 15									
1980/81	18 (11)	17	---	---	97	27 (17)	42	159	159
Count Area 16									
1983/84	19 (7)	28	---	---	170	67 (24)	79	284	284
Count Area 17									
1982/83	23 (8)	22	---	---	187	50 (18)	113	282	282
Count Area 18									
1982/83	43 (17)	40	---	---	146	28 (11)	50	257	257

Table 1 (Cont'd)

Regulatory year	Rams[a] full curl (%)	3/4 to full-curl	1/2 to 3/4-curl	<1/2-curl	Ewes[b]	Lambs (%)	Sheep/ hour	Total sheep observed	Estimated population size[c]
Count Area 19									
1982/83	16 (13)	16	---	---	62	34 (27)	28	128	128
Count Area 20									
1980/81	28 (17)	18	---	---	80	38 (23)	61	164	164
1983/84	12 (8)	15	---	---	105	23 (15)	55	155	164
Count Area 21									
1979/80	19 (7)	na	---	---	190	58 (22)	na	267	305
1981/82	25 (8)	24	---	---	187	69 (23)	127	305	305
1982/83	27 (10)	24	---	---	186	39 (14)	126	276	305
1983/84	23 (9)	29	---	---	157	43 (17)	105	252	305
1984/85	26 (10)	na	---	---	183	41 (16)	na	250	305
Count Area 22									
1980/81	27 (11)	28	---	---	143	51 (20)	71	249	249
1983/84	33 (14)	34	---	---	125	43 (18)	94	235	249
Count Area 23-E									
1982/83	26 (33)	20	---	---	26	7 (9)	44	79	79
Count Area 23-W									
1980/81	26 (11)	14	---	---	158	49 (20)	124	247	303
1981/82	20 (7)	23	---	---	194	66 (22)	116	303	303
1983/84	21 (8)	26	---	---	168	41 (16)	160	256	303
Count Area 24									
1982/83	14 (14)	5	---	---	56	23 (23)	34	98	98

[a] Legal rams included under "Full-curl" column, Sublegal rams included under "3/4 to full-curl" column. Prior to 1989, 7/8-curl horn or larger were legal. After 1989, full-curl horn or larger were legal for sport hunting and for subsistence hunting, any ram was legal.

[b] Includes yearlings of both sexes and rams of 1/4-curl or less.

[c] Equivalent to greatest historical count for individual Count Area.

Table 2. Unit 11, Wrangell Mountains, sheep harvest, 1987-92.

Regulatory Year	Rams[a]	Average Horn Length (in)[b]	% ≥ 40 in	Ewes	Total Sheep
1987/88	124	34.3	7	0	124
1988/89	112	35.1	10	0	112
1989/90	101	35.3	7	0	101
1990/91	125[d]	35.3	7	13	138
1991/92	129[e]	34.6	8	24	163[c]

[a] Prior to 1989, rams with 7/8-curl horns or larger were legal for sport hunting. Beginning in 1989, rams with full-curl horns or larger were legal for sport hunting and any sheep was legal for subsistence hunting.
[b] Average of only "legal" rams.
[c] Includes 10 sheep not classified as to sex on 1991/92 harvest report.
[d] Includes 11 rams with less than full-curl horns.
[e] Includes 18 rams with less than full-curl horns.

Table 3. Unit 11, Wrangell Mountains, harvest numbers for adult rams and average horn lengths (in), 1986-91[a].

	1986/87		1987/88		1988/89		1989/90		1990/91		1991/92	
Region	n	Average Horn Length	n	Average Horn Length	n	Average Horn Length	n	Average Horn Length	n	Average Horn Length	n	Average Horn Length
Eastern	18	35.6	28	37.0	16	37.4	12	37.5	41	37.9	33	36.7
Middle	56	34.7	52	33.4	66	34.7	50	35.7	38	34.6	44	35.0
Western	23	32.3	27	32.4	27	33.8	37	34.1	30	33.6	30	33.3
Unknown	7	33.5	16	34.8	3	33.7	2	36.0	5	35.2	4	36.1
Total	104	34.2	123	34.2	112	34.9	101	35.3	114	35.5	111	34.1

[a] Includes only those rams for which horn length was reported on harvest report.

Table 4. Unit 11, Wrangell Mountains, sheep hunter residency and success, 1987-92.

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[a] resident	Nonlocal resident	Non resident	Total[b] (%)	Local[a] resident	Nonlocal resident	Non resident	Total[b]	
1987/88	21	53	39	124 (52)	30	71	3	115	239
1988/89	13	49	42	112 (54)	33	53	4	97	209
1989/90	14	50	20	101 (45)	27	80	7	124	225
1990/91	33	58	36	138 (49)	52	77	8	141	279
1991/92	39	89	32	163 (45)	53	128	14	203	366

[a] Includes residents of Unit 11, eastern Unit 13, and southwestern Unit 12.
[b] Includes unspecified residency.

Table 5. Unit 11, Wrangell Mountains, sheep hunting effort[a], 1986-91.

Regulatory year	Successful Hunters			Unsuccessful Hunters			Total Hunters		
	No. Hunters	Total Days	Avg. Days	No. Hunters	Total Days	Avg. Days	No. Hunters	Total Days	Avg. Days
1986	105	633	6.0	138	764	5.5	243	1,397	5.8
1987	124	600	4.8	115	630	5.5	239	1,230	5.1
1988	111	545	4.9	94	501	5.3	205	1,046	5.1
1989	101	510	5.0	122	669	5.5	223	1,179	5.3
1990	135	712	5.3	139	782	5.6	274	1,494	5.5
1991	163	766	4.7	200	955	4.8	363	1,721	4.7

[a] Includes only those hunters reporting numbers of days hunted on their report.

Table 6. Unit 11, Wrangell Mountains, sheep harvest chronology percent by time period, 1987-92[a].

Regulatory year	Harvest Periods						n[a]
	8/10-8/16	8/17-8/23	8/24-8/30	8/31-9/6	9/7-9/13	9/14-9/20	
1987/88	41	17	14	16	6	6	117
1988/89	41	20	14	9	7	9	110
1989/90	46	15	21	7	9	2	96
1990/91	34	12	16	8	15	16	129
1991/92	29	15	17	9	11	20	157

[a] Includes only reports with date of kill.

Table 7. Unit 11, Wrangell Mountains sheep harvest percent by transport method, 1987-92.

Regulatory year	Percent of Harvest								n
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	
1987/88	63	7	4	7	0	3	8	9	124
1988/89	63	5	5	5	0	5	7	11	112
1989/90	55	5	3	18	0	4	10	5	101
1990/91	47	6	4	21	0	4	17	2	138
1991/92	42	4	2	23	0	1	22	6	163

LOCATION

Game Management Units: 11, 13D, 14A and 14C (13,200 mi^2)

Geographical Description: Chugach Mountains

BACKGROUND

Dall sheep have been observed and hunted in the Chugach Mountains since at least the early 1900s. Systematic, aerial composition surveys began during the late 1940s and have continued sporadically since.

Data from aerial survey data collected over the past two years (excluding Unit 11) indicate an estimated minimum of 5,100 sheep inhabit the Chugach Mountains. They were distributed as follows: Subunit 14C - 2,400 sheep; Subunit 14A - 900 sheep; Subunit 13D - 1,400-1,500 sheep; and Unit 11 - 400 sheep. Severe winters apparently caused a 15-20% decline in the Subunit 13D population during the late-1980s.

The mean annual harvest from the Chugach Mountains over the two decades before 1989 was 120 sheep (range = 81 to 195). During the past three years the harvest has averaged 196 sheep. Nearly all the increase was because of an "any sheep" bag limit in Subunit 14C. This bag limit was initiated in 1989 because of fears that the rapidly expanding population would exceed carrying capacity.

Hunting was under a general open season in Subunits 14A and 13D where one-half of the harvest occurs. In Subunit 14C, participation was limited by drawing permit and in the Chugach Mountains portion of Unit 11, hunting was limited to local subsistence hunters under federal regulations.

MANAGEMENT DIRECTION

Management Objectives

The sheep management objective for the Chugach Mountains is to maintain a minimum harvest of 120, full-curl or larger rams.

METHODS

Activities accomplished for 1989-1991 included summer aerial sex and age composition surveys; identification and documentation of critical sheep habitat, mineral licks and lambing areas; and, monitoring the number and horn size of harvested sheep as well as

harvest location. Each year we completed aerial sex and age composition surveys in Subunit 14C. We flew partial surveys in Subunits 13D and 14A in 1990. Unit 11 data was based on surveys flown in the 1970s.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: Sheep numbers in the western Chugach Mountains (Subunit 14C) have increased 150% during the past 13 years. In Subunit 14A, sheep numbers were increasing slightly. The status of sheep populations in Subunits 13D and Unit 11 was uncertain because of the absence of recent extensive aerial surveys. However, considering recent severe winters and a limited survey, numbers of sheep were probably 15-20% below levels observed during the late 1980s in most of the Subunit 13D portion of the range.

Population Composition: Current population size and composition data were only available for Subunit 14C (Table 1). The population has remained fairly stable at 2,400 sheep for the past three years. Since 1989, the percentage of 7/8 curl and larger rams in the herd has remained stable at 10%. The percentage of young rams also remained relatively constant but the percentage of lambs fluctuated from 12 - 18%, reflecting winter conditions. Data for Subunits 14A and 13D were last obtained in 1990 (Tables 2 and 3). Unit 11 composition data have not been collected since 1973 (Table 4). A lack of recent data precludes meaningful assessment of herd composition for these populations.

Distribution and Movements: Sheep distribution and movements during summer have been documented by aerial surveys. We have determined major late-summer concentration areas from harvest records and discussions with hunters. Although sheep were found throughout the mountain range below 7,500 feet elevation, concentrations vary greatly among drainages. In Subunit 14C, the Eagle River and Eklutna-Goat Creek drainages supported the largest numbers of sheep. In Subunit 14A, moderate numbers of sheep frequented the upper reaches of Coal, Carbon, Carpenter, Wolverine, Metal, and Friday creeks. In Subunit 13D, sheep were most abundant between the Nelchina and the Klutina glaciers. In Unit 11, most sheep inhabit Hanagita Ridge and the area from the Tana River to the Yukon border.

Little is known about winter distribution patterns except that most sheep frequent relatively snow-free areas and windblown ridges above 3,000 feet elevation. Lambing areas are widely scattered and usually located close to precipitous terrain with a southern exposure. Major rutting areas are unknown.

Mortality

Harvest:

Seasons and Bag Limits. The Unit 11 season was 10 August to 20 September. The bag limit for residents was 1 sheep and for nonresidents 1 ram with full-curl horn or larger.

In Subunits 13D and 14A the season was from 10 August to 20 September. The bag limit was 1 ram with full-curl horn or larger.

In Subunit 14C, the Eklutna Lake Management Area, the season was from the day after Labor Day to 30 September. The bag limit was 1 sheep by drawing permit only, and taken by bow and arrow only.

In the remainder of Subunit 14C, the season was 10 August to 30 September and the bag limit was 1 sheep by drawing permit only; and 1 - 10 October with a limit of 1 sheep by drawing permit only, and taken by bow and arrow only.

Board of Game Actions and Emergency Orders. During spring 1989, the Board of Game passed a regulation requiring that all sheep taken in the Chugach Mountains have horns full-curl or larger, except in Subunit 14C where the bag limit was changed to "any sheep" under a drawing permit. The prior regulation allowed 7/8-curl and larger rams to be taken throughout the Chugach Mountains. The rationale, supported by the ADF&G, for the full-curl regulation was to improve trophy quality. The "any sheep" bag limit was enacted to prevent a future die-off of the large sheep population in Subunit 14C.

Hunter Harvest. Hunting pressure has remained relatively constant in the Chugach Mountains over the past 8 years, while hunter success has increased slightly. The mean harvest for 1987 and 1988 was 157 sheep (Tables 5 and 8). The mean annual harvest for 1989-1991 increased to 192 sheep. Larger harvests resulted from increased opportunity because of more sheep, additional permits and the "any sheep" bag limit in Subunit 14C. The illegal harvest was unknown.

Permit Hunts. The number of drawing permits issued in Subunit 14C has remained unchanged since 1987 (Table 8). Each year 240 general permits and 105 archery only permits were issued. Success rates and harvests were nearly identical in 1989 and 1990. Inclement weather and a decline in the number of young rams in 1991 resulted in a 17% reduced harvest.

Hunter Residency and Success. In Subunits 14A and 14C nonresident hunters took 16 of 489 sheep (3.3%) during the past 5 years (Tables 9 and 10). In Subunit 13D, nonresidents comprised 44% (155 of 353) of all successful sheep hunters over the past 5 years (Table 11). In the Unit 11 portion of the Chugach Mountains, nonresidents were excluded from sheep hunting because it was within the Wrangell-St. Elias National Park. Despite this fact, harvest records over the past 5 years indicated that 33% of the harvest (9 of 27 sheep) was taken by nonresidents (Table 12). Apparently this quasi-illegal harvest was a result of inaccurate reporting. It seems illogical that hunters or guides would report an obviously illegal kill to ADF&G.

Local residents comprised 52% of all successful sheep hunters in the Chugach Mountains in 1991, and approximately 60% of unsuccessful hunters. Nonlocal residents commonly hunted in Subunit 13D where they accounted for 49% of the subunit's 1991 harvest.

Harvest Chronology. Harvest chronology fluctuated minimally from year to year influenced by weather patterns (Table 13). Almost one-half of the harvest occurred during the initial two weeks of the season.

Transport Methods. Methods of transport used by sheep hunters in Subunit 14C have not changed substantially during the past 5 years. Approximately 80% of all successful hunters utilized highway vehicles, and 3- or 4-wheelers were used by 5-10% of successful hunters (Table 16). In Subunit 14A, transport means varied: 45% of successful hunters utilized aircraft, 25% highway vehicles, 12% boats, and 10% horses (Table 15). In Subunit 13D, over 60% of the successful hunters utilized aircraft, 15% used highway vehicles and 12% used horses.

Other Mortality. Dall sheep natural mortality is seldom documented in the Chugach Mountains. However, in areas where annual counts occur and the population remains static from year to year, natural mortality is approximately equal to the lamb increment minus hunting mortality. Lambs, yearlings, and old rams are most susceptible to natural mortality.

An estimated 430 sheep died in Subunit 14C during the severe winter of 1989-90. This was the largest winter mortality on record. Apparently the Subunit 13D population declined by 15-20% as a result of severe winter weather in 1989-90 and 1990-91. Little mortality occurred during the mild winters of 1988-89 and 1990-91.

Habitat Assessment

Techniques for evaluating sheep winter range in Alaska have not been developed. Snow depth and hardness, more so than range quality or quantity, may be the primary determinant of winter mortality. Funding for winter range evaluation during the 1989-91 period was unavailable.

CONCLUSIONS AND RECOMMENDATIONS

The sheep population in Subunit 14C appeared to level off after a decade of annual increases. Winter mortality among lambs and old ewes on crowded winter range may prevent the population from increasing further. Numbers of 7/8-curl or greater rams are expected to increase for several more years as large cohorts of young rams reach maturity.

The Subunit 14A population increased slightly, however, the number of full-curl rams will remain depressed until the new bag limit allows more rams to reach full-curl.

The status of the Subunit 13D population was uncertain. Harvests over the past five years remained unchanged, although surveys indicated a population decline. Mortality probably occurred in the youngest age classes and the few very old rams and harvests will not reflect the smaller population for another 3-4 years. There was scant information about the small Unit 11 sheep population. Harvests have declined slightly over the past 8 years.

The harvest objective of a minimum of 120 full-curl or larger rams for the Chugach Mountains was exceeded by 10 sheep in 1989, 13 sheep in 1990, and 7 sheep in 1991. These figures did not include an additional 173 sheep, including 123 rams 7/8-curl and less and 50 ewes, taken from Subunit 14C from 1989 through 1991.

A thorough survey of all sheep habitat in the Chugach Mountains is needed to determine the overall population level. If substantially more sheep are found in Subunits 13D and 14A than are thought to exist, it may be appropriate to change the harvest objective. It is also appropriate to change the harvest objective in Subunit 14C because of the "any sheep" regulation.

We monitored harvests throughout the Chugach Mountains. However, recent budget constraints precluded documenting critical habitat. Given the number of recent land use proposals, related primarily to mining in sheep habitat, we should pursue efforts to acquire funding for habitat studies within or adjacent to sheep habitat.

In spring 1989, the Board of Game adopted a full-curl regulation for the Chugach Range except Subunit 14C where any sheep was legal. The full-curl regulation appeared to work well. Harvests in Unit 11 and Subunits 13D and 14A remained stable despite a 15-20% decline in sheep numbers in Subunit 13D. However, hunters and Chugach State Park staff have expressed substantial displeasure with the Subunit 14C, any sheep bag limit.

Since 1989 over 60 young rams (2-4 years) have been killed. During the same period, 50 ewes were taken, despite being at least twice as abundant as young rams. Killing young rams diminishes the number of larger rams available for hunting and viewing in future years and does not control the size of the sheep population. A proposal should be submitted to the Board of Game to repeal the current regulation.

Prepared by:

David Harkness
Wildlife Biologist

Submitted by:

Jeff Hughes
Wildlife Biologist

Table 1. Chugach Mountains, Subunit 14C aerial sheep composition counts and estimated population size, 1987-91.

Regulatory year	Rams		Ewes[a]	Lambs (%)	Sheep/ hour	Total Sheep observed	Estimated population size
	7/8 curl(%)	1/2 to 3/4-curl					
1987/88	162 (7.5)	427	1,228	352 (16.2)	181	2,169	2,300
1988/89	204 (9.6)	379	1,219	334 (15.6)	178	2,136	2,300
1989/90	214 (8.9)	456	1,355	387 (16.0)	201	2,412	2,500
1990/91	218(10.2)	440	1,224	259 (12.1)	178	2,141	2,300
1991/92	228(10.0)	416	1,228	410 (18.0)	190	2,282	2,400

[a] Includes yearlings of both sexes and rams of 1/4-curl or less.

Table 2. Chugach Mountains, Subunit 14A sheep composition counts and estimated population size 1987-1991 (partial survey).

Regulatory year	Full curl(%)	Sublegal	Ewes[a]	Lambs (%)	Sheep/ hour	Total sheep observed	Estimated population size
1987/88[b]	--	--	--	--	--	--	--
1988/89[b]	--	--	--	--	--	--	--
1989/90[b]	--	--	--	--	--	--	--
1990/91	6(2.0)	61	168	38(22.6)	131	301	900
1991/92[b]	--	--	--	--	--	--	--

[a] Includes yearlings of both sexes and rams of 1/4-curl or less.
[b] No survey data available.

Table 3. Chugach Mountains, Subunit 13D sheep composition counts and estimated population size 1987-1991 (partial survey).

Regulatory year	Full curl(%)	Sublegal	Ewes[a]	Lambs (%)	Sheep/ hour	Total sheep observed	Estimated population size
1987/88[b]	--	--	--	--	--	--	--
1988/89[b]	--	--	--	--	--	--	--
1989/90[b]	--	--	--	--	--	--	--
1990/91	52(11.4)	51	287	68(23.7)	36	458	1,450
1991/92[b]	--	--	--	--	--	--	--

[a] Includes yearlings of both sexes and rams of 1/4-curl or less.
[b] No survey data available.

Table 4. Unit 11, Chugach Mountains sheep population status as determined from aerial surveys, 1973.

Year	Legal rams (%)	Unidentified	Lambs (%)	Total	Estimated population size
1973	53(18.8)	199	30(10.6)	282	400

Table 5. Chugach Mountains, Subunit 11 sheep harvest[a], 1987-91.

Regulatory Year	Rams	Average Horn Length (inches)	% ≥ 40"	Ewes	Total sheep
1987/88	11	38.2	27	0	11
1988/89	6	38.7	50	0	6
1989/90	2	40.5	50	0	2
1990/91	7	39.3	14	0	7
1991/92	3	38.7	0	0	3

[a] Excludes permit hunt harvest.

Table 6. Chugach Mountains, Subunit 13D sheep harvest[a], 1987-91.

Regulatory Year	Rams	Average Horn Length (inches)	% ≥ 40"	Ewes	Total sheep
1987/88	77	34.6	4	0	77
1988/89	73	34.7	8	0	73
1989/90	71	35.2	6	0	71
1990/91	74	36.5	11	0	74
1991/92	69	37.0	7	0	69

[a] Excludes permit hunt harvest.

Table 7. Chugach Mountains, Subunit 14A sheep harvest[a], 1987-91.

Regulatory Year	Rams	Average Horn Length (inches)	% ≥ 40"	Ewes	Total sheep
1987/88	34	35.4	9	0	34
1988/89	27	33.8	0	0	27
1989/90	23	35.1	0	0	23
1990/91	16	35.7	13	0	16
1991/92	26	36.2	8	0	26

[a] Excludes permit hunt harvest.

Table 8. Chugach Mountains, Subunit 14C sheep harvest data by permit hunt, 1987-91.

Hunt Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Rams	horn length (inches)	# rams % ≥ 40"	Ewes (%)	Unk	Total harvest
Goat,	1987/88	75	33	70	30	15	33.0	0	0	0	15
Pioneer,	1988/89	75	24	80	20	11	35.4	0	0	0	11
Eklutna,	1989/90	60	13	48	52	24	33.0	0	3	0	27
Hunter,	1990/91	75	19	39	61	34	32.8	0	2	0	36
Lk George	1991/92[a]	105	16	53	47	28	33.2	1	8	5	41
Peters,	1987/88	45	20	75	25	9	33.3	0	0	0	9
Thunderbird	1988/89	45	42	69	31	8	35.3	2	0	0	8
N. Eagle	1989/90	60	20	50	50	21	29.3	1	6	0	27
	1990/91	60	20	54	46	10	33.6	0	3	0	22
	1991/92[b]	18	17	62	38	4	35.5	0	1	0	5
S. Eagle	1987/88	60	28	67	33	14	34.6	0	0	0	14
Bird	1988/89	60	33	75	25	10	35.8	1	0	0	10
Ship	1989/90	60	23	54	46	20	31.6	0	4	0	24
	1990/91	45	29	47	53	13	31.7	0	2	1	16
	1991/92	75	27	64	36	17	32.4	0	3	0	20
Late Season	1987/88	60	58	96	4	1	38.3	0	0	0	1
all hunt	1988/89	60	27	77	23	9	36.5	1	0	0	9
areas-	1989/90	60	25	53	47	16	31.7	1	1	0	17
rifle	1990/91	60	33	50	50	16	33.7	1	6	1	24
	1991/92	30	17	64	36	8	28.7	0	1	0	9

Table 8. (Continued.)

Hunt Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Rams	horn length (inches)	# rams % ≥ 40"	Ewes (%)	Unk	Total harvest
Late Season	1987/88	80	64	100	0	0	--	--	0	0	0
all hunt	1988/89	80	60	94	6	3	35.5	1	0	0	3
areas-	1989/90	80	48	88	12	2	24.9	0	1	0	3
archery	1990/91	80	35	98	2	0	--	0	1	0	1
	1991/92	80	24	95	5	0	--	0	3	0	3
Eklutna	1987/88	25	48	100	0	0	--	--	0	0	0
Archery	1988/89	25	44	64	36	5	36.3	0	0	0	5
	1989/90	25	16	90	10	2	33.6	0	0	0	2
	1990/91	25	8	83	17	2	32.2	0	2	0	4
	1991/92	25	8	78	22	2	38.7	0	3	0	5
Total all	1987/88	345	43	80	20	39	33.8	0	0	0	39
areas	1988/89	345	38	78	22	46	35.8	3	0	0	46
	1989/90	345	26	61	39	85	31.2	2	15	0	100
	1990/91	345	26	61	39	84	33.0	1	16	1	101
	1991/92	345	25	52	48	59	32.8	1	19	5	83

[a] Includes Peters and Thunderbird.
[b] N. Eagle only.

Table 9. Chugach Mountains, Subunit 14A sheep hunter[a] residency and success, 1987-91.

Regulatory year	Successful				Unsuccessful				Total[c] hunters
	Local[b] resident	Nonlocal resident	Nonresident	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Total (%)	
1987/88	29	1	4	27	81	7	2	73	126
1988/89	23	1	2	24	78	4	1	76	115
1989/90	19	0	3	23	72	1	2	77	104
1990/91	9	2	3	16	65	5	2	84	94
1991/92	19	3	4	27	67	2	1	73	97

[a] Excludes hunters in permit hunts.
[b] Local means residents of Unit 14.
[c] Total exceeds sum because some hunters fail to report residency.

Table 10. Chugach Mountains, Subunit 14C sheep hunter residency and success, 1987-91.

Regulatory year	Successful				Unsuccessful				Total[b] hunters
	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	
1987/88	36	3	0	19	135	24	2	81	200
1988/89	39	6	1	18	155	6	0	82	255
1989/90	85	12	2	39	142	9	1	61	254
1990/91	91	8	1	39	129	24	1	61	256
1991/92	73	8	2	31	166	19	1	69	269

[a] Local means residents of Unit 14.
[b] Total exceeds sum because some hunters fail to report residency.

Table 11. Chugach Mountains, Subunit 13D sheep hunter residency and success, 1987-91.

Regulatory year	Successful				Unsuccessful				Total[b] hunters
	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	
1987/88	4	43	24	31	21	120	16	69	243
1988/89	0	42	26	31	17	124	27	69	230
1989/90	1	36	40	41	7	88	14	59	194
1990/91	3	34	32	36	5	107	12	64	199
1991/92	2	33	33	31	11	111	29	69	221

[a] Local means residents of Unit 13.
[b] Total exceeds sum because some hunters fail to report residency.

Table 12. Chugach Mountains, Unit 11 sheep hunter residency and success, 1987-91.

Regulatory year	Successful				Unsuccessful				Total[b] hunters
	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	
1987/88	0	7	3	83	0	1	1	17	14
1988/89	0	6	0	60	0	2	1	40	10
1989/90	0	2	0	50	0	2	0	50	4
1990/91	0	2	5	78	0	2	0	22	9
1991/92	0	2	1	43	0	4	0	57	7

[a] Local means residents of Unit 11.
[b] Total exceeds sum because some hunters fail to report residency.

Table 13. Chugach Mountains, Unit 11 and Subunits 13D and 14A sheep harvest chronology percent by time period, 1987-91.

Regulatory year	Harvest periods						n
	8/10-8/16	8/17-8/23	8/24-8/30	8/31-9/6	9/7-9/13	9/14-9/20	
1987/88	43	18	12	12	8	7	106
1988/89	25	26	21	10	9	9	97
1989/90	42	15	13	15	13	4	101
1990/91	36	15	17	7	9	16	95
1991/92	30	17	17	11	10	15	96

Table 14. Chugach Mountains, Subunit 13D sheep harvest percent by transport method 1987-91.

Regulatory year	Percent of harvest								n
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	
1987/88	58	12	5	5	0	0	20	--	76
1988/89	72	7	7	0	0	3	10	--	69
1989/90	60	13	4	1	0	1	21	--	78
1990/91	61	19	3	1	0	1	14	--	72
1991/92	67	9	6	5	0	2	11	--	64

Table 15. Chugach Mountains, Subunit 14A sheep harvest percent by transport method 1987-91.

Regulatory year	Percent of harvest								n
	Airplane	Horse	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	
1987/88	44	6	22	0	0	0	28	--	32
1988/89	46	12	4	15	0	4	19	--	26
1989/90	32	16	21	11	0	5	16	--	19
1990/91	40	13	7	7	0	13	20	--	15
1991/92	48	4	4	0	0	9	35	--	23

Table 16. Chugach Mountains, Subunit 14C sheep harvest percent by transport method 1987-91.

Regulatory year	Percent of harvest								n
	Airplane	Horse	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	
1987/88	3	3	6	6	0	0	82	--	33
1988/89	2	4	4	9	0	2	78	--	46
1989/90	0	2	3	3	0	4	88	--	96
1990/91	2	5	5	11	0	2	74	--	92
1991/92	9	4	1	4	0	3	80	--	79

LOCATION

Game Management Unit: Portions of 12 (10,000 mi^2)

Geographical Description: Mentasta, Nutzotin, and Northern Wrangell Mountains

BACKGROUND

The sheep population in the northern Wrangell, Mentasta, and Nutzotin (WMN) mountains exists at relatively high densities in rugged, glaciated habitats. The WMN mountains sheep population produces rams with horns of below average size, compared with other sheep populations in Alaska (Heimer and Smith 1975). The relative abundance of sheep and production of rams with slightly less than average-sized horns suggest that conservative harvest for maximum trophy production would be an unsuitable management strategy for consumptive use in Unit 12 (Kelleyhouse and Heimer 1989). Consequently, the consumptive use goal for Unit 12 is to provide the greatest opportunity to participate in hunting sheep. No restrictions beyond limiting harvest to full-curl rams during the fall hunting season and requiring hunting licenses and harvest tickets are applied in Unit 12 (excluding the Tok Management Area). The evolution of these restrictions was presented by Kelleyhouse and Heimer (1989).

MANAGEMENT DIRECTION

Management Goals

Management goals for area Dall sheep are to: 1) protect, maintain, and enhance the sheep population and its habitat in concert with other components of the ecosystem; and 2) provide for diversified human recreational use of sheep in the WMN mountains.

Management Objectives

Management objectives for area Dall sheep are to: 1) manage for maintenance of a population of approximately 12,000 sheep; and 2) provide the greatest opportunity to participate in hunting sheep.

METHODS

Staff collected and analyzed harvest data and conducted aerial surveys during this report period. The Mentasta Mountains were surveyed through a cooperative effort by ADF&G, National Park Service (NPS), USFWS, and the Tetlin Native Corporation. The NPS also

did aerial surveys between 1990 and 1992 within portions of the Wrangell-St. Elias National Park and Preserve (northern Wrangells).

RESULTS AND DISCUSSION

Population Status and Trend

Kelleyhouse and Heimer (1990) reported that the sheep population was stable in 1988. Heimer (1988) found that Dall sheep populations tend toward stability under average prevailing climatic conditions. Between 1988 and 1991, no abnormally severe winters occurred. The NPS flew three aerial surveys, but it is difficult to determine trend of the population from their data. Local guides and area residents believe that during the past 2 years the WMN sheep population has declined. These people live among this sheep population and observe it throughout the year. They believe that the number of ewes has drastically declined and lamb production is low. The cause of the decline, they believe, is wolf and coyote predation. I received numerous reports of coyotes chasing lambs and ewes; a few people observed kills.

Population Composition:

Table 1 contains composition survey results. During the 1987 survey, lamb:ewe and ram:ewe ratios and percent lambs in the population were 38:100, 57:100, and 19%, respectively. During 1991, the lamb:ewe and ram:ewe ratios and the percent lambs in the population were 18:100, 42:100, and 10%, respectively. Lamb production remained low in 1992 with 19:100 ewes.

Population composition varies from year to year, depending on lamb production, yearling recruitment, and adult mortality. These parameters are directly influenced by weather, natural predation, and hunting management (Heimer 1988). Winter conditions were not unusual through the report period, but spring 1992 was unusually cold and deep snow conditions persisted late into June. Harvest remained constant with no significant increase ($P > 0.3$) in hunter numbers or in the success rate (Fig. 1). I have no estimates of predator densities in the WMN mountains, but trapper questionnaires, incidental sightings by ADF&G personnel, and public reports indicate that the coyote population in this area appears to have increased substantially and may be negatively impacting lamb survival.

Distribution and Movements:

There are no data that suggest distribution and movements are different than reported by Kelleyhouse and Heimer (1989).

Mortality

Harvest:

Season and Bag Limit. Open season for residents and nonresidents is 10 August to 20 September. Bag limit is one ram with full-curl horn or larger or with both horns broken.

Board of Game Actions and Emergency Orders. No changes in regulations occurred during the report period.

Hunter Harvest. During 1991, 491 hunters reported taking 272 sheep (256 full-curl rams, 1 ewe, and 15 unknown), exceeding the 5-year mean of 241 sheep (Table 2). The higher harvest probably resulted from excellent weather during hunting season and a slight increase in hunter numbers. Hunter numbers in 1991 exceeded the 5-year mean of 453.

Mean horn length was 34.3 inches, similar to the 5-year mean of 34.2 inches. Only two rams were taken with horns greater than 40 inches (<1%). The mean reported age of harvested rams was 8.7 years, which is typical for this area. In contrast, in the Tok Management Area, located just north of the WMN Mountains, the percentage of the harvested rams with horns >40 inches was 17 and the average reported age was 8.9 years.

Hunter Residency and Success. Of the 491 hunters in 1991, 111 were nonresidents (23%), 40 were unit residents (8%), and 340 were other state residents (Table 3). Success rates were 83%, 43%, and 48% for nonresidents, unit residents, and other state residents, respectively. Overall, the hunter success rate in 1991 was 55%, slightly exceeding the 5-year mean of 53%.

Harvest Chronology. Traditionally, in the WMN Mountains most sheep are taken early in the hunting season (Table 4). In 1991, 61% of the harvest was taken during the first 2 weeks of the season. This is typical for the WMN Mountains.

Transport Methods. In Unit 12, airplanes and horses are the primary modes of transportation for sheep hunters (Table 5). In 1991, of the 263 successful hunters reporting their transportation methods, 151 (57.4%) used aircraft and 59 (22.4%) used horses. Success rates for hunters using aircraft and horses were 63.1% and 86.8%, respectively, while the overall success rate was 55%.

Other Mortality:

No studies were conducted during this report period to determine if any changes occurred in the rate or type of natural mortality from what was reported by Kelleyhouse and Heimer (1989). Reports from members of the public indicate that predation by coyotes may be an increasingly significant source of mortality. During 1992, local residents and guides reported numerous sightings of coyotes chasing ewes and lambs; in several

incidents they witnessed a coyote killing sheep. Trapper questionnaires and incidental sightings by ADF&G personnel indicate coyote numbers in the WMN mountains have increased substantially during the past 5 years.

During the last 2 years, lamb survival has been low with 18 to 19 lambs:100 ewes by July. By comparison, calf survival in the sympatric Chisana caribou herd ranged from 0 to 1 calf:100 cows the past 2 years. Environmental conditions have not been favorable the past 2 years, but weather alone probably does not account for the magnitude of the lamb and calf mortality in this area. Predators may be having a much larger effect on sheep and caribou populations in the area compared with the 1980s. Additional research is necessary to determine causes and rates of mortality in the WMN mountains.

Habitat

Assessment:

The WMN Mountains are glaciated and offer steep, rugged terrain with excellent escape cover in close proximity to feeding areas dominated by *Dryas* spp. Human development has not substantially affected sheep habitat in the WNM mountains and the present land ownership pattern is expected to protect most sheep habitat in the future.

Enhancement:

No habitat enhancement for sheep is planned for the WMN Mountains.

CONCLUSIONS AND RECOMMENDATIONS

The management goals and objectives for Dall sheep in Unit 12 are being met. The number of hunters utilizing area sheep is high, averaging 453 hunters annually the past 5 years, and success rate remains between 52% and 55%. Harvest may decline after 1996 because of poor lamb production during the past 2 years. If the WMN sheep population is suffering from the same mortality factors as the sympatric Chisana caribou herd, lower lamb production may have begun as early as 1990.

The WMN mountains offers a unique research opportunity to study causes of natural mortality for both sheep and caribou. The sheep population is affected somewhat by human harvest, but the predator and caribou populations are close to being naturally regulated. Research in this area would help determine future management direction.

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Prepared by:

Craig L. Gardner
Wildlife Biologist III

Submitted by:

Kenton P. Taylor
Management Coordinator

Reviewed by:

Kenneth R. Whitten
Wildlife Biologist III

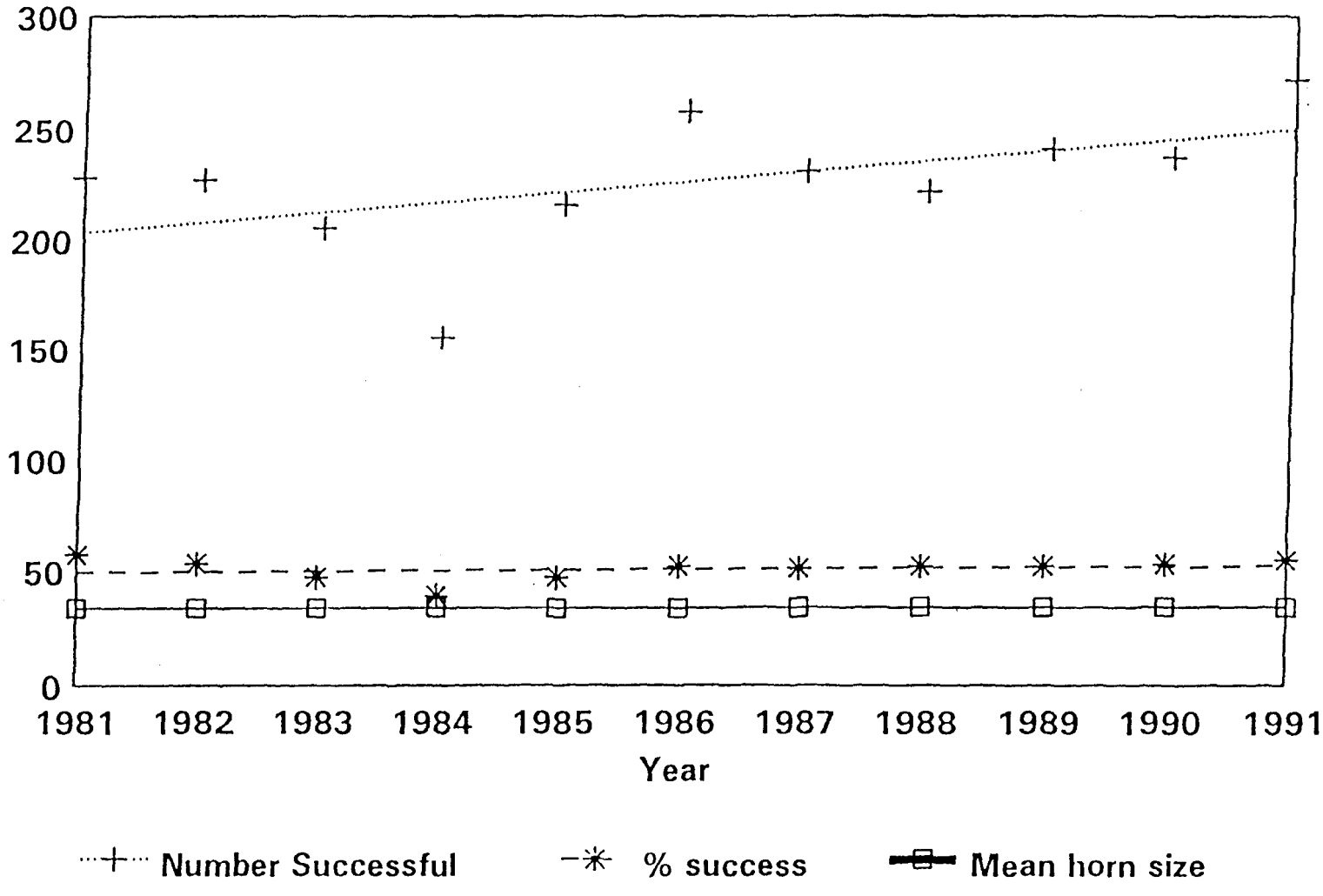

Figure 1. Unit 12 Sheep Harvest, 1981-1991.

Table 1. Unit 12 Dall sheep composition counts from aerial surveys conducted by Alaska Department of Fish and Game and National Park Service, 1987-92.

Sex/age class	1987	1991	1992
Legal rams[a]	79	--	31
Sublegal rams[b]	386	--	140
Unclassified rams	8	--	30
Total rams	473	174	201
Ewes[c]	825	416	440
Lambs	312	75	83
Unidentified	49	57	0
Total other sheep	1,186	548	523
Total sheep	1,659	722	724
Legal rams:100 ewes	9.6	--	7.1
Sublegal rams"100 ewes	46.8	--	31.8
Total rams:100 ewes	57.3	41.8	45.7
Lambs:100 ewes	37.8	18.0	18.9
Lambs % of total	18.8	10.4	11.5

[a] Full curl or larger.
[b] Greater then 1/4 curl but less than full curl.
[c] Ewe classification also includes yearlings of both sexes and rams of 1/4 curl or less.

Table 2. Unit 12 annual sheep harvest, 1987-91.

Year	Rams	$\bar{x}$ Horn length	$\bar{x}$ Age	Total sheep	# Hunters
1987	231	34.0	8.4	231	435
1988	222	34.3	8.7	222	427
1989	241	34.1	9.1	241	464
1990	237	34.4	--	237	448
1991	272	34.3	8.7	272	491

Table 3. Unit 12 annual sheep hunter residency and success, 1987-91.

	Successful				Unsuccessful				
Year	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	Total hunter[b]
1987	--	128	60	186 (51)	--	168	12	180 (49)	366
1988	--	145	73	218 (57)	--	152	12	164 (43)	382
1989	20	151	85	256 (52)	16	204	17	237 (48)	493
1990	12	129	83	224 (52)	28	159	16	203 (48)	427
1991	17	159	92	268 (55)	23	173	19	215 (45)	483

[a] Game Management Unit resident.
[b] Total hunters exclude hunters who did not report residency.

Table 4. Unit 12 annual sheep harvest chronology percent n by time period, 1987-91.

	Harvest dates						
Year	8/10-8/16	8/17-8/23	8/24-8/30	8/31-9/6	9/7-9/13	9/14-9/20	n
1987	37 (78)	--	--	--	--	--	231
1988	40 (87)	23 (50)	--	--	--	--	222
1989	39 (90)	16 (36)	17 (40)	14 (32)	9 (20)	6 (14)	232
1990	43 (99)	20 (47)	12 (27)	10 (24)	7 (17)	7 (16)	230
1991	40 (108)	21 (57)	8 (21)	13 (35)	12 (32)	5 (14)	267

Table 5. Unit 12 annual sheep harvest percent by transport method, 1987-91.

Year	Airplane	Horse	Boat	3-or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	n
1987	56	16	5	5	0	1	16	12	231
1988	62	19	4	3	0	0	11	12	210
1989	55	22	1	5	0	2	15	0	280
1990	53	21	2	9	0	2	16	1	266
1991	56	22	4	5	0	2	9	3	272

LOCATION

Game Management Units: Portions of 12, 13, and 20 (1,500 mi^2)

Geographical Description: Tok Management Area

BACKGROUND

The Tok Management Area (TMA) was created in 1974 to provide sheep hunters additional opportunity to harvest large-horned, trophy Dall sheep rams. This objective is the primary consumptive use aspect of a management goal to provide for diversified human recreational use in this area (Kelleyhouse 1989). The TMA is known for producing fast-growing, large-horned rams (Heimer and Smith 1975).

Sheep harvest in the TMA is managed by controlling hunter numbers through a limited entry drawing-permit system. This system keeps annual harvests low enough to allow some rams to attain their maximum potential horn size. Harvests are also restricted to rams with at least full-curl horns. This system has been successful, and the primary human-use objective (ADF&G 1976) of providing an opportunity to take large rams is currently being achieved.

A secondary management objective of providing the opportunity to hunt sheep under aesthetically pleasing conditions is being attained through this limited-entry drawing-permit system. Maintaining low hunter density has created a situation of high legal ram abundance and presence of large trophy rams and has allowed for the maintenance of varied opportunities for access to the area and other high-quality hunting experience components. A more complete history of management in the TMA is available in Kelleyhouse (1989).

MANAGEMENT DIRECTION

Management Goals

Management goals for Dall sheep in the Tok Management Area are to 1) provide for diversified recreational uses of wildlife, 2) provide for the opportunity to be selective in hunting, and 3) provide an opportunity to hunt under aesthetically pleasing conditions.

Management Objectives

Management objectives for Tok Management Area Dall sheep are to 1) maintain a population capable of allowing hunters to be selective in harvesting 30-45 rams each year,

2) maintain a mean horn length of 36-37 inches among harvested rams as well as a mean age of 8-9 years, 3) maintain an average of 7-10% rams with 40-inch or greater horns in the harvest, and 4) prevent unacceptable increases in hunter concentration and maintain the existing aesthetically pleasing qualities associated with sheep hunting in the TMA.

METHODS

Harvest was monitored through drawing permit reports. Staff analyzed data on harvest success, hunt area, hunter residence and effort, transportation type, horn size, and age.

We estimated population composition and productivity of the TMA sheep population from surveys conducted at the Sheep Creek mineral lick during June and July. We classified all sheep visiting the lick were classified and identified any marked individuals. We classified rams as 1/4, 1/2, 3/4, 7/8, or full curl or larger. Other sheep we classified as ewes, yearlings, or lambs. No aerial surveys were conducted during the report period.

A serologic survey of TMA sheep was continued during July 1992. We captured ewe sheep at the Sheep Creek lick and blood samples were taken. The objective of the study was to determine the occurrence of bacterial disease in TMA sheep.

RESULTS AND DISCUSSION

Population Status and Trend

Under normal environmental conditions, sheep populations in Interior Alaska are generally stable (Heimer 1988). Winter severity in the TMA has been mild to average the past 5 years. Temperatures were well below normal during spring 1992 and were accompanied by numerous snowstorms. During summers 1990 and 1991 ambient temperatures were higher and the amount of rainfall lower than average. Limited age structure data collected at the Sheep Creek lick suggest that the adult mortality rate decreased during this period. If this is the case, the TMA population may be slightly higher in comparison with the late 1980s when it was estimated to be about 2,000 sheep (Kelleyhouse 1989).

Population Composition:

Volunteers under the supervision of biologist Wayne Heimer (ADF&G) classified 898 sheep between 20 June and 7 July 1992 (Table 1). The 1992 lamb:ewe and yearling:ewe ratios were 17:100 and 24:100, respectively. The 1992 lamb:ewe ratio is substantially below the 1974-86 mean of 49:100. The low lamb crop is probably because of a combination of inclement spring weather and a higher than normal proportion of old ewes in the population. The 1992 yearling:ewe ratio was slightly lower than the 1974-86 mean ratio of 28:100. Ram:ewe ratios cannot be calculated from data collected at the Sheep

Creek lick because the dynamics of ram use of licks is not currently known. However, the population is thought to be minimally affected by the limited harvest of full-curl rams.

Distribution and Movements:

Heimer and Watson (1986) summarized movement and distribution data of ewes in the TMA. No further data on distribution and movements were collected during this report period.

Mortality

Harvest:

Season and Bag Limit. Harvest is restricted to one full-curl ram every 4 regulatory years by drawing permit only. Rams must have at least one full-curl horn or both horns broken. Up to 120 permits may be issued.

Board of Game Actions and Emergency Orders. No actions by the Board of Game or emergency orders affected the TMA during this report period.

Hunter Harvest. During 1991, hunters reported taking 52 full-curl rams in the TMA, exceeding the previous 5-year mean of 45 (Table 2). The higher harvest is probably a result of excellent weather during the hunting season and an increase in hunter participation. The 1991 participation rate was 77% compared with the 5 previous year's mean of 68%.

Mean horn length during 1991 was 36.9 inches, similar to the previous 5-year mean of 36.6 inches (Table 3). Nine rams (17%) had horns greater than 40 inches. This value is comparable with the 1990 harvest and higher than the average between 1987 and 1989 (10%). However, the proportion of >40-inch rams shot in 1990 and 1991 is not significantly higher than in 1987-89 ($\bar{x} = 2.4$). The average reported age of rams harvested was 8.9, equaling the 5-year mean. The mean horn length and age of harvested rams and the percentage of harvested rams exceeding 40 inches continue to meet or exceed the harvest management objectives.

Hunter Residency and Success. There were 1,949 applicants for the 120 available permits in 1991 (6.2% chance of being drawn). This represents a 10% annual increase in the number of applicants since 1988 and a decrease of the probability of being drawn from 1 in 12 to 1 in 16. Alaskan residents were responsible for 96% of the 1991 harvest (Table 4). Only five nonresidents participated in the hunt. The 1991 overall success rate was 56%, which is higher than 1990 (44%), but the combined success for 1990 and 1991 was significantly lower ($\bar{x} = 7.07$, $P < 0.05$) than the mean annual success rate during 1987 to 1989 (64%). The causes for the decline in success are not known; however, a slight decline in hunter effort occurred between 1988 and 1990.

Transport Methods. Airplanes and highway vehicles are the primary methods of transport into the TMA (Table 5). During 1991, 91% of all hunters used one of these two methods to access the area. Since 1987, average success rates for hunters using aircraft and highway vehicles for access have been 63% and 28%, respectively, while the overall success rate was 56%.

Harvest Chronology. Traditionally, the greatest harvest occurs early during the sheep season. During 1991, 56% of the harvest occurred during the first 10 days (10-20 August) of the season. Only 14% of the harvest occurred during the last 10 days of the season (10-20 September).

Other Mortality:

Severe winter weather and predation appear to be the most important natural mortality factors for Dall sheep (Murie 1944, Heimer and Watson 1986). Winter conditions in the TMA the past 5 years have been mild to average and have not negatively affected the overwinter mortality rate. Based on limited numbers of marked animal resightings, it appears that overwinter survival has recently been high. The late spring conditions during 1992 appear to have negatively affected the lamb cohort.

The effects of wolf predation on the TMA sheep population may have increased between 1989 and 1991. During this time, the Nelchina caribou herd wintered within the eastern half of the TMA. Based on trapper reports, the wolf population apparently increased during this time. Dall sheep are not normally a preferred prey for wolves; however, this larger population of wolves in the TMA may be having a greater impact on the sheep population, especially once the caribou migrate out of the area. I have received numerous reports of hunters finding extensive wolf sign in sheep habitat and wolf scats that appeared to contain sheep hair. Nevertheless, with the exception of low lamb survival during late spring 1992, overall sheep survival appears to have been high during this report period.

Presently, disease and accidents are not causing significant mortality and have little impact on the TMA's population trend.

Habitat

Assessment:

The TMA may be characterized as rugged, glaciated terrain with *Dryas* dominated habitats prevalent at elevations below 5,000 feet. Mixed bunch-grass and forb communities are also important to TMA sheep. In winter, windblown ridges are important when the sheep feed primarily on browse species and lichen (Heimer 1983).

The largest threat to TMA sheep habitat is the possibility of mining development. The upper Tok River and Rumble Creek drainages are mineralized areas and could be developed. Coordination with Habitat Division to minimize effects of any development will occur if any such plans materialize.

Enhancement:

No habitat enhancement for sheep is planned for the TMA.

CONCLUSIONS AND RECOMMENDATIONS

The sheep population in the TMA is probably comparable with the 1988 estimate of 2,000 sheep. Harvest has had little effect on the population, and the TMA continues to provide unique opportunities for hunters to seek large-horned rams under aesthetically pleasing conditions. Inclement weather during spring 1992 negatively influenced lamb production. This loss of a cohort will cause a decline in trophy ram recruitment in about 8 years, but should not cause a significant problem to the management objective as long as lamb production returns to normal. Management objectives are presently being met, making changes in the hunt format unnecessary.

To fully manage the TMA, additional information is necessary. The effects of trophy hunting on the ram population have not been evaluated nor the population estimated since 1980. Because the use of mineral licks by rams is not comparable with use by ewes, the trend in the ram population cannot be determined by composition data collected entirely at licks. Only aerial surveys can give an accurate indication of the ram trend and the effects of trophy management. Periodic aerial surveys may be necessary to supplement or replace mineral lick composition surveys if population trend of the TMA's sheep population is to be meaningfully tracked.

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Prepared by:

Craig L. Gardner
Wildlife Biologist III

Submitted by:

Kenton P. Taylor
Management Coordinator

Reviewed by:

Kenneth R. Whitten
Wildlife Biologist III

Table 1. Tok Management Area Dall sheep composition data collected from the Sheep Creek mineral lick, 1988-92.

Year	Full-curl rams (%)	3/4- to full-curl rams (%)	1/2- to 3/4-curl rams (%)	<1/2-curl rams (%)	Ewes	Lambs (%)	Total sheep	Sheep/ hour	Estimated population size
1988	0 (0)	1 (1)	1 (2)	7 (10)	56 (76)	35 (47)	136	--	--
1989									
1990	1 (3)	6 (19)	5 (17)	15 (52)	44 (150)	29 (98)	339	--	--
1991	3 (2)	3 (2)	5 (4)	5 (4)	52 (38)	19 (14)	73	--	--
1992	2 (22)	6 (53)	5 (45)	7 (67)	56 (506)	9 (85)	898	--	--

Table 2. Harvest of Dall sheep rams in the Tok Management Area, 1987-91.

Hunt No. /area	Year	Permits issued	Did not hunt %	Unsuccessful hunter %	Successful hunter %	horn length	% ≥ 40"	Total harvest
1102	1987	120	48	34	66	36.1	3 (7)	41
	1988	120	29	39	61	36.6	6 (12)	52
	1989	120	27	36	64	36.4	6 (11)	56
	1990	120	28	56	44	37.0	6 (17)	36
	1991	120	23	44	56	36.9	9 (17)	52

Table 3. Tok Management Area annual sheep harvest, 1987-91.

Year	Rams	Mean Horn length	No. ≥40" (%)	Mean Age	Ewes	Total sheep
1987	41	36.1	3 (7)	8.6	0	41
1988	52	36.6	6 (12)	8.8	0	52
1989	56	36.4	6 (11)	8.9	0	56
1990	36	37.0	6 (17)	9.2	0	36
1991	52	36.9	9 (17)	8.9	0	52

Table 4. Tok Management Area annual sheep hunter residency and success, 1987-91.

	Successful				Unsuccessful				
Year	Local resident	Nonlocal resident	Nonresident	Total (%)	Local resident	Nonlocal resident	Nonresident	Total (%)	Total hunter
1987	--	--	0	41 (66)	--	--	0	21 (34)	62
1988	--	--	3	52 (61)	--	--	1	33 (39)	85
1989	1	54	1	56 (64)	0	30	2	32 (36)	88
1990	2	31	3	36 (44)	3	43	0	46 (56)	82
1991	3	47	2	52 (56)	0	38	3	41 (44)	93

Table 5. Tok Management Area annual sheep harvest percent (n) by transport method, 1987-91.

Year	Airplane	Horse	Boat	3-or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	n
1987	76 (31)	0	2 (1)	5 (2)	0	2 (1)	15 (6)	0	41
1988	62 (32)	2 (1)	0	0	0	7 (4)	29 (15)	0	52
1989	59 (33)	2 (1)	0	2 (1)	0	2 (1)	32 (18)	3 (2)	56
1990	53 (19)	0	0	8 (3)	0	3 (1)	36 (13)	0	36
1991	63 (33)	2 (1)	0	0	0	6 (3)	27 (14)	2 (1)	52

LOCATION

Game Management Subunits: 13A, 13E, 14A (north), and 14B (14,849 mi^2)

Geographical Description: Talkeetna Mountains and Chulitna-Watana Hills

BACKGROUND

Sheep populations in the Talkeetna Mountains and Chulitna-Watana Hills (TCW) were believed to have increased rapidly from low numbers before 1950, reaching peak densities during the late 1960s (McIlroy 1976). Trend counts in part of the area suggested populations fluctuated slightly before peaking again during the 1980s.

Most of the area sheep habitat was aerially surveyed in 1974, large scale composition surveys were not conducted before this time. Survey results near peak densities in the 1980s produced a population estimate for TCW which approached 2,500 sheep (Grauvogel 1990). Included in that estimate were 200 sheep in the Sheep Mountain Closed Area, which has been closed to hunting since the 1940s.

Minimum sheep harvest data has been collected from hunter harvest reports since 1967. The reported harvest peaked at 118 during 1969 and again in 1986. A peak at 114 rams occurred during 1974 after a low of 61 rams taken in 1973. Harvests reached similar lows during 1977 and 1983.

Sheep harvest has been restricted to adult rams since statehood. Mean annual harvest under a 3/4-curl horn minimum regulation, 1967-1978, was 90 rams. Under a 7/8-curl horn minimum, 1979-1988, the annual harvest averaged 87 rams.

MANAGEMENT DIRECTION

Management Goals

The management goals for sheep populations in the TCW are to provide the greatest opportunity to participate in hunting sheep (Unit 14); to provide an opportunity to hunt sheep under aesthetically pleasing conditions (Unit 13); and to provide an opportunity to view, photograph and enjoy sheep (Sheep Mountain Closed Area).

Management Objective

The management objective for TCW sheep is to maintain sheep populations that will sustain an annual harvest of 75 rams.

METHODS

We monitored sheep harvest from harvest reports. Hunters were required to report within 15 days of the close of the season or within 15 days of killing a sheep. Days hunted, method of take, date of kill, location of kill, transportation used, length of horns and age of sheep were noted on the harvest report. We assumed that the number of sheep killed but not reported was small.

We did not conduct sex and age composition or identify critical habitat (mineral licks and lambing areas).

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

Hunter reports did not indicate any major changes in TCW sheep numbers. The mean annual harvest of 83 full-curl rams during 1989-1991, and the constant hunter success rate (23-24%) suggested population stability. The population was estimated at between 2,000 and 2,700 sheep (Table 1).

Mortality

Harvest:

Season and Bag Limit. The hunting season in Game Management Subunits 13A, 13E, 14A and 14B for regulatory years 1989/90 through 1991/92 was 10 August-20 September. The bag limit was 1 ram with a full-curl horn or larger.

Board of Game Actions and Emergency Orders. Minimum horn size for a legal ram was increased by the Board of Game beginning in the 1989/90 regulatory year. The minimum horn size was increased from 7/8-curl to full-curl.

Hunter Harvest. The change in minimum horn size caused, as expected, a temporary reduction in hunter harvest followed by a steady increase. The reported hunter harvest in 1989 declined to 75 full-curl rams following a year (1988) when 105 7/8-curl rams were harvested (Table 2). The harvest increased to 91 full-curl rams by fall 1991.

Minimum horn size regulations also appeared to cause an increase in mean horn length of rams harvested. The mean horn size was 33.2 inches (Table 3) before the full-curl regulation and 34.4 inches following the change. This happened despite fewer rams with horn lengths of 40 inches or greater being harvested (Table 3).

Hunter Residency and Success. The regulatory change in minimum horn size affected hunters' success rates. The resident hunters' success rate declined following the change in minimum horn size. Resident hunters' success dropped from 26% to 17% (Grauvogel 1990). The nonresident hunters' success rate increased slightly from 68% before the change, to 72% after the increase in minimum horn size (Grauvogel 1990).

During the period of full-curl minimums, 1989-1991, success of all hunters averaged 23% (Table 2). Grauvogel (1990) reported a mean success rate for all hunters of 30% during the 6 years preceding the regulation change.

The decline in the success rate after the regulation change coincided with an increase in participation by resident hunters. The mean annual number of nonresident sheep hunters remained stable at 40 (before and after the change), while the mean annual number of resident hunters increased from 197 to 297 (Grauvogel 1990) (Table 2). The total number of hunters (375) during 1991 represented a record high for TCW.

Harvest Chronology. The number of sheep harvested during the first 2 weeks of the hunting season continued to increase. During 1989-1991, 61% of the sheep taken were killed during the first 2 weeks of the season (Table 4). During 1983-1988, approximately 40% of the sheep harvested were killed during the first two weeks (Grauvogel 1990).

Transport Methods. The percentage of sheep harvested by hunters using 3- or 4-wheelers doubled since 1988. Grauvogel (1990) reported 14-16% of successful hunters used 3- or 4-wheelers during 1985-1988. During 1989-1991, 29% of successful hunters used these vehicles (Table 5). Concurrently, the percentage of hunters reportedly using highway vehicles declined, while those using aircraft or horses remained high (Table 5).

CONCLUSIONS AND RECOMMENDATIONS

The mean annual harvest of rams under the full-curl minimum requirement during 1989-1991 was 83, ranging between 75-91 sheep. This harvest met or exceeded management objectives for the population. We estimated the TCW sheep population to be stable at 2,000-2,700 sheep.

Three factors influenced sheep harvest by hunters: an increase in minimum horn size, an increase in hunter participation and an increase in the use of 3- or 4-wheelers. Harvest declined following changes in horn size minimums, but only temporarily. Guided, nonresident hunters maintained high success rates while an increased number of residents were unsuccessful. The decline was probably the result of crowding in areas accessible by 3- or 4-wheelers, in addition to greater horn size limitations. The increased competition for the limited number of legal rams apparently produced an urgency to harvest a sheep as soon as possible, effecting a 50% increase in the portion of sheep killed the first two

weeks. Despite increased competition for legal rams, the change in minimum horn size produced, on the average, larger rams in the harvest.

The infrequency of aerial surveys was identified by Grauvogel (1990) as being a major obstacle to managing sheep more intensively in TCW. Because harvest objectives were met or surpassed and the population appeared stable, complete surveys were only needed on a 4-5 year schedule. However, if funds were available, continuation of meaningful trend count areas would be useful in alerting biologists sooner to significant population or composition changes.

Management goals and population objectives in TCW conflict with current management philosophies and capabilities. Management goals for TCW change as one crosses unit boundaries. In Subunits 13A and 13E, goals call for aesthetic hunting conditions, implying lack of crowded hunting conditions. In Subunits 14A and 14B, just across a river boundary, crowded hunting conditions are acceptable to maximize hunting opportunities.

Competition by hunters to take Dall sheep in Alaska is intense and growing. To prevent piecemeal management I recommend reviewing population objectives. Among ideas to consider are a minimum acceptable or optimal hunter success rate, an optimal range of hunter-viewer recreation days and a minimum acceptable ratio of large rams to ewes. Population objectives should reflect meaningful management philosophies and capabilities. These proposed objective criteria would strive to match management goals as they relate to hunter-viewer opportunity and experience while ensuring an adequate number of reproductive males. These objectives would be attainable through regulation changes such as limited hunter access, redistribution of hunting effort or limited hunter participation.

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Prepared by:

Herman J. Griese
Wildlife Biologist

Submitted by:

Jeff Hughes
Wildlife Biologist

Table 1. Talkeetna Mountains and Chulitna-Watana Hills summer aerial sheep composition counts and estimated population size, 1987-92.

Regulatory year	Rams		Ewes[a]	Lambs(%)	Sheep/ hour	Total Sheep observed	Estimated population size
	≤ curl(%)	<7/8 and >1/4 curl					
1987/88	---	---	---	---	---	---	1,950-2,700
1988/89[b]	24 (3)	178	500	163 (19)	44	866	2,150-2,600
1989/90	---	---	---	---	---	---	2,100-2,600
1990/91	---	---	---	---	---	---	2,100-2,600
1991/92	---	---	---	---	---	---	2,000-2,700

[a] Includes yearlings of both sexes and rams of 1/4 curl or less.
[b] A summary of Subunits 14A and 14B within the Talkeetna Mountains.

Table 2. Talkeetna Mountains and Chulitna-Watana Hills sheep hunter residency and success, 1987-92.

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	
1987/88[b]	22	32	26	82 (22)	140	127	18	290 (78)	372
1988/89[b]	25	34	40	105 (32)	91	103	19	228 (68)	333
1989/90[c]	18	18	33	75(23)	97	130	12	248 (77)	323
1990/91[c]	27	27	25	82 (23)	108	135	18	270 (77)	352
1991/92[c]	31	27	29	91 (24)	126	149	4	284 (76)	375

[a] Local means residents of game management Subunits 13A, 13E, 14A and 14B.
[b] Legal animal means rams with horns ≥ 7/8 curl.
[c] Legal animal means rams with ≥ to full curl.

Table 3. Talkeetna Mountains and Chulitna-Watana Hills sheep harvest, 1987-92.

Regulatory Year	Rams	x Horn Length (inches)	% ≥ 40"	Ewes	Total sheep
1987/88[a]	81	33.2	2.4	0	82
1988/89[a]	105	33.2	2.9	0	105
1989/90[b]	75	34.0	1.3	0	7.6
1990/91[b]	79	34.5	0.0	1	82
1991/92[b]	86	34.7	2.2	0	91

[a] Legal ram ≥ 7/8 curl horn.
[b] Legal ram ≥ full curl horn.

Table 4. Talkeetna Mountains and Chulitna-Watana Hills sheep harvest chronology percent by time period, 1987-92.

Regulatory year	Harvest periods						n
	8/10-8/16	8/17-8/23	8/24-8/30	8/31-9/6	9/7-9/13	9/14-9/20	
1987/88	33	24	20	11	4	6	82
1988/89	29	10	13	10	15	15	103
1989/90	35	19	9	16	11	9	74
1990/91	45	17	15	5	9	9	76
1991/92	47	19	8	9	8	9	89

Table 5. Talkeetna Mountains and Chulitna-Watana Hills sheep harvest percent by transport method 1987-92.

Regulatory year	Percent of harvest							n
	Airplane	Horse	Boat	3- or 4-wheeler	ORV	Highway vehicle	Unknown	
1987/88	44	17	1	13	6	12	6	82
1988/89	44	16	4	15	6	10	6	105
1989/90	53	13	1	24	0	8	0	75
1990/91	39	15	0	35	1	9	1	82
1991/92	52	7	0	26	5	2	8	91

LOCATION

Game Management Unit: Subunits 13B, 20A, and 20D (1,680 mi^2)

Geographical Description: Delta Controlled Use Area (DCUA)

BACKGROUND

The ADF&G management plans for Dall sheep (ADF&G 1976, Bos 1988) define the management goals for sheep in Alaska. These goals include protection and maintenance, scientific and educational study, diversified recreational use, and commercial and subsistence uses. Federal and state subsistence laws mandate subsistence use as the highest priority of fish and wildlife when harvest is allowable. However, the Alaska Board of Game, acting in compliance with these subsistence laws, has found historic human use of Dall sheep rarely meets present definitions of subsistence use. Consequently, diversified human recreation is the predominant use of Dall sheep in Alaska.

The department revised management plans (Bos 1988) recognize that diversified human recreational uses of Dall sheep include consumptive and nonconsumptive uses. Nonconsumptive uses include viewing and photography. The consumptive use objectives for this species includes 1) maximum opportunity to hunt, 2) opportunity to hunt under aesthetically pleasing conditions, and 3) opportunity to harvest unusually large rams as trophies. Providing the opportunity to hunt sheep under aesthetically pleasing conditions is the consumptive use objective in the Delta Controlled Use Area (DCUA).

Sheep seasons and legal harvest have become increasingly restrictive in the eastern Alaska Range. This was necessary as human populations increased and Dall sheep conservation required more active management. As this process evolved, hunters began to demand assurance of certain types of hunting experiences. The DCUA, which was formerly known as the Delta Management Area, was the first attempt to meet these demands. The Delta Management Area was established before the hunting season in 1971 to provide sheep hunters with high quality walk-in hunting opportunities free from competition with other transportation types.

In the Delta Management Area, the use of motorized vehicles and pack animals for transporting hunters, hunting gear, or game was initially prohibited for the first portion of the 10 August-20 September hunting season. After 25 August, the transportation restrictions were lifted and mechanized and pack animal access was permitted. The bag limit was one ram with 3/4-curl or larger horns.

Designation of the Delta Management Area as a walk-in only area successfully provided walk-in only hunting opportunity, but failed to reduce harvest to the desired level or provide high-quality hunting experiences. The harvest and quality hunting experience

objectives were formally selected as consumptive use guidelines during the public planning project of the mid-1970s (ADF&G 1976). Rams in the Delta Management Area were still subject to heavy hunting pressure which resulted in excessive harvest, reduced horn size, and considerable hunter competition for available rams. During 1977 hunters killed 78 rams even though the desired harvest objective was 40 rams (Larson 1979).

In an effort to achieve the harvest and aesthetic quality objectives, sheep hunting in the Delta Management Area was restricted by lottery permit in 1978. Sixty permits were issued for a 10-25 August walk-in season, and 60 permits were issued for a 26 August-20 September open access season. The bag limit was one ram with 3/4-curl horns or larger. As expected, the permit hunt reduced the hunting pressure and harvest. Harvest was reduced from 78 rams in 1977 to 31 rams in 1978, but average horn size decreased to an all-time low of 31.2 inches (Larson 1979).

During 1979, minimum horn size for legal sheep in all of Unit 20 was increased from 3/4 to 7/8 curl. The 7/8-curl regulation did not affect the number of rams harvested in the Delta Management Area, but average horn size increased from 31.2 inches in 1978 to 34.6 inches in 1979 (Larson 1980).

In 1981 the Delta Management Area was renamed the Delta Controlled Use Area to reflect its classification as a controlled use area rather than a management area. During 1982 the number of drawing permits issued was increased to 75 for each portion of the drawing permit hunt (hunt numbers 1103 and 1104). During 1984, minimum horn size for legal sheep in Unit 20 was raised from 7/8 curl to full curl. The season and bag limit in the DCUA have not changed since 1984, with the exception of 1985, when Tier II subsistence regulations were adopted for the DCUA.

MANAGEMENT OBJECTIVES

Management objectives for area Dall sheep are to: 1) manage a population of 1,800 sheep to provide a mean annual harvest of 35 full-curl rams with a mean horn length of more than 36 inches and mean age exceeding 8 years, and 2) provide aesthetically pleasing hunting conditions by managing hunter numbers, hunter access, and transportation means so that virtually all hunters are satisfied with the aesthetic quality of their hunt.

METHODS

Human Use

Hunters selected in the permit lottery were required to report their activities. Data contained on permit reports were analyzed to determine hunter success, hunter residence, hunter effort, ram horn size, hunt location, transportation type, and other information.

During the 1990-91 hunting season, hunters were also asked to complete a questionnaire about their hunt. The questionnaires were mailed to all hunters and hunters were asked when, how many days, and where they hunted. They were also asked how many people were in their party, how many other parties were encountered, and how many people were in each party. Hunters also reported how many sheep were seen, their location, their composition, if any sheep had neck bands or ear tags, and neck band or ear tag number. Finally, hunters were asked if they were satisfied with the quality of their hunt, and if they have any suggestions for improvements.

Herd Inventory and Management

A serologic survey begun in 1987 continued through June 1992. The objective of this survey was to determine occurrence of microbial disease agents in DCUA sheep. Sheep were captured with a rocket net at the Granite Creek mineral lick (Heimer et al. 1980). Captured sheep were given injections of acepromazine, blind-folded, and hobbled. Twenty ml of blood were collected from each sheep, and serum was collected using techniques described in Heimer et al. (1982). Serum was tested for antibody titers to the following diseases: brucellosis, bovine progressive pneumonia, contagious ecthyma, epizootic hemorrhagic disease, bluetongue, Q–fever, infectious bovine rhinotracheitis, bovine viral diarrhea, parainfluenza III, and respiratory syncytial virus. Morphological data collected from each sheep included hind foot length, girth, contour length, and tongue color. Each sheep was inspected for lumpy jaw. Reproductive status was determined for ewes. Horn length was measured on rams. Colored and numbered plastic ear tags were placed in the ears of all sheep. Numbered neck bands were placed on all ewes.

Composition surveys were conducted from the ground at the Granite Creek mineral lick in conjunction with serologic investigations. Sheep that visited the lick were classified with the aid of binoculars or a spotting scope based on the criteria described by Heimer (1973). Rams were classified based on horn curl as 1/4-, 1/2-, 3/4-, 7/8-, or 4/4-curl. Other sheep were classified as ewes, yearlings, or lambs.

The Granite Mountain Trend Count Area (TCA) was established in 1992 and included the DCUA west of July Creek and north of the crest of the Alaska Range. This area encompasses approximately 156 mi^2 of sheep habitat and includes Granite Mountain, upper portions of McCumber Creek, Morningstar Creek, Jarvis Creek, portions of July Creek, and along the Richardson Highway from Ruby Creek south to Gunnysack Creek. We sorted previous aerial survey data for the DCUA to correspond with the Granite Mountain TCA.

We flew an aerial survey in the Granite Mountain TCA from a PA-18 Piper Super Cub aircraft on 21-22 July 1992. Ram horn curl was classified as 1/2, 3/4, 7/8, or 4/4. All sheep not classified as rams or lambs we classified as "ewes." This classification includes yearling and 2-year-old rams (often referred to as 1/4-curl rams) as well as all ewes regardless of age and reproductive status.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

No estimate of population size was calculated for the DCUA.

In the Granite Mountain TCA staff observed 662 sheep (Table 1) in 156 mi^2 during 10 hours of survey. Search effort was approximately 2.6 min/mi^2 of sheep habitat. Estimated density was 4.2 sheep/mi^2. Comparable data were collected during 1974, 1975, and 1980. Although survey times were not available for earlier years, a subjective evaluation of the data indicates that survey times were probably comparable with 1992 data.

Sheep numbers in the Granite Mountain TCA ranged from a high of 746 sheep in 1974 to a low of 561 sheep in 1975 (Table 1). No clear trends in population size are apparent from these data and trends in population size are not well understood in the DCUA because data are collected infrequently. However, it appears that the current population is comparable in size with the population in the mid-1970s through 1980.

Population Composition:

Heimer (1973) suggested a minimum of 500 sheep should be classified during ground surveys at mineral licks to overcome bias that results from factors such as bands of sheep repeatedly visiting the lick.

We collected ground composition data at the Granite Creek mineral lick in June 1991 and 1992 (Table 2). Sample size in 1991 was below Heimer's recommendation but met his recommendation in 1992. During both years, percent lambs in the population was low with only 9% lambs observed each year. Lamb:ewe ratios were 14 and 16:100 and percent ewes in the population was 61% and 60% in 1991 and 1992, respectively. Percent lambs in the population was also low during June 1987 and 1988; however, this conclusion is based on small sample sizes.

Aerial survey data collected in July 1992 confirm low lamb survival observed during ground surveys in June 1992. Aerial survey data resulted in estimates of 7% lambs in the population (Table 1). Percent lambs in the population from aerial surveys in 1974, 1975, and 1980 ranged from 16 to 24.

During the June 1992 ground composition counts, we observed 72 yearlings which represented 11% of the population. If one-half of these yearlings are rams, then 36 yearling rams were observed, which represents only 9 yearling rams:100 ewes. This recruitment rate is low for this cohort of rams. Rams in the 3/4- to full-curl cohort were abundant, but full-curl rams were scarce in the ground sample (Table 2). Full-curl rams

were better represented in the July 1992 aerial survey, with 39 legal rams observed (Table 1). If 39 legal rams were observed during July 1992 in the Granite Creek TCA, it does not appear that current DCUA harvest levels are excessive.

Distribution and Movements:

During the 1990 hunting season, all visually collared sheep reported by hunters were west of July Creek and north of the crest of the Alaska Range. Sightings were reported from Granite Mountain, Morningstar Creek, Riley Creek, and Bear Creek.

During the 1991 hunting season, all visually collared sheep reported by hunters were west of July Creek, although one sheep was in the head of July Creek. Other sightings were from Granite Mountain, Morningstar Creek, and Riley Creek.

During the July 1992 aerial survey of the Granite Mountain TCA, staff observed 18 collared ewes of the 38 visually collared ewes known to be alive and seen at the Granite Creek mineral lick in June 1992. Thirteen were observed on Granite Mountain, 1 was observed in July Creek, and 4 were observed at a lick in the headwaters of Darling/Bear Creek. The remaining unobserved ewes were probably distributed over a larger area than the Granite Mountain TCA.

Mortality

Harvest:

Season and Bag Limit. The sheep hunting season was open from 10 August to 20 September and was split between two drawing permit hunts. For permit hunt 1103, the season was open from 12:01 a.m. 10 August until 12:01 a.m. 26 August. Hunters were not allowed to use motorized vehicles or pack animals to transport sheep hunters, sheep hunting gear, or sheep within the DCUA from 5 August through this period. Normal travel continued on the Richardson Highway and at recognized airports lying within the DCUA boundaries. For permit hunt 1104 the season was open from 26 August through 20 September with no access restrictions. Each portion of the season had a bag limit of one full-curl ram. Seventy-five permits each were issued for hunt 1103 and 1104.

Human-induced Mortality. Hunters reported a total DCUA harvest of 50 rams during 1989, 28 rams during 1990, and 42 rams during 1991 (Table 3). A mean harvest of 39 sheep per year for the past 5 years meets the harvest management objective. During the past 5 years, harvest has been evenly split between the 2 permit hunts, with 51% of the harvest coming from hunt 1103 and 49% of the harvest coming from hunt 1104.

Mean horn length for sheep taken increased in 1989 to 36.8 inches, but declined in 1990 and 1991 to 34.6 and 36.2 inches, respectively (Table 3). Mean horn size the past 5 years is 35.8 inches and is very close to meeting the management objective of 36 inches.

Hunter Residency and Success. Most DCUA hunters are Alaskan residents (97%), with local residents composing 44% of all hunters. DCUA sheep hunters had overall success rates ranging from 27% to 50% during the previous 5 years, with a mean of 39% for both hunt 1103 and hunt 1104 (Table 4).

Permit Hunts. During 1989-91, ADF&G received 523, 680, and 786 applications for hunt 1103, and 675, 881, and 865 and applications for hunt 1104, respectively.

Transport Methods. Highway vehicles, 3- or 4-wheelers, and airplanes remain the most popular modes of transportation for accessing the DCUA (Table 5). Highway vehicles are used most commonly during hunt 1103 because of controlled use area access restrictions. Airplanes and 3- or 4-wheelers are used commonly during hunt 1104 along with highway vehicles.

Harvest Chronology. Harvest is highest during the first week of each permit hunt, and the first hunt (1103) is only 2 weeks long. Therefore, most sheep harvested each year in the DCUA were taken during the first 3 weeks of the combined permit hunting season (67% in 1990 and 71% in 1991, Table 6). Harvest, and presumably hunting pressure, was least during the final 3 weeks of hunt 1104.

Natural Mortality:

Serologic data were available from 19 sheep captured at the Granite Creek mineral lick in June 1989, and from 3 sheep killed by hunters in the DCUA. All 22 samples were negative for all disease agents except contagious ecthyma (CE). Four of 22 samples were positive for CE.

Predation rates on sheep in the DCUA are unknown. Wolves, coyotes, grizzly bears, black bears, and golden eagles all occur in the area and undoubtedly prey on sheep.

Climate is a chronically limiting, but infrequently depressing, factor for sheep in the DCUA. The DCUA is located at the north end of the 2,443-foot Isabel Pass through the Alaska Range, so winter storms frequently bring high winds and warm temperatures. Therefore, much of the area is either snow-free or has little snow during much of the winter and provides suitable stable winter range for Dall sheep.

Habitat

Sheep habitat appears sufficient to support the population at its current level, although no habitat assessment surveys have been conducted. The two greatest threats to sheep habitat in the DCUA are mining activities and military exercises on state land. Both of these activities should be monitored closely.

Board of Game Actions and Emergency Orders

The Alaska Board of Game approved a regulation proposal to change the boundaries of the DCUA effective 1 July 1992. The purpose of the change was to exclude a portion of nonsheep habitat between the Richardson Highway and the Delta River from the DCUA. This area of nonsheep habitat is popular for hunting small game and upland game. However, DCUA access restrictions complicated hunting in the area and confused hunters.

CONCLUSIONS AND RECOMMENDATIONS

The harvest objective for the DCUA calls for a harvest of 35 full-curl rams, with a mean horn length exceeding 36 inches and mean age greater than 8 years. Current harvest rates meet harvest quota and horn size objectives. Data indicate the harvest objective continues to be attained. Recent survey data indicate that current harvest rates are not excessive.

It is not known whether the population objective of 1,800 sheep is being met. A 1980 estimate of 1,500 sheep in the DCUA is below that objective, but no population estimates have been made since 1980. Lamb survival has been low in recent years which may result in population declines and reduced hunting opportunity.

The management objective of providing aesthetically pleasing hunting conditions is being met in the DCUA. Results of the 1991 DCUA questionnaire indicate that hunters during hunts 1103 and 1104 were satisfied with current DCUA regulations and with the quality of their hunt.

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Prepared by:

Stephen D. DuBois
Wildlife Biologist III

Submitted by:

Kenton P. Taylor
Management Coordinator

Reviewed by:

Kenneth R. Whitten
Wildlife Biologist III

Table 1. Delta Controlled Use Area trend count area, July aerial sheep composition counts, 1974-92.

Regulatory year	No. of rams (%)				Ewes[b] (%)	Lambs (%)	Unclass (%)	Sheep/ hour	Total sheep observed
	Legal ram[a]	Sublegal ram	Unclass ram	Total ram					
1974-75	72 (45)	72 (45)	15 (9)	159 (21)	315 (42)	142 (19)	130 (17)	unk	746
1975-76	34 (43)	45 (57)	0	79 (14)	394 (70)	88 (16)	0	unk	561
1980-81	63 (48)	68 (52)	0	131 (22)	319 (54)	144 (24)	0	unk	594
1992-93	39 (21)	147 (79)	0	186 (28)	428 (65)	48 (7)	0	66	662

[a] Ram composition data are not comparable because of changes in definition of a legal ram; 1992-93 = 7/8 curl; 1974-76 = 3/4 curl.
[b] Includes yearlings of both sexes and rams of 1/4 curl or less.

Table 2. Delta Controlled Use Area, June ground sheep composition counts, 1987-92.

Regulatory year	No. of rams (%)				Total rams	Ewes (%)	Lambs (%)	Total sheep observed
	Full-curl	3/4- to full-curl	1/2- to 3/4-curl	<1/2-curl				
1987-88	4 (12)	3 (9)	5 (15)	21 (63)	33	60 (59)	9 (9)	102
1988-89	4 (9)	6 (14)	10 (23)	23 (53)	43	145 (68)	24 (11)	212
1989-90	2 (22)	0	1 (11)	6 (67)	9	41 (58)	21 (29)	71
1990-91	7 (11)	15 (24)	22 (35)	19 (30)	63	127 (61)	18 (9)	208
1991-92	3 (2)	69 (35)	47 (24)	80 (40)	199	395 (60)	62 (9)	656

Table 3. Delta Controlled Use Area sheep harvest data by permit hunt, 1987-92.

Hunt No. /area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Rams	$\bar{x}$ horn length (inches)	% ≥ 40"	Ewes	Unk	Total harvest
1103	1987-88	75	25	40	29	22	35.4	--	0	0	22
	1988-89	75	36	47	17	13	35.4	15	0	0	13
	1989-90	75	29	35	36	27	37.0	7	0	0	27
	1990-91	75	32	44	20	15	34.6	0	0	0	15
	1991-92	75	21	48	31	23	35.9	13	0	0	23
1104	1987-88	75	41	35	15	11	35.1	--	0	0	11
	1988-89	75	23	39	39	29	36.3	3	0	0	29
	1989-90	75	35	32	31	23	36.6	13	0	0	23
	1990-91	75	27	49	17	13	34.8	8	0	0	13
	1991-92	75	36	37	25	19	36.5	21	0	0	19
Totals for all permit hunts	1987-88	150	33	37	22	33	35.3	--	0	0	33
	1988-89	150	29	43	28	42	35.9	7	0	0	42
	1989-90	150	32	33	33	50	36.8	10	0	0	50
	1990-91	150	29	47	19	28	34.6	4	0	0	28
	1991-92	150	29	43	28	42	36.2	17	0	0	42

Table 4. Delta Controlled Use Area sheep hunter residency and success, 1987-91.

Hunt no.	Regulatory Year	Successful					Unsuccessful					Total hunters
		Local[a] resident	Nonlocal resident	Nonresident	Unk	Total (%)	Local[a] resident	Nonlocal resident	Nonresident	Unk	Total (%)	
1103	1987-88	12	9	0	1	22 (42)	9	20	0	1	30 (58)	52
	1988-89	3	10	0	0	13 (27)	19	13	1	2	35 (73)	48
	1989-90	12	13	2	0	27 (51)	10	16	0	0	26 (49)	53
	1990-91	6	8	1	0	15 (31)	9	22	2	0	33 (69)	48
	1991-92	9	21	2	0	32 (39)	15	33	3	0	51 (61)	83
1104	1987-88	7	4	0	0	11 (30)	17	9	0	0	26 (70)	37
	1988-89	13	15	1	0	29 (50)	18	11	0	0	29 (50)	58
	1989-90	12	10	1	0	23 (49)	11	12	1	0	24 (51)	47
	1990-91	8	4	0	0	12 (24)	19	17	1	0	37 (76)	49
	1991-92	14	3	0	0	17 (38)	19	9	0	0	28 (62)	45
Total for all permit hunts	1987-88	19	13	0	1	33 (37)	26	29	0	1	56 (63)	89
	1988-89	16	25	1	0	42 (40)	37	24	1	2	64 (60)	106
	1989-90	24	23	3	0	50 (50)	21	28	1	0	50 (50)	100
	1990-91	14	12	1	0	27 (28)	28	39	3	0	70 (72)	97
	1991-92	23	24	2	0	49 (38)	34	42	3	0	79 (62)	128

[a] Local is a hunter who resides in the Game Management Unit.

Table 5. Delta Controlled Use Area sheep harvest percent by transport method, 1987-91.

Permit hunt no.	Regulatory year	Percent of harvest								
		Airplane	Horse	Boat	3-or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	n
1103[a]	1987-88	6	0	0	0	0	0	88	6	52
	1988-89	10	0	4	0	0	2	79	4	48
	1989-90	8	0	0	2	0	0	87	4	53
	1990-91	8	0	8	0	0	0	75	8	48
	1991-92	12	0	5	0	0	0	76	7	59
1104	1987-88	18	3	0	30	0	16	32	0	37
	1988-89	38	0	3	12	0	14	31	2	58
	1989-90	43	0	0	13	0	13	32	0	47
	1990-91	38	0	0	34	0	4	24	0	50
	1991-92	26	2	0	45	0	4	23	0	47
Total for all permit hunts	1987-88	11	1	0	12	0	7	65	3	89
	1988-89	25	0	4	7	0	8	53	3	106
	1989-90	24	0	0	7	0	6	61	2	100
	1990-91	23	0	4	17	0	2	49	4	98
	1991-92	18	1	3	20	0	2	53	4	106

[a] No motorized vehicles or pack animals are allowed during Hunt 1103.

Table 6. Delta Controlled Use Area sheep harvest chronology percent by time period, 1990-91.

Hunt no.	Regulatory year	Harvest dates 8/10-8/16	8/17-8/23	8/24-8/30	8/31-9/6	9/7-9/13	9/14-9/20	Unk	n
1103[a]	1990-91	60	27	7	--	--	--	7	15
	1991-92	48	39	9	--	--	--	4	23
1104[b]	1990-91	--	--	38	15	15	23	8	13
	1991-92	--	--	42	26	11	21	0	19
Total for all permit hunts	1990-91	32	14	21	7	7	11	7	28
	1991-92	26	21	24	12	5	10	2	42

[a] Season open from August 10 to 25 August.
[b] Season open from August 26 to 20 September.

LOCATION

Game Management Subunit: 20A (6,796 mi^2, less than half of which is sheep habitat)

Geographical Description: North side of the Alaska Range east of the Nenana River and west of the Delta River

BACKGROUND

The mountains of Subunit 20A have been one of the most popular sheep hunting areas in Interior Alaska because of their proximity to Fairbanks (approximately 60 miles south), the open general season (no drawing permits required), and the opportunity to also hunt moose, caribou, and grizzly bears. Subunit 20A has been managed to provide for a wide variety of hunting opportunities, and includes areas closed to the use of motorized vehicles (except aircraft) and an area open to hunting by bow and arrow only. Since 1981, harvests have ranged from 102 to 163 rams/year taken by 292 to 410 hunters/year.

Research on sheep in this study area has included periodic aerial surveys, a study comparing sheep in Subunit 20A (very poor ram horn growth) with sheep in Subunit 12 (very good ram horn growth) (Heimer and Watson 1986), a study from 1968 through 1988 of sheep use of the Dry Creek mineral lick, and a cooperative project between the department and the U.S. Army to study movements and seasonal ecology of 15 radio-collared sheep on and adjacent to Fort Greely (Spiers and Heimer 1990). Ver Hoef (1992) thoroughly reviewed the methodology, applications, and limitations of sheep data collected at mineral licks.

Heimer and Watson (1986) summarized the following trends in sheep population changes. The sheep population in Subunit 20A was probably relatively high in the 1960s because of widespread predator control programs before statehood (1959) and because of favorable weather conditions. Aerial wolf hunting was prohibited in 1963 and the wolf population grew dramatically (Harbo and Dean 1981). By 1970, wolves were abundant and sheep were at an all-time high in the Dry Creek sheep study area. However, during the next 5 years, the sheep population declined approximately 20%. In late winter 1976 a wolf control program was initiated to provide relief for declining moose and caribou populations in Subunit 20A. By fall 1978, the wolf population was approximately one-third of its former size. The sheep population stopped declining and remained relatively stable for several years (Heimer and Stephenson 1982). The wolf control program ended in 1982 and the wolf population has since recovered to precontrol levels.

A comprehensive aerial survey of sheep in Subunit 20A was last conducted in 1977. During that survey, observers counted 3,576 sheep with a low survey intensity of approximately 1.3 min/mi^2. Based on an assumed sightability of 70-80%, incomplete

coverage of some sheep habitat, and population growth since 1977, McNay (1990) believed that 5,000 sheep was a reasonable estimate for the population in 1989.

However, recent aerial surveys in portions of Subunit 20A indicate that the sheep population may have declined dramatically between 1984 and 1991. During a survey of 220 mi^2 in July 1991, we saw 47% fewer sheep and very few lambs (18 lambs:100 "ewes") compared with a survey of the same area in 1984. Therefore, the objective to maintain a population of approximately 5,000 sheep area is probably not being met.

MANAGEMENT DIRECTION

The following goals and objectives for Dall sheep in Subunit 20A were listed in the last management report (McNay 1990).

Management Goals

The management goal for Subunit 20A Dall sheep is to maintain a Dall sheep population and its habitat with biological diversity in concert with other components of the ecosystem.

Management Objectives

The management objectives for Subunit 20A Dall sheep are to: 1) provide the greatest sustainable annual opportunity to hunt Dall sheep, 2) provide the greatest sustainable annual harvest of Dall sheep, and 3) provide the opportunity to view and photograph Dall sheep under natural conditions.

Population Objectives

Population objectives for Subunit 20A Dall sheep are to 1) manage for a Dall sheep population of approximately 5,000 sheep and 2) maintain naturally regulated ewe and subadult ram segments of the population.

METHODS

Population Status and Composition

We monitored population status with two aerial surveys during this report period. During both surveys, we classified sheep as lambs, "ewes," or rams based on horn size/shape and body conformation. "Ewes" included young rams that could not be distinguished from ewes and yearlings of both sexes. We did not classify rams to horn size because of the

difficulty in adequately judging horn curl. However, in 1992 we did classify rams as legal (full-curl or both horns broomed), sublegal, or unknown.

1991:

On 22, 23, and 25 July 1991, we searched for and classified sheep in approximately 220 mi^2 of sheep habitat between the Wood River and the West Fork of the Little Delta River. For comparative purposes, we divided the area into the same four sample units used during the last survey in 1984 (Fig. 1). We searched sample units by flying low-level contours and circles at 60-80 knots/hr. Total search time was 12 hours 33 minutes (3.4 min/mi^2).

Survey conditions were good to excellent during the 3 days we surveyed. We surveyed two of the four sample units on the last day when conditions were optimal (high overcast, flat light of medium intensity, calm). Low ceilings and turbulence prevented us from surveying on 24 July.

Although two pilots participated (Bill Lentsch [Tamarack Air] and Mark McNay), I was the only observer during the 3 days of surveying. Lentsch has been the pilot for most sheep surveys during the last 10 years, so I believe that our search intensity and pattern of flying contours were consistent with previous surveys.

1992:

On 28-29 July 1992, Pilot Lentsch and I counted and classified sheep within 153 mi^2 of sheep habitat west of the Wood River and north of the Yanert drainage (Fig. 2). We primarily searched the vicinity of Mystic Mountain, Keevy Peak, and upper Healy/Moody Creeks. Total search time was 7 hours 7 minutes (2.8 min/mi^2). Survey conditions were good to excellent throughout most of the survey. Winds and turbulence increased during the latter part of the days, however. Light was excellent (medium/high intensity and flat).

Harvest

We monitored harvest and hunting pressure with harvest report cards. We also monitored sheep hunters/hunting with a check station in Healy Creek from 12 to 15 August 1991.

RESULTS

Population Status and Trend

Population Size:

I believe that the Subunit 20A sheep population has declined considerably since 1984 and currently includes only 2,000-4,000 sheep. This estimate is derived by revising McNay's (1990) estimate of 5,000 sheep downward because aerial surveys in 1991 and 1992 indicated lower densities of sheep and very poor recruitment.

In July 1991, we only observed 698 sheep in 220 mi^2 of core sheep habitat, which represents a 47% decline from the 1,313 seen in 1984 in the same area (Table 1). Although the decline was evident in all three sex/age categories, the largest discrepancy was in the number of lambs in the sample (73% decline). The number of nonlamb sheep observed declined by 40%. Pilot Lentsch commented that he had never seen so few sheep in this area, and he has been flying the Alaska Range for over 15 years.

In July 1992, our survey west of the Wood River confirmed general low densities of sheep and a second year of very poor recruitment. Although I did not find much comparative data from previous surveys for that area, Lentsch again commented on how few sheep he saw relative to previous years.

Population Composition:

According to the 1991 survey, the population decline between 1984 and 1991 was evident in all three sex/age categories (Table 1). However, the largest discrepancy in the composition was in the lamb segment of the population. In 1991, the lamb:"ewe" ratio (18:100) and the percent lambs in the population (11%) were substantially lower than in 1984 (38:100 and 21%, respectively). I did not classify yearlings, although I did see them frequently enough to infer that we had some (albeit very little) recruitment. We classified 698 sheep during this survey, including 423 "ewes," 76 lambs, and 197 rams.

During 1992, lambs were nearly absent from the area we surveyed. The lamb:ewe ratio (5:100) was even lower than what we observed in 1991 (18:100) east of the Wood River (Table 2). Only 3% (7/222) of the sheep we observed were lambs, compared with 21% and 11% east of the Wood River in 1984 and 1991, respectively. The ram:ewe ratio was relatively high (62:100), with 8 of the rams legal, 63 sublegal, and 11 with unknown horn size. We classified 222 sheep on this survey, including 133 ewes, 7 lambs, and 82 rams.

Distribution and Movements:

Sheep are distributed throughout the mountains of Subunit 20A. A small number of sheep are also occasionally seen in the foothills near Jumbo Dome, Molybdenum Ridge, Needle Rock, the Totatlanika River Canyon, and Rex Dome. During summer, sheep densities in Subunit 20A are highest between the Wood River and the West Fork of the Little Delta River. Densities decrease east and west of this core area. From early May to early July, sheep distribution is largely influenced by their use of mineral licks.

In a study of 15 radio-collared sheep in eastern Subunit 20A (Spiers and Heimer 1990), winter ranges tended to lie within summer ranges. During an aerial survey in July 1988, no sheep were seen on the northfacing slopes between McGinnis Creek and Trident Glacier, but 161 sheep were seen on the north side of Black Rapids Glacier. Older rams traveled greater distances than ewes and young rams; the greatest distances traveled by these collared sheep were made by two radio-collared rams that moved between Whistler Creek and Trident Glacier (approximately 12 miles [19 km]).

Mortality

Harvest:

Seasons and Bag Limits. The sheep hunting season was open 10 August through 20 September throughout this report period. The bag limit was one ram with a full-curl horn (includes rams that are at least 8 years old or with both horns broken) or larger.

Board of Game Actions and Emergency Orders. The Board of Game did not change any seasons or bag limits for sheep in Subunit 20A during this report period.

Hunter Harvest. One of the management objectives for this area is to provide for the greatest sustainable annual harvest of sheep. Reported sheep harvest in Subunit 20A steadily increased from 102 rams in 1985 to 163 in 1989 (Fig. 3). Harvests have decreased since then, with 124 rams taken by 379 hunters in 1990 and 109 rams taken by 338 hunters in 1991.

Above-average yearling recruitment in 1980 and 1981 probably contributed to the high harvest from 1986 to 1988 or 1989 (McNay 1990). However, yearling recruitment since 1981 has been moderate, and harvests decreased after 1989. Because of the weak cohorts that we have documented in 1991 and 1992, we expect harvest to be fairly low in 1999 and 2000 as rams in those weak cohorts mature and become legal to hunt.

Distribution of Harvest and Hunting Pressure. Harvest and hunting pressure are highest in western and southern Subunit 20A. In 1991, the area west and south of the Wood River drainage had 54% (52/109) of the harvest and 65% (220/337) of the hunters (Table 3). The Wood River drainage had 17% (19/109) of the harvest and 14% (47/337) of the hunters. The Little Delta River had 15% (16/109) of the harvest and 11% (37/337) of the hunters.

Horn Size of Harvested Rams. Mean horn length of harvested rams has ranged from 34 to 35 inches since 1984 when the bag limit was changed from 7/8-curl to full-curl rams (Table 4). Only 1% of the rams harvested since 1986 have had horns >40 inches long.

Hunter Residency and Success. During the last 5 years, 29-37% of the sheep harvested annually from Subunit 20A were taken by nonresidents (Table 5). However, only a small proportion (1-8%) of the unsuccessful hunters were nonresidents.

Success rates are much higher for nonresidents than for resident hunters. Eighty percent (225/283) of the nonresidents hunting sheep in Subunit 20A during the last 5 years were successful. In contrast, only 29% (411/1,417) of the residents were successful. Nonresidents must hunt sheep with a licensed guide or a relative within the second degree of kindred.

Overall success rates of 33% (124/379) and 32% (109/338) in 1990 and 1991, respectively, are the lowest recorded for this area since the early 1970s (Table 4). In August 1991, only 4 of the 16 (25%) sheep hunters we contacted at our check station were successful. Most hunters commented on how relatively few sheep they saw.

Harvest Chronology. During the last 5 years, 49-60% of the annual sheep harvest was taken during the first 11 days of the season (10-20 Aug) (Table 6). Harvest tended to taper off as the season progressed; <10% of the harvest was taken during the last 10 days (11-20 Sept.).

Transport Methods. The Wood River and Yanert Controlled Use Areas are closed to the use of motorized vehicles, except aircraft, for big game hunting and transportation throughout the sheep hunting season. These areas contain approximately half of the Dall sheep range in Subunit 20A. Therefore, most successful sheep hunters during the last 5 years have used airplanes (50-60%) or horses (19-30%) as transportation to their hunt (Table 7). Although many sheep hunters used 3- or 4-wheelers, ORVs, and highway vehicles, their success rates were lower.

Other Mortality:

Severe winter weather and predation appear to be the most important natural mortality factors for Dall sheep (Murie 1944, Heimer and Watson 1986). Relatively severe winters occurred in the Fairbanks area in 1989-90 and 1990-91. Valkenburg (1992) listed the maximum snow depth in March on the range of the Delta caribou herd (Subunit 20A) as 43 inches in 1990 and 41 inches in 1991, versus 4-25 inches between 1980 and 1989. He thought that these two winters contributed to increased winter mortality of the Delta caribou herd. They may have similarly affected sheep.

Predators of sheep in Subunit 20A include wolves, grizzly bears, coyotes, and eagles. Wolf densities in Subunit 20A are at an all-time high (16 wolves/1,000 km2). Prey selection by these wolves has probably not been consistent throughout the last few years. In 1989, a study of four wolf packs in Subunit 20A indicated that wolves in the foothills killed primarily moose (by weight), although wolves killed two sheep during this 30-day study (Valkenburg 1992). After that study, there was evidence that wolf predation shifted

to caribou and may have accelerated the Delta herd's decline from approximately 11,000 in 1989 to 6,000 in 1991. In 1992, most of the Delta herd moved north of their traditional area in the Alaska Range and onto the Tanana Flats after a record deep snowfall in September. The deep snow also may have prevented some moose from making their traditional movement from the Tanana Flats into the foothills of the Alaska Range. Predation on sheep may have increased during this latter period because of the relative scarcity of alternate prey in the foothills.

The importance of coyote predation on sheep in Subunit 20A is unknown. However, anecdotal information indicates that coyote populations have increased in recent years. Coyotes are significant predators on sheep in other areas.

During our aerial survey of sheep in 1991, we observed a ewe standing by a dead lamb with 5-10 ravens nearby, 2 coyotes (1 of which was feeding on another sheep), several golden eagles, and 1 bald eagle.

Habitat

Although we know of at least 19 mineral licks used by sheep in Subunit 20A, their relative importance to sheep populations is unknown. Sheep fidelity to specific home ranges is relatively high. Therefore, disturbance or destruction of sheep habitat may be detrimental to local subpopulations of sheep. We will coordinate with Habitat Division to minimize negative impacts of development on sheep habitat.

Spiers and Heimer (1990) recommended that the Army protect all sheep habitat on Fort Greely land by excluding vehicular traffic from areas above 3,500 ft (1,070 m) between Buchanan Creek and Delta Creek. They also recommended that large ground exercises not be spread over extensive portions of sheep range because sheep need ample area to escape when disturbed by people or equipment.

Nonregulatory Management Problems/Needs

Subunit 20A has been a popular area for guides to take clients sheep hunting. Before 1989, a longstanding system of exclusive guide areas limited guided hunting pressure in the area. However, a Supreme Court decision in 1988 abolished the exclusive guide areas. Since 1989 the number of guides operating in an area has not been limited and the potential exists for conflicts between guides. Because the bag limit for sheep is restricted to the taking of full-curl or larger rams, we do not anticipate problems with overharvest. However, a much higher proportion of the legal rams may be harvested with this anticipated additional hunting pressure.

McNay (1990) identified the following five priority information needs for sheep management in Subunit 20A:

1. A reliable index to, or estimate of, population size.
2. Unbiased estimates of lamb production and yearling recruitment.
3. Age/sex-specific natural mortality rates.
4. Knowledge of the harvest rate among available legal rams each year and the age composition of that harvest.
5. An estimate of the impact of predation on Dall sheep.

Ver Hoef (1992) reviewed methods, applications, and limitations of sheep data collected at mineral licks. I recommend that we carefully consider his conclusions while developing projects to study sheep population size, mortality, and recruitment.

CONCLUSIONS AND RECOMMENDATIONS

We are currently meeting three of the five objectives for sheep in Subunit 20A. We continue to meet the objective of providing the greatest sustainable annual opportunity to hunt Dall sheep by maintaining a resident and nonresident open season for full-curl rams from 10 August through 20 September. The restriction to full-curl rams also allows us to meet the objective to maintain naturally regulated ewe and subadult ram segments of the population. The objective to provide the opportunity to view and photograph sheep under natural conditions is easily met with access into many areas of sheep habitat.

However, with the current estimates of 2,000-4,000 sheep in Subunit 20A, we are not meeting the objective to manage for a sheep population of approximately 5,000 sheep. Recruitment has been very poor for sheep throughout much of the Interior. The 1992 lamb:ewe ratio was lowest in Subunit 20A (5:100), but was also low in the Delta Controlled Use Area (11:100) and the White Mountains (15:100).

I believe that the lack of sheep seen during the 1991 and 1992 aerial surveys reflects a substantial decline in population. Sightability during the survey should have been very high; survey conditions were good/excellent and the pilots and observer were experienced. Sheep tend to have a high fidelity to their home ranges so a shift in distribution was probably not responsible for the low number of sheep seen. The decline is probably primarily due to several years of relatively severe winters that decreased survival rates. Sheep in poor physical condition due to severe winter/snow conditions may be more vulnerable to predation. Although weather will continue to be unpredictable, the Implementation Plan to remove a substantial number of wolves from Subunit 20A should result in fewer sheep being killed by wolves.

With this decline in the sheep population, we are probably not meeting the objective to provide for the greatest sustainable harvest of sheep. Hunting is restricted to the taking of full-curl (or larger) rams, so we are not concerned about an overharvest of sheep and have no recommendations for changes in hunting regulations. However, we expect harvest to decline as weak cohorts from the last few years mature and become legal to hunt.

Increased mortality of adults may also contribute to a smaller number of legal rams in future years.

I recommend that in 1993 we gather more information on the Subunit 20A sheep population size, productivity, and/or mortality after reviewing Ver Hoef's (1992) analysis of techniques most appropriate to each objective.

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Prepared by:

Robin M. Eagan
Wildlife Biologist III

Approved by:

Kenton P. Taylor
Management Coordinator

Reviewed by:

Kenneth R. Whitten
Wildlife Biologist III

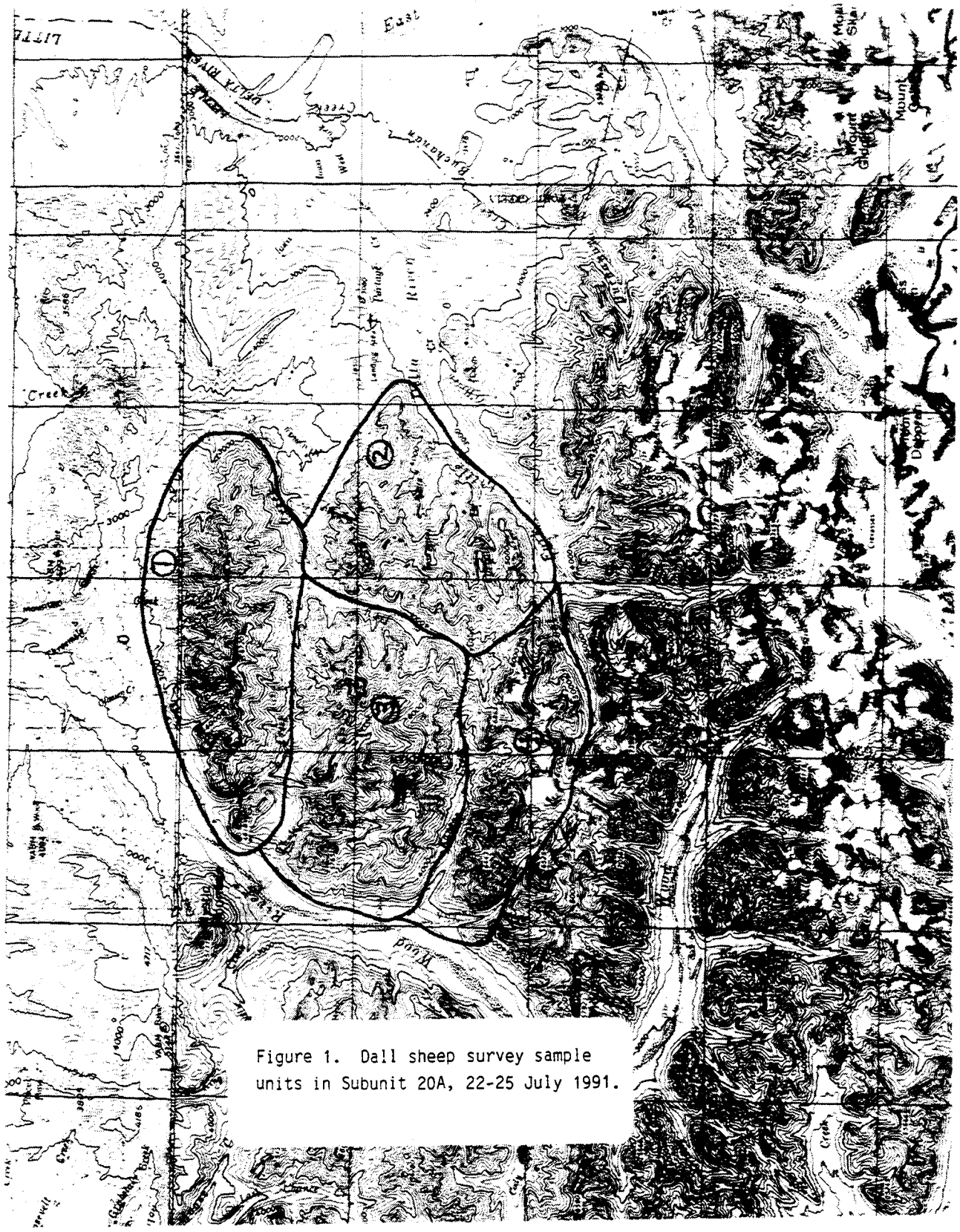

Figure 1. Dall sheep survey sample units in Subunit 20A, 22-25 July 1991.

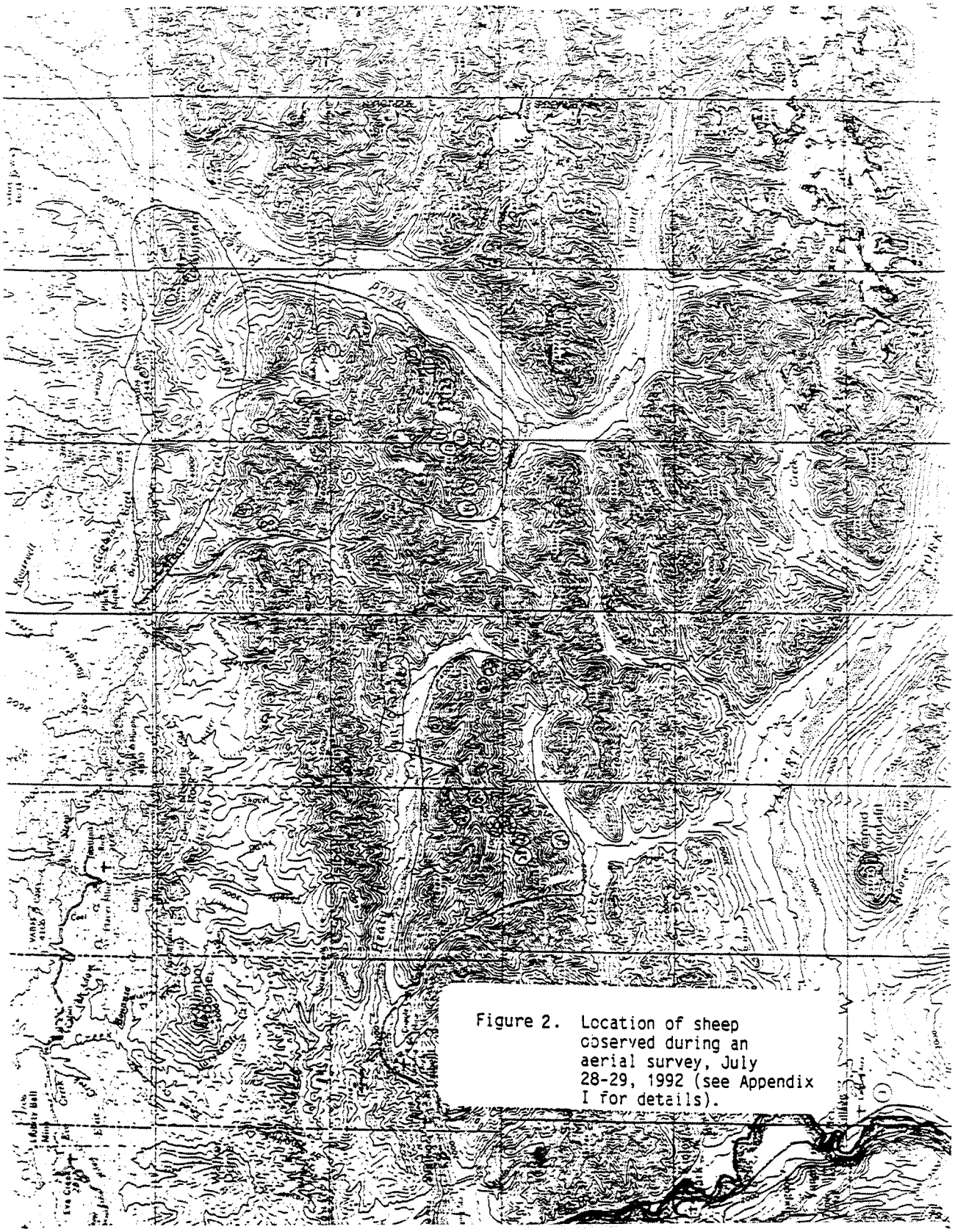

Figure 2. Location of sheep during an aerial survey, 28-29 July 1992.

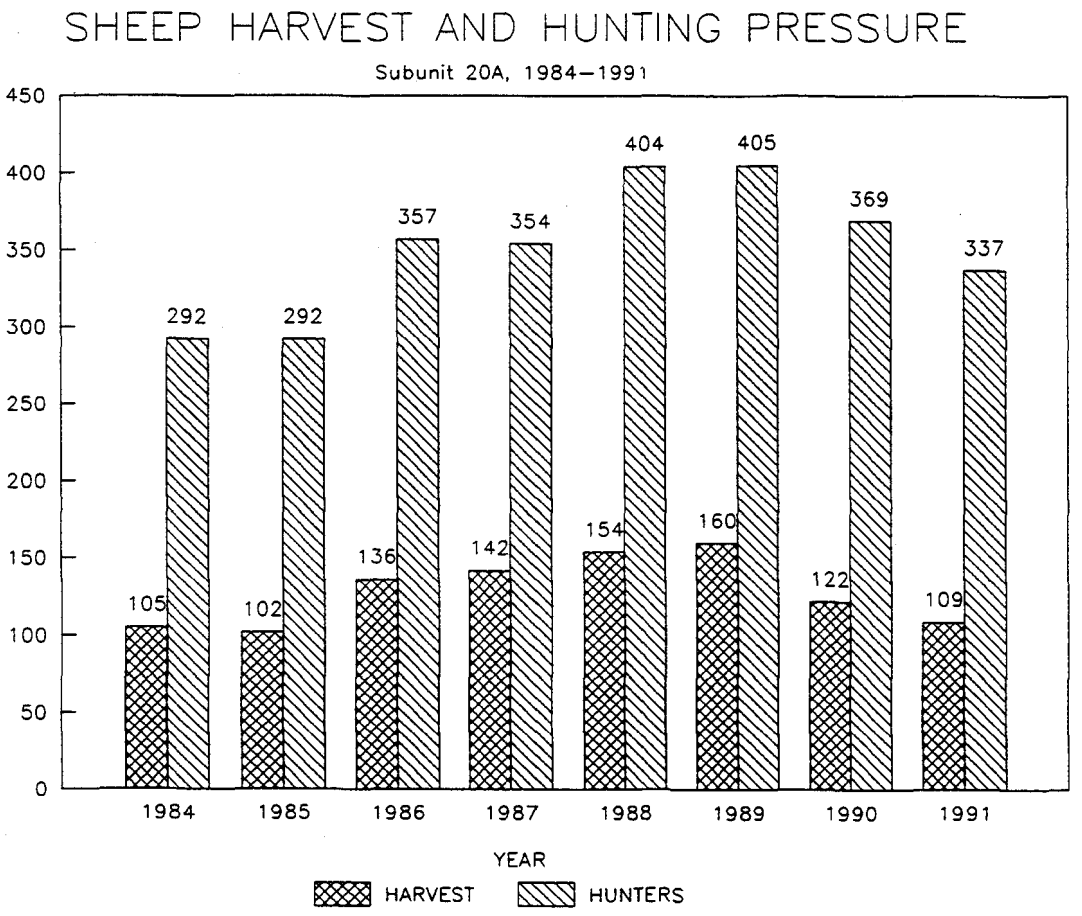

Figure 3. Sheep harvest and hunting pressure in the Central Alaska Range (Subunit 20A), 1981-1991.

Table 1. Results of sheep survey between the Wood River and the East Fork of the Little Delta River (Subunit 20A), July 1984 and July 1991.

Sample Unit	Area (mi^2)	Date	Pilot/Observer	Aircraft	Search time	Composition					No. collars seen
						"Ewes"	Lambs	Rams	Unk	Total	
1	71	7/12,13/84	Sibbett (12) and Lentsch(13)/Heimer	PA18	3:20	192	58	113	0	363	9
		7/22/91	McNay/O'Connor	Scout	3:30	123	20	75	2	220	5
2	50	7/11/84	Lentsch/Heimer	PA18	2:45	241	94	58	0	393	37
		7/25/91	Lentsch/O'Connor	PA18	3:30	177	39	72	0	288	15
3	64	7/12/84	Lentsch/Watson	PA18	4:15	172	79	95	0	346	12
		7/23/91	Lentsch/O'Connor	PA18	3:22	74	9	48	0	131	0
4	35	7/13/84	Lentsch/Heimer	PA18	1:20	137	49	25	0	211	1
		7/25/91	Lentsch/O'Connor	PA18	2:11	49	8	2	0	59	0
Total	220	7/11-13/84			11:40	742	280	291	0	1,313	59
	--	7/22-25/91			12:33	423	76	197	2	698	20

[a] "Ewes" includes unidentified young rams and yearlings of both sexes.

Table 2. Results of aerial sheep survey in Subunit 20A, 28 and 29 July 1992.[a]

Area	Area (mi^2)	Search Time	Composition						Total
			"Ewes"[b]	Lambs	Rams				
					Legal	Sublegal	Unk.	Total	
Mystic Mtn	40	4:14	34	1	2	6	0	8	43
Keevy Peak	69		64	0	3	30	0	33	97
Upper Healy/ Moody Creeks	44	2:53	35	6	3	27	11	41	82
Total	153	7:07	133	7	8	63	11	82	222

[a] Pilot W. Lentsch/observer R. Eagan counted and classified all sheep from a PA-18.
[b] Includes unidentified young rams and yearlings of both sexes.
[c] Full-curl or broomed on at least one side.

Table 3. Distribution of sheep harvest, Subunit 20A, 1986-91.

Area	Uniform Location Code	1986		1987		1988		1989		1990		1991	
		Harvest	Hunters	Harvest	Hunters	Harvest	Hunters	Harvest	Hunters	Harvest	Hunters	Harvest	Hunters
Rex Dome	(0102)	0	5	11	13	4	10	4	14	3	5	9	13
Healy Creek	(0103)	20	64	19	72	11	56	20	66	10	44	17	76
Moody Creek	(0104)	10	24	10	23	13	32	8	27	11	38	7	19
Yanert	(0105-0109)	24	56	19	53	27	73	16	56	22	64	18	68
Totatlanika River	(0202, 0200, 0201)	4	21	3	20	7	24	7	34	2	28	4	33
Tatlanika River	(0302, 0300)	3	3	5	13	3	12	9	14	1	2	3	9
Total west & south of Wood R. drainage[a]		61	173	67	194	65	207	64	211	49	181	58	218
Wood River West	(0402, 0403)	22	37	13	30	25	43	24	47	13	39	6	14
Wood River East	(0404)	16	30	19	32	26	48	28	51	17	46	6	19
Wood River South	(0405)	4	6	7	8	2	3	5	7	4	6	0	3
Total Wood River[a]	(all 0400s)	46	87	45	79	54	104	62	113	38	103	19	47
W. Fork Little Delta	(0603, 0604)	0	8	2	0	1	1	6	10	6	13	2	8
Buchanan Creek	(0602)	1	6	6	0	2	4	0	2	0	1	4	5
E. Fork Little Delta	(0605)	10	23	5	14	9	15	5	1	8	18	8	17
Total Little Delta[a]	(all 0600s)	15	45	18	32	15	30	12	7	16	36	16	37
Dry Creek	(0505, 0507)	7	16	4	13	10	19	11	20	15	27	9	17
Delta Creek	(0702)	4	15	2	3	4	8	8	15	3	15	5	8
McGinnis Glacier	(0800, 0802)	1	6	1	3	1	2	0	1	0	2	1	2
Unknown 20A	(000, 100)	2		5		5	34	6	13	3	15	1	8
Total Subunit 20A		136	357	142	354	154	404	163	410	124	379	109	338

[a] Includes harvest for which no specified area was given.

Table 4. Historic sheep harvests and hunter participation, Subunit 20A, 1968–91.

Year[a]	Reported harvest	Total hunters	Percent success	Mean horn length (inches)[b]
3/4-curl				
1968	138	366	38	33.1
1969	97	262	37	32.9
1970	119	269	44	33.6
1971	133	376	35	33.8
1972	120	359	33	32.5
1973	78	246	32	31.3
1974	101	232	43	31.8
1975	97	217	45	32.3
1976	112	248	45	32.3
1977	116	233	50	32.3
1978	98	248	40	31.8
7/8-curl				
1979	86	226	38	33.4
1980	88	214	41	34.9
1981[a]	116	252	46	34.9
1982	112	189	59	34.0
1983	121	297	41	33.7
Full-curl				
1984	105	292	36	34.0
1985	102	292	35	34.0
1986	136	357	38	34.2
1987	142	354	40	35.0
1988[c]	154	404	38	34.7
1989[d]	163	410	40	34.3
1990[d]	124	379	33	34.4
1991[d]	109	338	32	34.5

[a] The boundary of Subunit 20A was different prior to 1981, but has remained the same since 1981.
[b] Includes broomed horns.
[c] Data from harvest printout 1-30-89.
[d] Data from harvest summary book.

Table 5. Dall sheep hunter residency and success, Subunit 20A, 1984-91.

	Successful					Unsuccessful					
Year	Unit res.	AK res.[a]	Non-res.	Unk	Total	Unit res.	AK res.[a]	Non-res.	Unk	Total	Total hunters
1984	--	78	27	0	105	--	177	7	3	187	292
1985	44	65	36	1	102	143	177	10	3	190	292
1986	59	90	36	10	136	141	196	13	12	221	357
1987	61	80	49	13	142	100	166	9	37	212	354
1988[b]	43	72	45	37	154	125	175	3	72	250	404
1989[c]	78	110	52	1	163	158	223	19	5	247	410
1990[c]	49	73	46	5	124	167	235	12	8	255	379
1991[c]	50	76	33	0	109	146	207	15	7	229	338

[a] Includes unit residents.
[b] Data from harvest printout 1-30-89.
[c] Data from harvest summary books.

Table 6. Sheep harvest chronology in Subunit 20A, 1984-91.

	Percent of total harvest			
Year	10-20 Aug	21-31 Aug	1-10 Sep	11-20 Sep
1984	56	18	13	13
1985	52	23	15	9
1986	38	29	25	8
1987	49	29	13	10
1988	50	26	15	9
1989[a]	--	--	--	--
1990[b]	60	21	7	4
1991[b]	56	20	16	5

[a] Data not readily available in this format. However, 45% of sheep harvested in 1989 were taken by 19 August. An additional 36% were taken by 2 September.
[b] Additional percent unknown/other.

Table 7. Subunit 20A sheep harvest percent by transport method, 1985-91.

Regulatory year	Percent of harvest							n
	Airplane	Horse	Boat	3 or 4-Wheeler	ORV	Highway vehicle	Unknown	
1985	56	27	1	1	3	12	0	96
1986	48	29	0	1	6	16	0	127
1987	50	30	0	2	5	13	0	131
1988	62	20	0	1	5	12	0	142
1989	55	20	0	5	4	15	1	160
1990	56	23	0	4	6	10	1	122
1991	57	19	1	6	3	8	6	109

LOCATION

Game Management Subunits: Portions of 20B, 20F, and 25C (534 mi^2)

Geographical Description: White Mountains area

BACKGROUND

Dall sheep in the White Mountains provide the public with opportunities to view and hunt sheep relatively close to Fairbanks with access from the road, by air, or by boat. Because the sheep population is small (<400 sheep) and harvest is low (<7 sheep/year), these sheep have received relatively little attention and surveys have been infrequent. The only research project during recent years was a study (1983-88) of 10 radio-collared sheep to identify their distribution, movements, and seasonal use areas as part of a cooperative study between the Bureau of Land Management (BLM) and ADF&G (Durtsche et al. 1990). Previous population studies were conducted by the USFWS as far back as 1950 (Gross 1963).

Most sheep habitat in the White Mountains area lies within the White Mountains National Recreational Area (WMNRA) and the Steese National Conservation Area (SNCA), which were established by the Alaska National Interest Lands Conservation Act in 1980 and are managed by BLM. Increases in public use as a result of development of trails, roads, public use shelters, and mineral exploration and development may conflict with the existing management goal to provide for the opportunity to hunt sheep under aesthetically pleasing conditions.

MANAGEMENT DIRECTION

Management Goal

The management goal for area Dall sheep is to provide the opportunity to hunt Dall sheep in the White Mountains under aesthetically pleasing conditions.

Management Objectives

Management objectives have been modified slightly since the last survey-inventory report (Beasley 1989*a*) and now read as follows: 1) manage for the sustained annual opportunity to harvest full-curl rams from a population of at least 250 Dall sheep and 2) cooperate with the Bureau of Land Management and potentially affected interest groups to protect sheep habitat.

METHODS

Population Status and Composition

To estimate population size and composition, biologists conducted 3 aerial surveys of sheep in the White Mountains during this report period. Observers classified sheep as lambs, ewes, or rams based on horn size/shape and body conformation. The "ewes" category included young rams that could not be distinguished from ewes, and yearlings of both sexes. In 1989, we classified rams to horn size, and in 1991 and 1992 as legal (full-curl or both horns broomed) or sublegal because of the difficulty seeing rams adequately to judge horn size.

Observers searched alpine and subalpine sheep habitat by flying low-level contours and circles at 60-80 knots/hr in a PA-18. Pilot W. Lentsch (Tamarack Air) has flown most of the sheep surveys in this area and his knowledge of sheep distribution increased effectiveness of our surveys.

1989:

On 4 August, Pilot W. Lentsch and ADF&G biologist R. Beasley surveyed the Mount Schwatka area for 35 minutes (Beasley 1989*b*). Because of strong winds on the north side, they had to fly relatively fast and high. They were unable to complete the survey because of low ceilings (3,200 ft., only the base of the mountain was visible) and moderate/heavy turbulence.

On 6 August, Pilot S. Hamilton (Tamarack Air) and R. Beasley surveyed the Lime Peak and Mount Prindle areas for 115 and 68 minutes, respectively. Survey conditions were good, with winds 0-5 mph, light/no turbulence, and good light due to high overcast.

Because poor weather continued until the onset of sheep hunting season, they did not complete surveys of Victoria Mountain, portions of Mount Schwatka, and Cache Mountain. However, two ADF&G biologists (P. Valkenburg and E. Crain) reported observations from their sheep hunting trip in the White Mountains west of Fossil Creek, which also was not surveyed. We added their information to our data.

1991:

From 30 September to 3 October, Pilot W. Lentsch and BLM biologists S. Watson and W. Hobgood surveyed 4 areas: Mount Prindle; Lime Peak; the White Mountains between Beaver Creek, Fossil Creek, and Willow Creek; and most of the Mount Schwatka area (Watson 1991). Total search time was 8.8 hours. Overall survey conditions were ideal.

1992:

On 1, 3, and 4 August, Pilot W. Lentsch and BLM biologist J. Herriges surveyed the vicinities of Mount Schwatka, Victoria Mountain, White Mountains, Lime Peak, Willow Creek, upper Sheep Creek, and Mount Prindle (Herriges 1992). Total search time was 11.8 hours. Survey conditions were excellent; skies were mostly sunny, and turbulence was light on 1 August and moderate on 3 and 4 August.

Harvest

We monitored harvest through harvest ticket report cards. Seasonal movements and distribution of sheep were monitored with 10 radio-collared sheep (Durtsche et al. 1990).

RESULTS AND DISCUSSION

Population Status and Trend

Surveys indicate the size of the sheep population in the White Mountains fluctuated widely during the last 22 years. Biologists flew aerial surveys in 1970, 1977, 1982, 1986, 1989, 1991, and 1992 (Fig. 1, Table 1). According to these surveys, the population was high in 1970 (285 sheep counted) but declined 56% (124 sheep counted) by 1977. The observer in both surveys, A. Smith (ADF&G biologist), believed that this dramatic decline was real and not an artifact of survey conditions or techniques (A. Smith memo, 26 Aug 1977, ADF&G files). He stated that important factors contributing to this decline were probably deep snow during winter 1970-71 and increased wolf predation related to lack of caribou west of the Steese Highway after 1971. Some fluctuations in numbers of sheep observed during surveys are because of differences in area covered, survey intensity, and sheep sightability, rather than changes in population size. The number of sheep observed during surveys increased from 1977 through 1991, but may have stabilized in 1992.

Population Size:

We estimate that the White Mountains area currently includes approximately 325-375 sheep, which is the highest estimate since at least 1970. During aerial surveys in 1991 and 1992, observers counted 354 and 324 sheep, respectively (Table 1). Although high search intensity (8.8 and 11.8 hours, respectively) should have resulted in high sightability during these surveys, sheep in this area sometimes use habitat well away from escape terrain, including timber and shrub-covered areas near mineral licks. Therefore, we adjusted our estimate upward to account for sheep not observed.

Population Composition:

Recruitment of lambs appeared moderate (23 to 37 lambs:100 "ewes") between 1986 and 1991. During 1992, recruitment was very low (15:100). This low recruitment accounts for most of the decrease in number of sheep counted in 1992 versus 1991. A widespread phenomena such as weather probably contributed to this low recruitment in 1992 because biologists also documented low lamb:ewe ratios in Subunit 20A (5:100) and the Delta Controlled Use Area of Subunit 20D (11:100).

During the last 7 years, 35 to 45 rams:100 ewes have been counted during aerial surveys (Table 1). The number of legal rams has generally decreased since 1970, largely because of restrictions in the definition of "legal." Legal rams included 3/4-curl or larger rams from 1970 to 1978; 7/8-curl rams from 1979 to 1985; 7/8-curl rams for Unit 25 and full-curl rams for Unit 20 in 1986; and full-curl rams since 1987.

Caution should be used in interpreting composition data from aerial surveys in the White Mountains area. Survey areas varied throughout the years because weather often prevents portions of sheep habitat from being surveyed. Because ram groups and ewe/lamb groups often occupy different ranges during summer, the area surveyed affects composition. In addition, sheep are distributed differently in September/October than in June/August, so the survey date should be noted. Composition data from aerial surveys of sheep underestimate true lamb:ewe and ram:ewe ratios because the "ewe" category contains yearlings and young rams.

Distribution and Movements:

Sheep in the White Mountains occur in small, widely scattered groups throughout approximately 534 mi^2 of alpine habitat near Victoria Mountain, Mount Schwatka, Mount Prindle, Lime Peak (Rocky Mountain), and White Mountains proper. Because this area is geographically isolated from other sheep populations (ADF&G 1976), sheep in the White Mountains area may have relatively unique gene pools (Durtsche et al. 1990).

The seasonal movements and distribution of sheep described in the remainder of this section were taken primarily from a study of 10 radio-collared sheep between 1983 and 1988 by Durtsche et al. (1990). Movement from wintering areas to lambing areas usually occurred between late May and mid-June, with most lambs being born between 15 May and 30 May (earliest was 10 May). Movements to rutting areas usually occurred from late September to late October. Additional movements by rams to winter range occurred from late November through December.

Individual sheep associated themselves with one of several bands. Separate bands used disjunct ranges most of the year, intermingled with other bands during pre-rut and rut, then returned to their favored areas post-rut. Bands of ewes often used the same range as

bands of rams though not at the same time. Rams shifted notably away from easy access points during the sheep hunting season.

Although some mixing occurs, sheep in the White Mountains are found in two main areas, Lime Peak/Mount Prindle and Victoria Mountain/Mount Schwatka.

Lime Peak/Mount Prindle. Sheep wintered at Lime Peak, VABM Fossil, and the headwaters of Willow Creek. Ewes moved to lambing areas and summer ranges at the headwaters of Mascot Creek west of Lime Peak, and in the ridge complex around Mount Prindle. Sheep used mineral licks in upper Mascot Creek and Preacher Creek. Rutting and wintering areas included Lime Peak, VABM Fossil, and the headwaters of Willow Creek.

Victoria Mountain/Mount Schwatka. During winter, sheep inhabited Victoria Mountain and the ridges north and east of Mount Schwatka. Lambing occurred on Victoria Mountain and the ridge complex in upper Jefferson Creek, upper Big Creek, and Mount Schwatka. Sheep used mineral licks in the headwaters of Jefferson Creek and along Victoria Creek north of Victoria Mountain. The major rutting area for this region appears to be east of Mount Schwatka and north of Victoria Mountain.

Mortality

Harvest:

Seasons and Bag Limits. The sheep hunting season was 10 August to 20 September throughout this report period. The bag limit was one full-curl ram (includes rams that are at least 8 years old or have both horns broomed) (Table 2).

Board of Game Actions and Emergency Orders. No board actions or emergency orders were issued this report period.

Hunter Harvest. During the last 5 years (1987-91), only 18 sheep were reported harvested from the White Mountains area (Table 3). Harvests in 1989 and 1991 represented 100% (6/6) and 36% (5/14), respectively, of the legal rams observed during aerial surveys that year (5 rams harvested in 1991 were added to the 9 rams seen during the post-hunting season survey).

Dall sheep in the White Mountains area tend to have more massive horns than sheep in other portions of the Interior. The horns tend to have much bigger bases and seem more likely to be broomed. Since 1987, horn size of harvested sheep has ranged from 31.5 to 43.0 inches long with 13- to 15-inch bases ($\bar{x}$ = 14.1 inches). Fifty-five percent of these sheep had at least one broomed horn. We did not calculate mean horn length because some lengths included broomed horns. Since 1989, sheep harvest reports have asked how many horns were broomed. This will facilitate more meaningful mean horn length for areas with larger harvests.

During the last 5 years, the reported ages of harvested rams have ranged from 7 to 15 years old ($\bar{x}$ = 9.1 years, $\underline{n}$ = 18).

Hunter Residency and Success. Nonresidents have not reported hunting sheep in the White Mountains since 1984 (Table 4). Success rate for resident and nonresident hunters for the last 5 years combined was 21% (11/87). During the last 5 years, 86 hunters reported spending 409 days hunting sheep in the White Mountains area (Table 5).

Harvest Chronology. Sixty-one percent (11/18) of the sheep harvested since 1984 were taken during the first 11 days of the season (Table 6). It is not possible to determine whether the timing of the hunt influences the probability of success because unsuccessful hunters are not asked to report when they hunted. It is also difficult to identify trends in harvest because of the relatively low number of sheep harvested from this area.

Transport Methods. Main access points for planes are a small airstrip on Lime Peak and gravel bars and several private strips along Beaver Creek. Float planes can land on several small lakes north of Mount Schwatka and sometimes on Beaver Creek. Ground access is primarily from trails and mining roads off the Steese Highway. In 1988, BLM established ORV restrictions throughout the WMNRA and SNCA. With these restrictions, most of the sheep range in the White Mountains area is closed to the use of ORVs. However, ORVs weighing <1,500 pounds are allowed in most of the area between the Steese Highway and Mount Prindle, which provides good access to sheep habitat.

Despite the scarcity of landing sites, airplanes were the most common means of transportation for successful and unsuccessful sheep hunters. From 1987 to 1991, 42% (15/36) of the hunters using airplanes were successful (Table 7). During these 5 years, 83% (15/18) of the successful hunters used airplanes. Three- or four-wheelers were the most common (35%, 27/78) method of transportation for unsuccessful hunters. Hunters using ORVs and highway vehicles were usually unsuccessful. The use of 3- or 4-wheelers for hunting increased from <8/year before 1991 to 15 in 1991; no one was successful.

Natural Mortality:

Natural mortality of sheep in the White Mountains area is probably caused primarily by weather and predation. Deep snow has been implicated as an important cause of sheep mortality in some years (Heimer and Watson 1986).

Weather during winter 1989-90 was relatively mild (i.e., low snowfall) and probably was not directly responsible for much sheep mortality. The 1990-91 winter in Fairbanks included a record snowfall of 144.7 inches and average temperatures. The 1991-92 snowfall was greater than average with mild temperatures and snow present in Fairbanks until the middle of May. This late snow could have contributed to the low lamb survival observed during spring 1992 (15 lambs:100 ewes). Recent adverse weather apparently has

not reduced the number of adult sheep in the White Mountains, but the population is probably no longer increasing.

Sheep in the White Mountains frequently travel through forested areas because of scattered, low-elevation sheep habitats and the scarcity of rugged escape terrain in the alpine areas (ADF&G 1976). Although these forested areas may provide some escape cover from eagles, traveling through these areas probably increases sheep susceptibility to predation by terrestrial predators. The risk of sheep traveling away from escape terrain was illustrated in November 1988, when a pack of 5 wolves killed 13 rams in Unit 11. These rams had crossed a flat, 1- or 2-mile drainage bottom and begun to ascend but had not reached escape cover (R. Tobey, pers. commun.).

Little is known about predation rates or predator populations in the White Mountains area. Since 1988, sealing documents show an annual harvest in Subunit 25C of 3-11 wolves, 0-3 wolverines, 2-4 grizzly bears, and 3-23 lynx. McNay (1989) estimated that 87 wolves reside in Subunit 25C. One collared ewe was killed by wolves in winter 1983-84, and golden eagles have been seen on Lime Peak.

Habitat Assessment and Enhancement

Important features of sheep habitat include summer range, winter range, travel routes between the two ranges, mineral licks, lambing areas, and escape terrain. Protection of these features is important to the long-term welfare of sheep in the White Mountains area because the relatively low-elevation, discontinuous alpine areas offer limited sheep habitat and few alternatives. Mineral licks have been identified at Mount Schwatka (Jefferson Creek), Lime Peak (Mascot Creek), Mount Prindle (Convert Creek), along Beaver Creek, and possibly at Victoria Mountain (B. Durtsche, pers. commun.).

Caves have been used by sheep in the White Mountains area for many years, perhaps for relief from hot weather. In 1950 L.E. Powell (ADF&G files) wrote that "A cave on the eastern slope of the White Mountains had considerable sheep sign in it. The entrance was approximately 25' high and 14' wide. A water hole 25' inside the cave was inaccessible to sheep because it was sunken in shear walls below ground level. The floor of the cave was covered with an inch of old sheep droppings. No prominent or recently used trails were found in the immediate area." In 1982, five rams were seen leaving a cave during a "hot and buggy day" (E. Crain, pers. commun.).

Protection of sheep habitat is important. Three potential threats to sheep habitat include mineral exploration, BLM's development of recreational facilities in the WMNRA and SNCA, and forest succession encroaching on sheep range in the absence of a natural fire regime. BLM's facilities include trails and remote cabins that are intended to substantially increase human use of the area. BLM is developing the 18-mile Nome Creek Road, which links the Steese Highway with two new campgrounds and several trailheads, to increase recreational opportunity.

To improve moose browse quantity and quality, the BLM burned, by prescribed fire, approximately 5,000 acres in the upper Bear and Quartz creek drainages in June 1987. A natural fire also burned 35,000 acres south of Cache Mountain during summer 1987. In 1988 the Livengood fire burned approximately 517,000 acres, and another fire burned the area north of the White Mountains. These burns may benefit sheep habitat by retarding encroachment of forest upon the alpine areas and establishing an earlier stage of plant succession in the area.

CONCLUSIONS AND RECOMMENDATIONS

The opportunity to hunt sheep in the White Mountains under aesthetically pleasing conditions is being provided. Human use of sheep in the White Mountains area is relatively low, and it is unnecessary to limit the number or distribution of hunters. To maintain aesthetically pleasing conditions, activities such as use of ORVs, mineral exploration, and development of trails, access, and cabins should be monitored and discouraged if necessary. Nonconsumptive use of sheep, such as viewing, will probably increase during the next few years as the BLM promotes recreational use of the area.

We are meeting the management objective to provide sustained opportunity to harvest full-curl rams from a population of at least 250 sheep. We maintained a resident and nonresident season for a full-curl ram from 10 August to 20 September. The population estimate of 325-375 sheep exceeds our minimum population objective. During the next report period we will determine whether or not this minimum estimate should be adjusted because of evidence that the White Mountains sheep have a relatively isolated gene pool.

We are also meeting the objective to work cooperatively with BLM and other potentially affected groups to protect sheep habitat. Mineral licks are important year-round use areas and any activity that limits sheep from these areas should be closely examined and discouraged if necessary. ORVs have emerged as a potential problem by rapidly expanding the existing trail system in areas where their use is permitted, and also in prohibited areas, including sheep habitat (Durtsche et al. 1990). During the next report period, we plan to assess the effects of increased road and trail access on the number of hunters and on aesthetic hunting conditions.

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Prepared by:

Robin M. Eagan
Wildlife Biologist III

Toby A. Boudreau
Wildlife Biologist I

Submitted by:

Kenton P. Taylor
Management Coordinator

Reviewed by:

Kenneth R. Whitten
Wildlife Biologist III

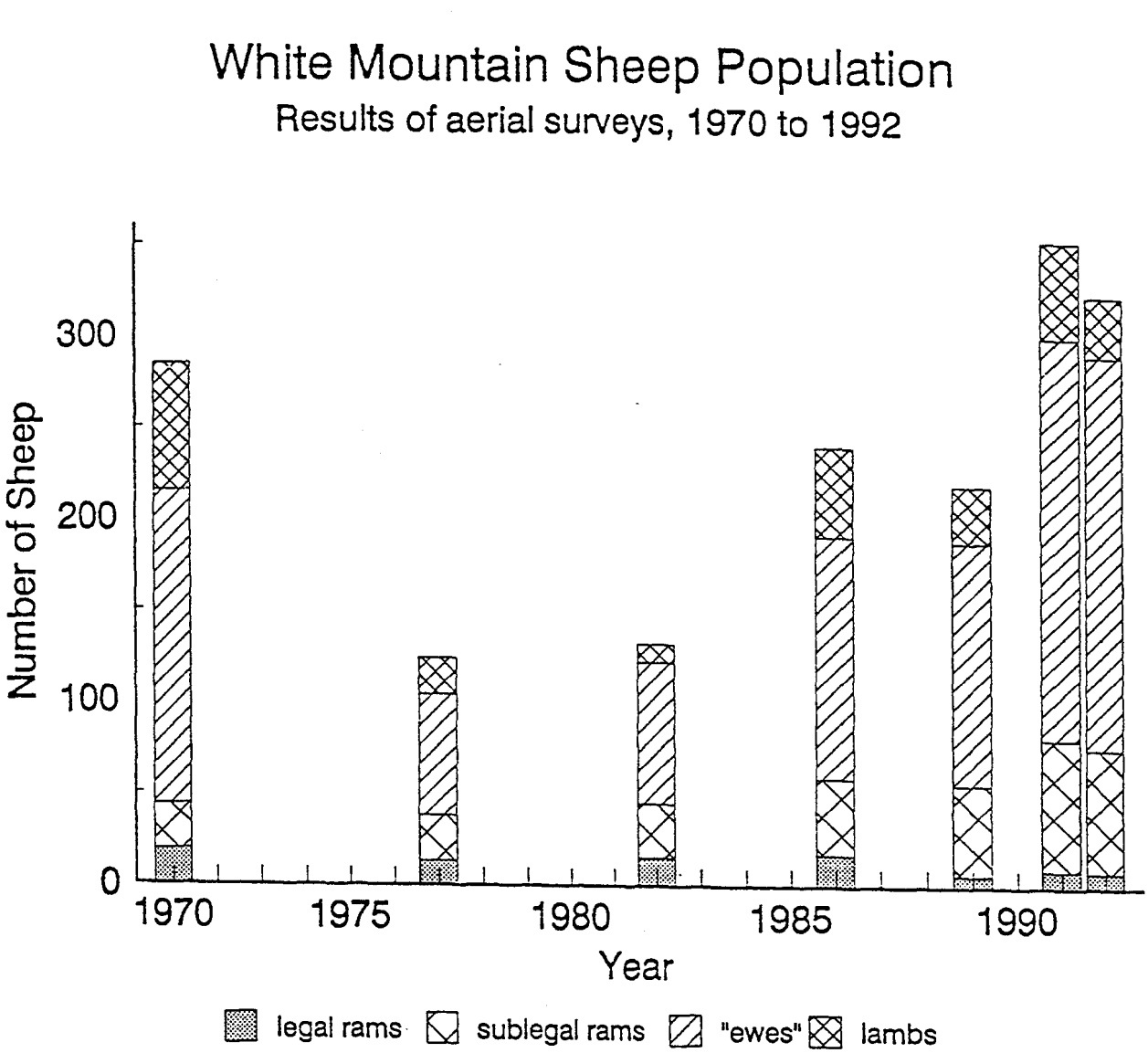

Figure 1. Composition of sheep observed during aerial surveys of the White Mountains area, 1970-92 ("legal rams" included 3/4-curl from 1970-1978; 7/8 curl from 1979 to 1985; and 7/8 curl for that portion in Unit 25, and full-curl for that portion in Unit 20 in 1986; and full-curl for both units since 1987).

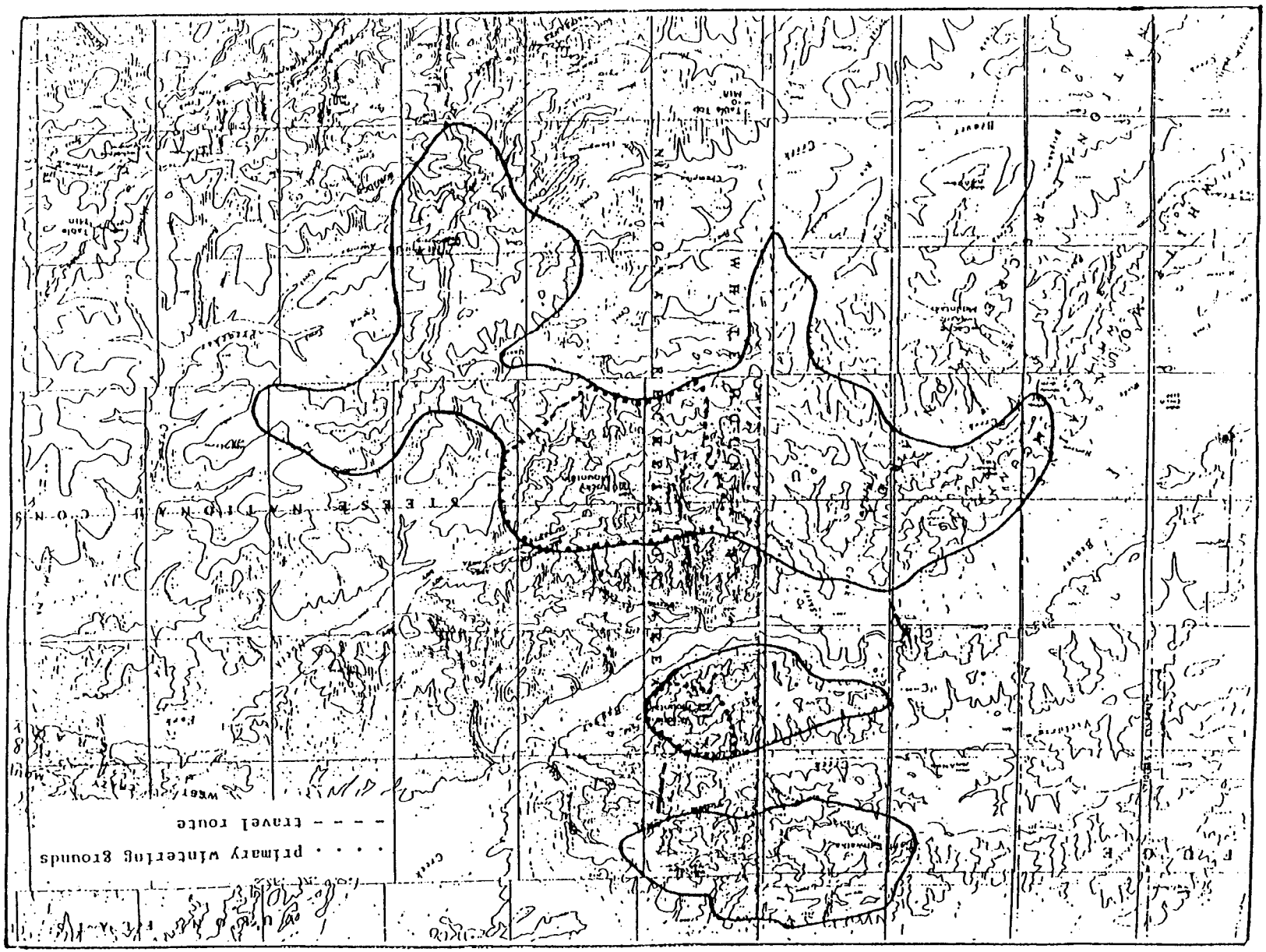

Figure 2. Primary range of sheep in the White Mountains area (1 square = 36 mi^2).

Table 1. Composition of sheep counted during aerial surveys in the White Mountains area, Subunits 20B and 25C, 1970-92.

Date	Rams		Total	"Ewes"[b]	Lambs	Nonlambs	Total sheep	Count (hrs)	% Lambs	Lambs: 100 ewes	Rams: 100 ewes
	Legal[a]	Sublegal									
28 Aug 1970	19	25	44	171	70	215	285	5.9	25	41	26
5-8 Aug 1977	13	25	38	66	20	104	124	6.5	16	30	58
29 Jun-3 Jul 1982	15	30	45	77	10	122	132	9.6	8	13	58
17-29 Jun 1986	17	42	59	132	49	191	240	14.6	20	37	45
4-10 Aug 1989	6	50	56	132	31	188	237[c]	3.6	13	23	42
30 Sep-3 Oct 1991	9[b]	72	81[d]	220	53	301	354[d]	8.8	15	24	37
1-4 Aug 1992	8	68	76	215	33	291	324	11.8	10	15	35

[a] "Legal" rams = 3/4-curl in 1970 and 1977, 7/8-curl in 1982 and 1986, full-curl since 1987.

[b] "Ewes" includes unidentified young rams and yearlings of both sexes.

[c] Total number includes 18 sheep that were not classified. Count also includes ground observations by P. Valkenburg and E. Crain on 9-10 August when they observed 17 rams, 12 ewes, and 7 lambs.

[d] Does not include five rams harvested during the 1991 hunting season.

Table 2. Sheep seasons and bag limits in the White Mountains area, Subunits 20B and 25C, 1983-92.

Year	Season	Bag limit	Legal horn size[a]	
			Portion in Unit 20	Portion in Unit 25
1983	10 Aug-20 Sep	1 ram with:	7/8-curl horn or larger	7/8-curl horn or larger
1984-86	10 Aug-20 Sep	1 ram with:	Full-curl horn or larger	7/8-curl horn or larger
1987-92	10 Aug-20 Sep	1 ram with:	Full-curl horn or larger	Full-curl horn or larger

[a] Full-curl and 7/8-curl restrictions also allow harvest of rams with both horns broken.

Table 3. Characteristics of sheep reported harvested in the White Mountains area, Subunits 20B and 25C, 1983-91.

Year	Horn			Days hunted
	Age (yrs)	Broomed?[a]	Length (in)	Base (in)
1983	--[b]	N	36	12	15
	--	N	37.5	14	15
	--	Y	35	12.5	7
1984	11	Y	34	15	8
	7	Y	35.5	13	8
1985	7	N	34.25	14	8
	8	Y	32.5	15.5	7
	6	N	32	13	5
	8	N	37.25	15.25	4
	14	N	33.5	14	5
1986	8	Y	28	15	15
	10	N	37.5	14	6
	8	Y	35	--	6
	9	Y	35	13	10
	10	N	32	11	10
1987	9	Y	36	15	7
	8	N	37.5	14.5	5
1988	13	Y	34.5	14	2
1989	11	1[a]	43	14.5	4
	10	0	38.25	14	1
	6	0	38.25	14.5	4
	8	0	38	14.87	2
	15	2	33	14	3
	12	0	34.5	13.25	3
1990	7	0	31.5	14	3
	9	1	41.5	14	8
	10	2	39	15	2
	11	2	39.13	13.5	6
1991	11	2	37	14.13	7
	9	2	34	13	2
	8	0	35.5	14.5	7
	7	0	38.5	14	5
	10	1	41	13	2

[a] Prior to 1989, "Y" indicates 1 or 2 horns broomed. Since 1989, the number of horns broomed was reported.
[b] Age data not available.

Table 4. Sheep hunter residency[a] and success for the White Mountains area, Subunits 20B and 25C, 1984-91.

	Successful hunters				Unsuccessful hunters				Total hunters	
Year	Res.	Nonres.	Unspec.	Total	Res.	Nonres.	Unspec.	Total	No.	% Success
1984	0	2	0	2	21	0	1	22[b]	24	8
1985	5	0	0	5[c]	12	0	0	12[d]	17	29
1986	4	0	1	5	4	0	1	5	10	50
1987	2	0	0	2	11	0	0	11[c]	13	15
1988	1	0	0	1	8	0	6	14[c]	15	7
1989	6	0	0	6	8	0	3	11	17	35
1990	4	0	0	4	13	0	1	14	18	22
1991	5	0	0	5	19	0	0	19	24	21

[a] Resident of Alaska.

[b] Includes one coded as unspecified locations in Unit 20 that could have been from Tanana Hills.

[c] Does not include one hunter in Subunit 20F.

[d] Includes two coded as 27Z that could have been from Tanana Hills.

Table 5. Mean number of days hunted for sheep in the white Mountains area Subunits 20B and 25C, 1984-91.[a]

Year	Successful		Unsuccessful		Total
	No. hunters	Mean no. days	No. hunters	Mean no. days	no. hunters
1984	2	8 ± 0.0	22[b]	7 ± 6.3	24
1985	5[c]	6 ± 1.6	12[d]	4 ± 1.4	17
1986	5	9 ± 3.7	5	6 ± 2.6	10
1987	2	6 ± 1.0	11[c]	4 ± 2.1	13
1988	1	2 ± 0.0	14[c]	4 ± 2.0	15
1989	6	3 ± 1.2	11	4 ± 1.8	17
1990	4	5 ± 2.8	14	4 ± 2.3	18
1991	5	5 ± 2.5	18	6 ± 3.0	23
1987-91	18	4 ± 2.2	68	5 ± 4.2	86

[a] Not all hunters reported the number of days they hunted.
[b] Includes one coded 20Z that could have been from Tanana Hills. Also includes two, 25-day hunts.
[c] Does not include one hunter from Subunit 20F.
[d] Includes two coded 27Z that could have been from Tanana Hills.

Table 6. Harvest chronology for sheep in the White Mountains area, Subunits 20B and 25C, 1984-91.

Year	Harvest chronology			
	10-20 Aug	21-31 Aug	1-10 Sep	11-20 Sep
1984	2	0	0	0
1985	3	1	1	0
1986	1	2	1	1
1987	2	0	0	0
1988	0	1	0	0
1989	4	0	0	2
1990	1	1	1	1
1991	4	0	0	1
1987-91	11	2	1	4

Table 7. Transport methods for sheep hunters in the White Mountains area, Subunits 20B and 25C, 1984-91.

Year	Airplane	3- or 4-wheeler	ORV	Highway vehicle	Other/ unknown
Successful					
1984	2	0	0	0	0
1985[a]	5	0	0	0	0
1986	3	0	1	0	1
1987	2	0	0	0	0
1988	1	0	0	0	0
1989	5	0	0	0	1
1990	4	0	0	1	0
1991	3	0	0	0	1
1987-91	15	0	0	1	2
Unsuccessful					
1984[b]	8	6	3	2	3
1985[c]	4	1	4	3	0
1986	0	1	3	1	0
1987[a]	6	2	1	0	2
1988[a]	4	1	3	2	4
1989	1	1	4	3	2
1990	7	8	2	1	1
1991	3	15	0	4	1
1987-91	21	27	10	10	10

[a] Does not include one hunter from Subunit 20F.
[b] Includes one coded as 20Z that could have been from Tanana Hills.
[c] Includes one coded as 27Z that could have been from Tanana Hills.

LOCATION

Game Management Units: Portions of 20D and 20E (1,000 mi^2)

Geographical Description: Tanana Hills

BACKGROUND

Dall sheep populations inhabiting the Tanana Hills may be characterized as low density and disjunct. These populations are at low densities because of the geography of the Tanana Hills, which is atypical Dall sheep habitat (Kelleyhouse and Heimer 1989). Because the Tanana Hills are at a fairly low elevation and have a rolling physiography, escape terrain is limited, making sheep more vulnerable to predation. In an effort to maintain sheep habitats in the Tanana Hills, where forest succession occurs to the top of most hills, the ADF&G continues to support wildfire management plans that should increase the extent of this marginal sheep habitat over time.

MANAGEMENT DIRECTION

Management Goals

Management goals for area Dall sheep are to: 1) protect, maintain, and enhance the sheep population and its habitat in concert with other components of the ecosystem and 2) provide an opportunity to hunt sheep under aesthetically pleasing conditions.

Management Objectives

The management objectives for area Dall sheep are to: 1) maintain the current aesthetically pleasing hunting conditions and 2) perpetuate this remnant sheep population, and, if feasible, increase the population from an estimated 350 to 700 by the year 2000.

METHODS

The currently high aesthetic qualities of hunting sheep in the Tanana Hills exist because of limited hunter participation and use of this small sheep resource. Sheep may be hunted without permit in the Glacier Mountain Controlled Use Area southwest of Eagle and west of the Taylor Highway, but the use of motorized vehicles is prohibited. In the remainder of the area, sheep may be hunted only under terms of limited drawing permits. Four permits are issued for each of three hunt areas. Harvest is restricted to full-curl rams only.

Harvest is monitored through drawing permit report cards. Data on harvest success, hunt area, hunter residence and effort, transportation type used to the hunt area, and animal horn size and age were analyzed.

RESULTS AND DISCUSSION

Population Status and Trend

The last complete survey of sheep habitat was conducted in 1982, and yielded a population estimate of 365 sheep. Under normally prevailing environmental conditions in the Interior, recruitment and mortality are roughly balanced and sheep populations stable (Heimer 1988). During this report period climatic conditions were mild to average, except possibly winter 1991, which was probably severe in terms of snow depth. National Park Service (NPS) staff conducted 4 aerial surveys for Dall sheep between 1983 and 1990 within the Yukon-Charley Rivers National Preserve (YCNP) (hunt areas 1107 and 1108) (Ulvi and Knuckles 1990). Based on their data, the area's sheep population increased between 1983 and 1990, possibly by as much as 10% annually. I suspect the Mt. Harper and Glacier Mountain sheep populations benefited from the favorable climatic conditions during this period. However, no surveys have been conducted since winter 1991.

Population Composition:

We have not collected any composition data from this area since 1982. Table 1 presents composition data collected by the NPS staff in the YCNP. The 1983 lamb:ewe, yearling:ewe, and ram:ewe ratios were 48:100, 27:100, and 142:100, respectively. In 1990, the lamb:ewe, yearling:ewe, and ram:ewe ratios were 47:100, 44:100, and 84:100, respectively. The legal ram:ewe ratio was 38:100 and 20:100 in 1983 and 1990, respectively. The number of legal rams remained the same (18) during both surveys, even through the total number of sheep increased by two-thirds. Lamb production and yearling recruitment were high in 1991. Harvest of rams was low during 1983-89, and the small change in ram numbers relative to a large increase in ewe numbers is difficult to explain unless ewes were missed in the 1983 survey and/or rams were missed in 1990.

Distribution and Movements:

There are no data that suggest distribution and movements are different than reported by Kelleyhouse and Heimer (1990).

Mortality

Harvest:

Season and Bag Limit. The open season for resident and nonresident hunters in Subunits 20D and 20E is 10 August to 20 September; the bag limit is one ram with full-curl or longer horns. Lottery permits (four each) were issued for hunt area nos. 1106, 1107, and 1108. Hunters using the Glacier Mountain Controlled Use Area (GMCUA) may not use motorized vehicles from 5 August through 20 September, but participation is not limited by a lottery-permit requirement. A harvest ticket is required for the GMCUA.

Board of Game Actions and Emergency Orders. No actions by the Board of Game or emergency orders affected the Tanana Hills sheep hunts during this report period.

Hunter Harvest. Hunters reported taking three rams in the GMCUA during 1991. The mean horn length was 33.7 inches (Table 2). The average harvest during the past 5 years has been 2.6 rams with a horn length of 34 inches. Six hunters out of the possible 12 participated and harvested three rams in the permit area (Table 2). Two hunters were successful and one was unsuccessful in the Mt. Harper hunt area (1106) (Table 3). One hunter participated (unsuccessful) in the Mt. Sorenson hunt area (1107). Two hunters participated in the Charley River hunt area (1108), and one ram with 37-inch horns was taken. In hunt 1107 there have been 1.2 hunters participating each year with an average harvest of 0.4 rams. In hunt 1108, there has been less than one hunter participating each year with an average harvest of 0.2 rams. Harvest is having a negligible effect on the sheep populations in the Tanana Hills.

Hunter Residency and Success. Thirteen state resident (includes one unit resident) hunters harvested three rams (23% success) in the GMCUA. All six hunters who participated in the drawing hunts were state residents (no unit residents); they harvested three rams (50% success). The overall number of hunters in the Tanana Hills was 19, and the harvest was six rams. The 1991 annual success rate of 32% is typical for the Tanana Hills.

Permit Hunt. During 1991, 6 of the 12 permits were used. During the past 5 years, the average permit use rate was 36.6% for the 3 permit areas combined. However, for hunts 1107 and 1108 the participation rate averaged only 25%; only 3 rams have been harvested over the past 5 years.

Harvest Chronology. In the GMCUA, two rams were harvested during the third week of the season and one was harvested the last week. The timing of sheep harvest varies annually in the GMCUA, possibly because many hunters also wish to hunt caribou and do not begin their hunt until caribou are accessible. Hunters may not feel compelled to hunt early because competition is so low in this area.

Transportation Methods. In the permit areas, which are remote, all hunters traveled to the area using aircraft. In the GMCUA, all successful hunters reported walking into the area. In past years, hunting by horseback has been common among successful hunters. Mechanized transportation is prohibited for sheep hunting in this area.

Other Mortality:

Most sheep mortality in the Tanana Hills is attributable to natural factors. Predation by wolves, grizzly bears, and golden eagles occurs, and the scarcity of escape cover may enhance predator effectiveness. Before 1991, winter severity has been mild to average, and it appears that the sheep populations in the Tanana Hills may have increased during that favorable period. The effects of the 1991 winter on these populations are not known.

Habitat

Assessment:

Kelleyhouse and Heimer (1989) detailed an explanatory hypothesis of habitat limitation based on physical geography of the Tanana Hills. While it is unlikely that summer range is limiting in extent or quality, it seems probable that winter range availability may limit population growth. Inconsistent winter winds and snowpacks averaging 50 inches per year combine to produce variable winter foraging conditions.

Portions of the Tanana Hills included in the YCNP will be protected from most human disturbance. Mt. Harper has known mineral potential and was subject to mining in the past. Any full-scale development of the area must entail sufficient measures to minimize disturbance of sheep or destruction of sheep escape cover or winter range. Coordination with Habitat Division to minimize any development will occur if such plans materialize.

Over 30 years of wildfire suppression has caused lower elevation winter ranges and travel routes to become cloaked in spruce forest. Implementing the Alaska Interagency Fire Management Plan-Fortymile Area should result in a near-natural fire regime throughout this area. Tanana Hills sheep populations should benefit from this plan.

CONCLUSIONS AND RECOMMENDATIONS

Based on surveys conducted by NPS staff, the sheep population in the Tanana Hills probably increased during the 1980s. Harvests have been low during the report period, with little effect on the population. The management objective of maintaining aesthetically pleasing hunting conditions is being met. However, based on the amount of hunter participation in the Mt. Sorenson area (hunt area 1107) and in the Charley River area (hunt area 1108), the objective of maintaining aesthetic hunting conditions could still be met while allowing for greater sheep hunting opportunity by taking these areas off drawing permit. Because of the remoteness of these two areas and the associated expense to travel there, the number of hunters will remain low. Harvest is not expected to increase significantly due to the difficult hunting conditions found in these areas. Sheep in this area tend to be widely dispersed and often occur below treeline. Because of the low use by hunters and the low harvest in the portion of the GMCUA that can be reached by foot

or horses, opening these areas to a general hunt is not expected to increase harvest by more than 3 to 5 sheep per year.

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Prepared by:

Craig L. Gardner
Wildlife Biologist III

Submitted by:

Kenton P. Taylor
Management Coordinator

Reviewed by:

Kenneth R. Whitten
Wildlife Biologist III

Table 1. Tanana Hills Dall sheep composition counts from aerial surveys conducted by the NPS within Yukon-Charley Rivers National Preserve, 1983 and 1990.

Sex/age class	1983	1990	% Change
Legal rams[a]	18	18	0
Sublegal rams[b]	44	52	18.2
Unclassified rams	6	5	--
Total rams	68	75	10.3
Ewes[c]	48	89	85.4
Lambs	24	42	75.0
Yearlings	13	39	200.00
Unidentified	2	14	--
Total other sheep	87	184	--
Total sheep	155	259	67.1
Legal rams:100 ewes	37.5	20.2	
Sublegal rams:100 ewes	91.7	58.4	
Total rams:100 ewes	141.7	84.3	
Lambs:100 ewes	50.0	47.2	
Lambs % of total	15.5	16.2	
Yearling: 100 ewes	27.1	43.8	

[a] Full curl or larger.
[b] Greater then 1/4 curl but less than full curl.
[c] Ewe classification also includes yearlings of both sexes and rams of 1/4 curl or less.

Table 2. Glacier Mountain Controlled Use Area annual sheep harvest, 1987-91.

Year	Rams	x Horn length	x Age	Ewes	Total sheep	No. hunters
1987	5	32.6	8.4	0	5	11
1988	3	34.1	unk	0	3	12
1989	1	34.0	9.0	0	1	7
1990	1	36.0	11.0	0	1	4
1991	3	33.7	8.3	0	3	13

Table 3. Tanana Hills annual sheep harvest data by permit hunt, 1987-91.

Hunt No. /area	Year	Permit issued	Did not hunt	Unsuccessful hunters	Successful hunters	horn length	Total harvest
1106	1987	4	unk	unk	1	36.5	1
	1988	4	0	2	2	36.6	2
	1989	4	3	0	1	34.8	1
	1990	4	2	1	1	39.8	1
	1991	4	1	1	2	37.0	2
1107	1987	4	unk	unk	1	38.0	1
	1988	4	3	0	1	34.0	1
	1989	4	4	0	0	--	0
	1990	4	4	0	0	--	0
	1991	4	3	1	0	--	0
1108	1987	4	unk	unk	0	--	0
	1988	4	3	1	0	--	0
	1989	4	4	0	0	--	0
	1990	4	4	0	0	--	1
	1991	4	2	1	1	37.3	1
1991 Totals		12	6	3	3	37.1	3
All permit hunts[a]		48	33	7	8	36.6	8

[a] Excludes 1987.

LOCATION

Game Management Units: 23 (44,000 mi^2) and 26A (53,000 mi^2)

Geographical Description: Western Brooks Range

BACKGROUND

Dall sheep are indigenous to northwest Alaska. For centuries, Inupiat residents in this area hunted sheep for subsistence. Sheep are now hunted by resident and nonresident recreational hunters in addition to local subsistence hunters.

Little is known about the historical abundance of sheep populations in northwest Alaska although it is thought that sheep had periodically declined to very low densities (W. Heimer, pers. comm.). Because sheep in Unit 23 and Subunit 26A are at the northwestern margin of their range in Alaska, these populations may be less robust than populations farther south, and may be more prone to large fluctuations in population size caused by adverse weather conditions. Long-term local residents have suggested that the abundance of predators such as wolves and brown bears has fluctuated widely during the last 50 years in response to subsistence hunting pressure on brown bears, the presence of reindeer and caribou, and the effects of aerial wolf hunting.

In Unit 23 and Subunit 26A, sheep are distributed as relatively small and discreet subpopulations. Most of these areas are accessible to aircraft and snowmachines. Sheep habitat in northwestern Alaska is easy to hunt, and increasing numbers of non-local recreational hunters are using the area. High losses of sheep to natural mortality through starvation, wolf predation, and disease have occurred since at least 1990. As a result, staff from the Department and the National Park Service (NPS) have made sheep management a high priority in Unit 23 and Subunit 26A since 1988, and have committed substantial time and money to collect survey and inventory data.

MANAGEMENT DIRECTION

Management objectives for area Dall sheep are as follows:

Baird Mountains:

1. Maintain a post-hunt (fall and winter) population of 450-600 adult sheep.

2. Maintain a minimum ratio of 7 to 10 7/8-curl-and-larger rams per 100 "ewes" ("ewe" defined as adult female, yearling of either sex, or 1/4-curl ram).

DeLong Mountains:

1. Collect 5 years of survey data by 1995 in the Wulik Peaks and Kugururuk River/Trail Creek trend count areas to determine the status of DeLong Mountain sheep populations.

2. Once 5 years of data have been collected, establish biologically-based management objectives for sheep.

3. Maintain a minimum ratio of 7 to 10 7/8-curl-and-larger rams per 100 "ewes" ("ewe" as defined above).

METHODS

Aerial fixed-wing surveys have been conducted yearly in a 768 mi^2 (1989 km^2) portion of the Baird Mountains in cooperation with the NPS since 1986. However, this trend count area and the survey techniques employed were not standardized until 1988. During this report period, this area was surveyed on 20-21 July 1989, 23-25 July 1990, and 28-29 June 1991. Survey data from 2-4 July 1992 is also reported for comparative purposes even though it was collected after the report period.

Surveys were timed to coincide with the formation of large ewe-lamb bands on the Kilyaktalik Peaks. Two to 3 Piper PA-18 aircraft, each with an observer experienced in conducting sheep counts, were used each year. Survey intensity was 3 to 4 minutes/mi^2. Locations of sheep were plotted on U.S.G.S. 1:250,000 topographic maps, and group composition was recorded using categories of lambs, "ewes" (adult females, yearlings of either sex, and 1/4-curl rams), 1/2-curl rams, 3/4-curl rams, 7/8-curl rams, and full-curl rams. We made no effort to evaluate sightability of sheep.

In 1990, immediately after completing the Baird Mountain sheep trend count, that portion of the Baird Mountains west of the count area and east of the Hunt River was searched for 12 to 13 hours using 2 aircraft with experienced observers. Survey intensity was approximately 1 to 3 minutes/mi^2. The purpose of this additional effort was to determine whether the decline in sheep from 1989 to 1990 was attributable to emigration from the trend count area, and to evaluate the assumption that the Baird Mountain sheep trend count area encompasses at least 90 to 95% of the range of this subpopulation. Sheep and sheep sign (trails and beds) were mapped on U.S.G.S. 1:250,000 scale maps.

Sheep surveys have been conducted in the DeLong Mountains since the 1960s. However, survey areas and search techniques were never standardized. As a result, we have no basis for evaluating temporal changes in sheep populations for the area. To rectify this, the Wulik Peaks sheep trend count area (261 mi^2; 676 km^2), and the Kugururuk River/Trail Creek trend count area (411 mi^2; 1064 km^2) were established during July 1991. We

surveyed these areas using techniques described above at a survey intensity of 3 to 4 min/mi^2. We compared data from these areas with data gathered from previous years whenever possible.

During 26 to 30 June 1991, we searched at low intensity that portion of the DeLong Mountains between the Wulik Peaks and the western boundary of Gates of the Arctic National Park (approximately 0.5 minutes/mi^2) using four-place, fixed-wing aircraft (Cessna 206, Cessna 185, and Maule M-6). We flew these flights to assess the distribution of sheep throughout this area. Three observers, at least 1 of which was experienced in sheep counts, were used on each flight. We plotted locations of sheep and sheep sign (trails and beds) on U.S.G.S. 1:250,000 topographic maps and made no effort to collect sex and age composition data, or to evaluate sightability of sheep.

We collected harvest information through the statewide sheep harvest ticket and registration permit system. During all 3 regulatory years, hunters were required to use a statewide harvest ticket for the fall hunt in the DeLong Mountains, a registration permit for the fall Baird Mountain hunt, and a subsistence harvest ticket for the winter hunt in Unit 23.

RESULTS AND DISCUSSION

Population Size, Status and Trend

Baird Mountain Population Size: Sheep density in the Baird Mountains, even before the decline of 1990-92, was low compared to densities reported in the southern Yukon Territory (Burles et al. 1984), and in other areas of Alaska (Singer 1984, Table 1).

The size of the Baird Mountain population peaked during summer 1989, but began to decline during winter 1989-90 (Table 1). Additional search effort completed during July 1990 from the eastern boundary of the trend count area to, and including, the Akiak Mountains near the Hunt River revealed fewer than 20 sheep and, more importantly, almost no sheep trails or beds. This indicates that the decline from 981 to 718 sheep between 1989 and 1990 probably did not result from sheep emigrating out of the trend count area.

This population declined dramatically during the exceptionally severe winter of 1990-91. Freezing rain occurred during October just before snowfall and was quickly covered by snow. As a result, groundfast ice did not sublimate until late winter or spring. Deep snow accumulated by early November and eventually reached record depths. Repeated blizzards with record-setting low temperatures occurred throughout winter making the snow very hard and consolidated in exposed areas, and extremely deep and drifted in valleys and protected areas. Surprisingly, the upper ridges of traditional sheep winter range did not blow clear of snow until late February. Based on my examination of several sheep

carcasses and numerous reports from local hunters, we believe that starvation was the principal cause of the population decline.

Throughout the report period, wolf numbers in the Kobuk and Noatak river drainages were increasing and considered to be high by long-term area residents. We believe that wolf predation contributed to the decline in sheep numbers. Although wolf predation alone did not precipitate this decline, it will probably affect the magnitude and duration of the decline.

Delong Mountain Population Size: Sheep survey data for the DeLong Mountains is not as complete as for the Baird Mountains. Only limited comparisons between these areas are possible. However, these comparisons should be considered tentative until additional data are collected in the DeLong Mountains. Sheep density in the Kugururuk River/Trail Creek area is roughly comparable to densities observed in the Baird Mountains (Tables 1 and 2). Sheep density in the Wulik Peaks area appears much lower than in the Bairds although this may partially be an artifact of the count area excluding some portions of this subpopulation's range.

Sheep populations in the Delong Mountains have apparently declined slowly since at least 1983 (Table 2). Although causes for the decline are not known, we believe that starvation during severe winters and wolf predation have been contributing factors.

Low-intensity surveys conducted by agency biologists, reports from guides (J. Jacobsen, P. Driver, J. Walker, and N. Walker, pers. comm.), and anecdotal information from local residents indicate that sheep are not uniformly distributed throughout the DeLong Mountains. In fact, very few sheep occur between the headwaters of the Nimiuktuk and Nuka rivers, and the Midas-Douglas Creek area. The mountains in this area are composed of poor sheep habitat characterized by little vegetation or escape terrain.

Population Composition: The number of lambs and lamb:ewe ratios observed during surveys peaked during 1988 and 1989 (Table 1). The small decline in lamb production from 1988 to 1989 is probably attributable to a very large ewe-lamb band that was categorized as "unknown sex/age" during the 1989 survey. In order to avoid excessive harassment of the large group, survey personnel chose instead to incompletely classify the group and listed many animals in the "unknown" category. Since 1989, lamb production appears to have steadily declined except during 1991 when very few lambs were produced. Winter severity has been reported to significantly affect lamb production during the following spring in a Yukon sheep population (Burles et al. 1984). The exceptionally low lamb production observed during 1991 is almost certainly because of the extremely harsh winter of 1990-91.

The number of ewes declined precipitously from 1990 to 1991 (Table 1). This was probably because heavy mortality among older ewes which had accumulated in the population during the period of growth (see also Watson and Heimer 1984). The poor

lamb production during 1991 combined with the large decline in ewes will adversely affect recovery of this population in the future.

In contrast to ewes, the number of rams in the Baird Mountains remained about the same during the population decline (Table 1). Virtually all old rams in the population were harvested during the fall hunting season before the severe 1990-91 winter, and relatively few old rams were left that would have been predisposed to starvation. The observed increase in the ram:ewe ratio from 1990 to 1991 is almost certainly the result of fewer ewes in the population and does not represent an increase in ram numbers.

Before 1991, lamb production in the Kugururuk River/Trail Creek area of the Delong Mountains was comparable to a productivity of 42 lambs:100 ewes reported necessary to maintain stable sheep populations in the Alaska Range (Heimer and Watson 1986), and higher than lamb:ewe ratios reported for the Yukon Territory (Burles et al. 1984, Table 2). However, lamb production in this area was substantially lower during 1991 and 1992. As in the Baird Mountains, severe winter conditions were probably largely responsible for this decline. Lamb production was also low during 1991 in the Wulik Peaks; however, data is insufficient to reveal any trend in productivity for this area. Also, the Wulik Peaks trend count area may exclude an important post-lambing area (P. Driver, pers. comm).

The Kugururuk River/Trail Creek count area has typically maintained higher proportions of rams in the population than the Baird Mountains. This is probably because less recreational hunting has occurred in the DeLong Mountains than in the Baird Mountains. No trend in the abundance of rams is evident for the Wulik Peaks count area.

Mortality

Seasons and Bag Limits:

Unit 23*	**Resident Open Season**	**Nonresident Open Season**
Resident Hunters: 1 sheep; season will be closed in that portion south and east of the Noatak River (excluding Gates of the Arctic National Park) when 30 sheep have been taken.	Oct. 1-April 30	
All Hunters: 1 ram with 7/8-curl horn or larger; a registration permit is	Aug. 10-Sept. 20	Aug. 10-Sept. 20

required in that portion south and east of the Noatak River (excluding Gates of the Arctic National Park); a harvest quota will be announced before the permit hunt.		
Subunit 26A		
1 ram with 7/8-curl horn or larger.	Aug. 10-Sept. 20	Aug. 10-Sept. 20

* During the 1991-92 regulatory year, the season in most of Unit 23 was closed by Emergency Order, and the season in Subunit 26A west of Howard Pass was shortened to Sept. 1-Sept. 20.

Human-Induced Mortality: More sheep were reported harvested in Unit 23 during the 1989-90 regulatory season than in any previous year on record despite an emergency closure of the fall 1989 hunting season in the Baird Mountains (Table 3). In the Baird Mountains, 16 rams were harvested by 29 August 1989, closely approaching the fall quota of 18 rams. As a result, the fall season in the Baird Mountains was closed on 29 August, and 2 additional rams were taken by hunters still afield at the time of emergency closure.

The number of rams harvested in Subunit 26A were 15 for 1987-88, 11 for 1988-89, 12 for 1989-90, 20 for 1990-91, and 21 for 1991-92. Most sheep harvested from Subunit 26A were taken in the Nanushuk-Shainin Lake area. Typically, only 2 to 4 rams were taken in the western portion of the subunit (G. Carroll, pers. comm.).

From 1970 to 1990, the number of hunters participating in the Unit 23 fall hunting season has gradually increased. No trend in number of hunters is apparent for the winter subsistence season. This is probably because weather and snow conditions strongly affect the ability of local hunters to access sheep hunting areas during March and April when most subsistence sheep hunting occurs.

Noncompliance with harvest reporting requirements by local residents continued to seriously compromise the usefulness of harvest data in Unit 23. Reported harvests should be viewed as minimum estimates of actual harvest, especially for the winter season. Georgette and Loon (1991) reported that Unit 23 residents currently harvest 20-56 sheep for subsistence annually. Assuming that most of this harvest occurs during winter, the reported harvest during winter is substantially smaller than the actual harvest (Table 3).

Hunter Residency and Success: Most sheep harvested in Unit 23 and Subunit 26A during the fall season were taken by non-local Alaska residents or nonresidents (Tables 4 and 5). In contrast, virtually all sheep harvested during the Unit 23 winter season were taken

by local residents. Overall hunter success rates were 54% for 1989-90, 42% for 1990-91, and 55% for 1991-92.

Transport Methods: Nearly all sheep hunters accessed hunting areas using aircraft during the Unit 23 fall hunting season in the Baird and DeLong mountains (Table 6). Aircraft were the only means of transportation used by sheep hunters in Subunit 26A (excluding Gates of the Arctic National Park) for all 3 regulatory years. Snowmachines were the only means of transportation used by subsistence hunters during the Unit 23 winter sheep season during this period.

Natural Mortality: As previously mentioned, starvation probably caused the Baird Mountain sheep population to decline precipitously in size during winter 1990-91. Although wolf predation undoubtedly contributed to the decline, its primary effect will probably be on the magnitude and duration of the decline.

During July 1992, 6 intact sheep carcasses were found during sheep surveys in the Trail Creek/Kugururuk River trend count area. The carcasses were very fresh (at least 2 were certainly less than 12 hours), and 2 were subsequently necropsied within 36 hours of death. Laboratory analyses of tissue samples did not reveal a definitive cause of death because the carcasses quickly deteriorated in the summer heat. The presence of large amounts of brown serous fluid in the thoracic cavity of both sheep suggests that the animals probably died of a respiratory malady (R.A. Dieterich, pers. commun.). Respiratory ailments have been documented in western bighorn sheep populations. Whatever the cause, these sheep died of a very acute disease rather than from predation, trauma, or parasitism.

Two additional intact carcasses were observed in the Trail Creek/Kugururuk River trend count area 1 week after the surveys had been completed, and an intact sheep carcass was reportedly observed in the Baird Mountains near the headwaters of Timber Creek during late July. These observations suggest that disease may be causing significant mortality among sheep in Unit 23.

The WAH has been increasing since the mid-1970s and, as of July 1990, numbered at least 415,692 caribou (ADF&G unpub. data). The abundance, movements, and distribution patterns exhibited by this growing herd may have significant short and long-term effects on Unit 23 and Subunit 26A sheep populations.

The trend toward increasing numbers of wolves in northwestern Alaska is at least partially a numeric response to growth of this caribou herd, and probably will have a negative long-term effect on sheep populations. The presence of large numbers of overwintering caribou in the Baird and DeLong mountains reduces wolf reliance on sheep for food, and may represent a positive short-term effect. However, the effect of huge, insect-induced aggregations of 50,000-200,000 caribou traveling through sheep ranges during summer has a tremendous impact on vegetation. This impact occurs through removal of vegetation

by feeding caribou, and more importantly through the destruction of vegetation by trampling (a negative short-term effect).

Board of Game Actions and Emergency Orders

Hunting regulations and bag limits in Unit 23 and Subunit 26A during 1990-91 were the same as in 1989-90. As a result of the McDowell court decision, however, all Alaskan residents became qualified to participate in the Unit 23 winter subsistence sheep hunt on state and federal lands during the 1990-91 regulatory year. During prior years, only hunters residing north of the Arctic Circle in Unit 23 were qualified to participate during the winter hunt.

At the urging of the NPS, the Federal Subsistence Board established regulations for the 1990-91 regulatory year limiting participation in the Unit 23 winter sheep hunt on Federal lands to only those residents of the unit who resided north of the Arctic Circle. After we verified the severe decline in Unit 23 sheep populations did actually occur, all sheep hunting in the Baird Mountains was closed by ADF&G and Federal Emergency Order during the 1991-92 regulatory year. In addition, the Emergency Order issued by the department shortened the fall season in the DeLong Mountains to September 1 through September 20 for Unit 23, and that portion of Subunit 26A west of Howard Pass.

The method of allocating sheep between the fall and winter hunts in the Baird Mountains is complex. Thirty sheep are allocated to the winter season, and 10 rams are allocated to the fall season. When the Board of Game considered sheep regulations for the Baird Mountains during 1986, they assumed that equal numbers of rams and ewes would be harvested during the winter season. If fewer than 15 rams are harvested during the winter hunt, the balance of these "unharvested" rams is applied to the subsequent fall hunt. The fall quotas for rams during 1989 and 1990 were 18 (i.e., 10 rams allocated to the fall hunt and 8 unharvested rams left over from the 1988-89 winter season) and 19, respectively.

CONCLUSIONS AND RECOMMENDATIONS

Given the low density of northwestern Alaska sheep populations, especially in relation to wolf and caribou densities, the discreet distribution of individual sheep subpopulations, and the frequency of severe winters in this area, it is unlikely that managers can maintain stable populations of sheep at even modest densities. Considering the vulnerability of sheep in this area to hunting by recreational and subsistence hunters, managers should implement conservative hunting regulations to avoid exacerbating dramatic, naturally-caused declines in sheep populations.

The accuracy of sheep harvest data from rural hunters needs to be significantly improved if it is to be of any value for determining harvest levels or for making allocation decisions. One option is to invest more time and money into making the existing harvest

system work. Most urban hunters comply with existing harvest reporting requirements. Over 75% of all rural hunters who buy a hunting license and pick up harvest tickets complete and return them to the department. This system currently fails because many rural hunters do not buy a hunting license or pick up harvest tickets.

To improve the accuracy of harvest information, rural hunters may need more incentive to become part of the existing system through: 1) better license vending (e.g., paying vendors a reasonable fee to do a reasonable job, or paying vendors to collect completed harvest reports rather than merely issue them); 2) impressing upon rural hunters the necessity of harvest information, and fostering their sense of contributing to management of wildlife; or 3) more enforcement action. Department personnel in Unit 23 and Subunit 26A have pursued the second course of action since at least 1982 with little results. Increased enforcement action is probably the least effective means of improving the accuracy of harvest data.

The best option for improving harvest data from rural residents is to develop a different system for collecting this information that would be acceptable to local hunters. Two alternative systems for collecting harvest information recently supported by members of the Kotzebue Fish and Game Advisory Committee were harvest calendars and village monitors. These alternatives and others need to be more fully explored with the public and other land and resource management agencies, and tested in one or two communities.

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Prepared by:

Geoff Carroll
Wildlife Biologist

Submitted by:

Steve Machida
Survey-Inventory Coordinator

Table 1. Baird Mountain sheep aerial fixed-wing (PA-18) survey data, Unit 23.

	1986[a]	1987[b]	1988	1989	1990	1991	1992
Rams 1/2-curl and larger[c]	145	129	136	162	105	108	130
Rams 7/8-curl and larger	47	50	35	51	32	35	42
"Ewes"[d]	416	393	484	574	466	239	267
Lambs	105	143	187	170	133	17	59
Unknown	4	0	5	75	14	36	0
Total	670	665	812	981	718	400	456
Adults[e]	561	522	620	736	571	347	397
Lambs:100 "ewes"	25	36	39	30	29	7	22
Rams:100 "ewes"	35	33	28	28	23	45	49
Rams 7/8-curl and larger: 100 "ewes"	11	13	7	9	7	15	16
Density:							
No. adults/mi^2	0.73	0.68	0.81	0.96	0.74	0.45	0.52
No. adults/km^2	0.28	0.26	0.31	0.37	0.29	0.17	0.20

[a] Data collected in 768 mi^2 (1989 km^2) area.
[b] Data represent minimum counts; surveys not directly comparable to subsequent years.
[c] Rams 7/8-curl and larger are included in total rams.
[d] "Ewe" defined as adult female, yearling of either sex, and 1/4 curl ram.
[e] "Adult" defined as all sheep excluding lambs and unknowns.

Table 2. DeLong Mountain sheep survey data, Unit 23 and Subunit 26A.

	Kugururuk R/Trail Creek[a]				Wulik Peaks[b]		
	1983[c]	1987[d]	1991	1992	1987	1991	1992
Rams 1/2-curl and larger[e]	95	77	81	72	26	38	27
Rams 7/8-curl and larger	54	49	38	26	8	17	7
"Ewes"[f]	171	90	159	99	88	78	67
Lambs	61	50	24	20	19	11	26
Unknown	9	0	1	0	0	10	0
Total	336	217	265	191	133	137	120
Adults[g]	266	167	240	171	119	116	94
Lambs:100 "Ewes"	36	56	15	20	22	14	39
Rams:100	56	86	51	73	30	49	40
Rams 7/8-curl and larger: 100 "ewes"	32	54	24	26	9	22	10
Density:							
No. adults/mi^2	1.02	0.64	0.92	0.66	0.29	0.28	0.23
No. adults/km^2	0.39	0.25	0.36	0.25	0.11	0.11	0.09

[a] Data collected in a 261 mi^2 (676 km^2) area using fixed-wing (PA-18) aircraft except where noted.
[b] Data collected in a 411 mi^2 (1,064 km^2) area using fixed-wing (PA-18) aircraft.
[c] Helicopter used to conduct surveys during 1983.
[d] Incomplete survey; several large ewe bands observed in count area but not included in counts.
[e] Rams 7/8-curl and larger are included in total rams.
[f] "Ewe" defined as adult female, yearling of either sex, and 1/4 curl ram.
[g] "Adult" defined as all sheep excluding lambs and unknowns.

Table 3. Summary of Unit 23 Dall sheep harvests, 1970-71 through 1991-92 (R=rams, E=ewes, U=unknown sex).

					Winter Season[b]										
	General Season[a]				Baird Mts			DeLong Mts			Unknown			Total winter	Total
Year	Bairds	DeLongs	Unk.	Total	R	E	U	R	E	U	R	E	U	harvest	harvest
1970-71			17	17											17
1971-72			16	16											16
1972-73			26	26											26
1973-74			13	13											13
1974-75			19	19											19
1975-76			17	17											17
1976-77			22	22											22
1977-78			34	34											34
1978-79			35	35											35
1979-80			25	25											25
1980-81			16	16											16
1981-82	3	10		13											13
1982-83	10	11		21	2	2	5							9	30
1983-84	12	8		20										0	20
1984-85	8	8	3	19	2	2								4	23
1985-86	28	8	1	37	10	7	3			1				21	58
1986-87	9	14		23	8	4			2					14	37
1987-88	18	19		37	3	6		1	1					11	48
1988-89	17	20		37	6	3					1			10	47
1989-90	19	26		45	5	2		7	2					16	61
1990-91	17	16		33	4		1					1		6	39
1991-92[c]	0	10		10				1						1	11

[a] August 10-September 20; 3/4+ curl rams only through 1977-78, 7/8+ curl rams only after 1978-79.

[b] October 1-April 30; season established during 1982-83; limit 1 sheep ("ewe" defined as adult female, yearling of either sex, 1/4 curl ram, or lamb).

[c] Baird Mountains fall and winter hunts closed by emergency order; DeLong Mountain fall hunt September 1-20; DeLong Mountain winter hunt October 1-April 30.

Table 4. Sheep hunter success rates, hunter residency, and horn length for Unit 23, 1989-90 through 1991-92 regulatory seasons.

	1989-90[a]			1990-91[a]			1991-92		
	Fall Season			Fall Season			Fall Season		
	Baird Mts	DeLong Mts	Winter season	Baird Mts	DeLong Mts	Winter season	Baird[b] Mts	DeLong[c] Mts	Winter season
Successful	19	26	16	17	16	6	0	10	1
Unsuccessful	8	27	17	11	22	10	0	9	4
Total	27	53	33	28	38	16	0	19	5
Unit resident	8	6	33	3	8	13	0	2	5
Non-unit resident	14	23	0	13	9	1	0	9	0
Nonresident	5	18	0	10	18	0	0	6	0
Unknown	0	6	0	2	3	2	0	2	0
Horn length (in.)	31.9	34.4	23.1	29.7	32.1	24.4	NA	33.8	33.0

[a] Fall season August 10-September 20 (1 ram 7/8+ curl); winter season October 1-April 30 (1 sheep)
[b] Fall and winter seasons closed in Baird Mountains
[c] September 1-20 (1 ram 7/8+ curl)
[d] October 1-April 30 (1 sheep)

Table 5. Sheep hunter success rates, hunter residency, and mean horn length for Subunit 26A[a], 1989-90 through 1991-92 regulatory seasons.

	1989-90	1990-91	1991-92
Successful	12	20	21
Unsuccessful	12	4	11
Total	24	24	32
Unit Resident	1	0	0
Non-unit Resident	12	8	16
Nonresident	11	15	16
Unknown	0	1	0
Horn mean length (in.)	34.8	33.3	34.2

[a] Excluding that portion of Subunit 26A within Gates of the Arctic National Park but including Gates of the Arctic National Preserve.

Table 6. Transportation methods for sheep hunters (successful and unsuccessful combined) in Unit 23, 1989/90-1990/91.

	1989-90			1990-91			1991-92		
	Fall Season			Fall Season			Fall Season		
Means of transportation	Baird Mts	DeLong Mts	Winter season	Baird Mts	DeLong Mts	Winter season	Baird Mts	DeLong Mts	Winter season
Airplane	27	48	0	28	32	0	0	10	0
Snowmachine	0	0	33	0	0	6	0	0	1
Boat	0	4	0	0	2	0	0	0	0
3- or 4-wheeler	0	1	0	0	0	0	0	0	0
Unknown	0	0	0	0	4	0	0	0	0
Total	27	53	33	28	38	6	0	10	1

LOCATION

Game Management Unit: 24 (eastern portion), 25A, 26B, and 26C (49,600 mi^2)

Geographical Description: Eastern Brooks Range

BACKGROUND

Dall sheep are found throughout the mountains of the eastern Brooks Range. Highest densities occur in northern drainages, where weather and habitat conditions provide the most favorable winter range. Sheep have been generally abundant the last several decades. Although systematic surveys were sporadic in most areas, available data, as well as observations by hunters familiar with the area, suggest relatively high populations occurred during the 1980s, followed by declines in numbers in recent years.

Human use of sheep in the eastern Brooks Range increased steadily the last two decades. The existence of the Arctic National Wildlife Refuge (ANWR), the opening of the Dalton Highway to commercial and general public use, and the loss of sport hunting opportunity in Gates of the Arctic National Park have all contributed to increased human activity.

Hunting, viewing, and photography have increased as access has been developed and public interest in the area has grown. Sheep hunting is important to local residents of Kaktovik and Arctic Village.

MANAGEMENT DIRECTION

Management Goals

Management goals for eastern Brooks Range Dall sheep are to:

1) protect, maintain, and enhance the sheep population and its habitat in concert with the other components of the ecosystem;
2) provide for continued subsistence use of sheep by rural Alaskan residents who have customarily and traditionally used the population;
3) provide an opportunity to hunt sheep under aesthetically pleasing conditions; and
4) provide an opportunity to view and photograph sheep.

Management Objectives

Management objectives for eastern Brooks Range Dall sheep are to:

1) select trend indicator areas for determination of herd size, composition, productivity, and population trends by 1991;
2) develop subsistence harvest assessment techniques by 1991;

3) maintain the opportunity to harvest rams with a mean horn length exceeding 34 inches and a mean age of more than 8 years under aesthetically pleasing conditions (theoretically sustainable ram harvest probably exceeds 500 rams per year);
4) maintain an annual hunter harvest success of at least 40% among recreational hunters;
5) determine hunter attitudes regarding the aesthetic quality of sheep hunting in the eastern Brooks Range by 1991; and
6) identify suitable sites for viewing and photographing sheep and cooperate with other agencies in promoting those sites by 1992.

METHODS

Staff conducted ground composition count surveys in Atigun Gorge (annually) and in the Hulahula and Chandalar drainages (1992) during this report period. The USFWS and ADF&G personnel did these surveys in June with the aid of spotting scopes.

During September 1992 ADF&G and USFWS biologists captured and radio-collared 26 ewes and 6 rams in the Hulahula and East Fork of the Chandalar drainages. These sheep are being radio-tracked periodically as part of a cooperative study to define sheep populations and establish areas for trend counts. Since 1988 approximately 60 sheep have been radio-marked in a continuing effort to understand sheep population identity and other aspects of sheep ecology in the area. Data on harvest, hunter effort, horn size, and hunting methods were gathered from mandatory harvest reports.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

Current population size is unknown, but both survey data and anecdotal reports from the public suggest that sheep numbers have probably declined somewhat in recent years. Poor recruitment caused by severe weather and possibly by increased predation appear to be contributing to the decline. Heimer (1985) estimated there were 13,000 sheep in the eastern Brooks Range in 1985.

Population Composition:

Lamb production and initial survival in the Atigun area during this period have been fairly good except in 1986, 1989, and 1992 when the occurrence of lambs during June dropped below 20% (Table 1). Lamb survival was extremely low in the Hulahula drainage

in 1992, with only 3% lambs in the population, but lamb survival was moderately good in the Chandalar area where 16% lambs were observed (Table 2). Poor lamb survival appears to be closely associated with severe winters and cold spring weather, especially in the relatively dense sheep populations in the northern drainages.

Distribution and Movements:

Limited movement data from radio-marked sheep show that populations north and south of the Junjik River are discrete because sheep collared west of this river do not move across the East Fork of the Chandalar nor do sheep marked on the east or west sides of the Hulahula River cross it either. Sheep home range size appears similar to that observed in other areas, although movements of sheep near the East Fork of the Chandalar are relatively extensive, perhaps because of the less stable weather patterns and changes in range availability (USFWS, unpubl. data).

Mortality

Harvest:

Season and bag limit.

	Resident Open Season	Nonresident Open Season
Units 25(A) and 26(C) Resident Hunters: 1 ram with 7/8 curl horn or larger Aug. 10-Sept. 20 or three sheep may be taken by registration permit Oct. 1-Apr. 30	Aug. 10-Sept. 20 Oct. 1-Apr. 30	
Nonresident Hunters: One ram with 7/8 curl horn or larger.		Aug. 10-Sept. 20
Remainder of Unit 24, and Unit 26(B), including Gates the Arctic National Preserve: One ram with 7/8 curl horn or larger.	Aug. 10-Sept. 20	Aug. 10-Sept. 20

Board of Game Actions and Emergency Orders. Regulatory changes during this report period affected two issues related to long-term concerns of Arctic Village residents and adjustments in the hunt area of registration hunt 1195.

In 1982, residents of Arctic Village were allocated a portion of the 50 sheep quota that had been established in 1979 for a late season hunt by Kaktovik residents in Subunit 26C. The season and bag limit for this hunt were extended to include Subunit 25A. In 1988 residents of Arctic Village expressed concern about reduced subsistence sheep hunting success and, in 1989, petitioned the board to establish a special use area that would exclude aircraft north of Arctic Village. This petition was denied, but in 1990 ADF&G established a check station at the headwaters of the East Fork of the Chandalar River to monitor aircraft activity and harvest. ADF&G and USFWS personnel also initiated more intensive monitoring of sheep numbers and movements.

Field studies showed that although aircraft activity was not excessive, sheep density was low enough to warrant additional protection. The existing 7-month season with a three-sheep bag limit was thought to be too liberal. Acting through the Federal Subsistence Commission, the USFWS established the Arctic Village Sheep Management Area and eliminated the harvest of mature rams by nonlocal hunters where sheep populations could not sustain harvest of ewe sheep. The Federal Subsistence Commission also established a more conservative bag limit of two rams for the 7-month subsistence hunting season. Hunting in the Arctic Village Sheep Management Area is limited to federally recognized subsistence hunters and requires a federal permit. However, some residents of Arctic Village reject the idea of being required to have a permit to hunt sheep, and few permits have been obtained from USFWS.

Important changes in conditions of registration hunt 1195 also occurred. This hunt, with its liberal 7-month season and bag limit of three sheep, was established in 1980 to provide for "rural" subsistence hunters as legally defined at that time. The taking of ewe sheep was known to carry a management risk, but the exclusion of aircraft and low participation limited this risk.

The 1989 Alaska Supreme Court decision that classified all Alaskan residents as subsistence users significantly increased the number of hunters who could participate in hunt 1195. Limitations on aircraft prevented increases in hunting pressure in Subunit 26C, but sheep populations adjacent to the Dalton Highway in western Subunit 25A were readily accessible to any Alaskan resident. Awareness of this opportunity gradually increased, and in 1990-91, 67 permits were issued and 13 sheep were taken by 9 hunters.

To prevent excessive harvest of sheep near the Dalton Highway, permit conditions were changed administratively in 1991 by the Division of Wildlife Conservation. The western boundary of the hunt area was moved east to the Middle Fork of the Chandalar River, thereby protecting sheep near the Dalton Highway while providing for subsistence opportunities authorized by the Board of Game.

Hunter Harvest. Table 3 shows the combined harvest of sheep and average horn size in Subunits 25A, 26B (excluding the Dalton Highway Corridor), and 26C. Table 4 shows similar data for individual subunits and the Dalton Highway area. The eastern Brooks

Range has experienced a long-term increase in the number of hunters and harvest that began in the early 1970s. Harvest appears to have plateaued and declined during the last few years, although participation remains high.

Permit Hunts. Sheep registration hunt 1195 was limited to residents of Subunits 25A and 26C until regulatory year 1990-91 when it became open to all Alaskan residents. Because reporting by local residents is limited, the most reliable estimates of total harvest are based on interviews and informal discussions with residents of Kaktovik and Arctic Village (S. Pedersen, ADF&G, pers. commun.) (Table 5). Although the largest reported harvest was 14 sheep in 1990-91, the actual harvest is estimated to range from 30 to 40 sheep most years. Sheep are taken primarily in the Hulahula drainage by residents of Kaktovik. Most harvest occurs during November, March, and April.

Hunter Residency and Success. Most sheep hunters using the eastern Brooks Range were Alaskan residents, although a large number of nonresidents also use the area (Table 6). Sixty-seven percent of the 2,905 hunters reporting during the 7 regulatory years from 1985 to 1991 were residents. Nonresident hunters have a higher success rate, however, 85% of reporting nonresidents were successful compared with 49% of area residents. This pattern is similar to that observed before 1985 (Golden 1989).

From 1985 to 1989 overall hunter success ranged from 60% to 67%. The success rate declined in 1990 and 1991 to just over 50%, suggesting that legal rams are more difficult to find. Reports from hunters familiar with the area indicate that legal rams have in fact become more difficult to obtain. Current success rates continue to be acceptable, however, and exceed the goal of maintaining a success rate of at least 40%.

Harvest Chronology. Most sheep hunting in the eastern Brooks Range occurs during August when weather is most favorable. From 80% to 90% of the sheep harvest occurs before 1 September (Table 7). Most of the remaining harvest occurs in September, with from 1 to 16 sheep reported being taken during October and November.

Transport Methods. Aircraft are the primary means of transportation for most hunters, being used in 80-90% of successful hunts (Table 8). The remaining harvest involves use of horses, boats, and, in the Dalton Highway area, highway vehicles.

CONCLUSIONS AND RECOMMENDATIONS

Management goals and objectives for sheep in the eastern Brooks Range were generally met during this report period, but apparent declines in sheep numbers, availability of legal rams, and quality of hunting conditions concern me. Management goals appear suitable for the future, but some objectives should be reevaluated.

The USFWS provided valuable support and cooperation that contributed toward meeting a number of objectives. Population identity studies have allowed the establishment of trend indicator areas in the Hulahula River drainage and in the East Fork of the Chandalar River both north and south of the Junjik River. I recommend continuing cooperative efforts to gather data on productivity, survival, adult mortality, and population identity.

Regarding development of techniques to assess subsistence harvest, it would be more appropriate to encourage subsistence hunters to use permitting and reporting procedures already in place. Registration permit hunt 1195 has been in place for several years, but local hunters do not reliably submit harvest reports. Local harvest is known primarily through personal contact by ADF&G staff. The USFWS is now responsible for administering the hunt in the Arctic Village Sheep Management Area, where local attitudes toward the permit system are negative. Informal personal contact may be the most feasible approach in this area as well. I suggest restating this goal, emphasizing the long-term need to encourage voluntary compliance with permit reporting requirements.

The area continues to meet objectives for minimum average horn size, age, and hunter success, but by a declining margin in some areas. These trends indicate that changing legal minimum horn size from 7/8 to full curl would be appropriate. This would provide a biologically more conservative harvest regime for a stressed sheep population subject to significant hunting pressure. Establishing a full-curl regulation apparently has strong public support; it would create greater uniformity in regulations statewide and would be unlikely to compromise sheep harvest in the long term. In the short term more conservative horn curl regulations, combined with a declining sheep population and continued high numbers of sheep hunters, will probably reduce success rates.

The need to determine hunter attitudes regarding aesthetic and other aspects of sheep hunting is being addressed during 1992-93 through a hunter questionnaire that is being sent to 750 hunters. The response to this inquiry will help establish whether increased hunting pressure has detracted from the quality of sheep hunting or contributed to changes in availability of legal rams.

Based on field work in the Dalton Highway area, suitable sites for sheep viewing and photographing exist at various places near the road, including areas near Coldfoot, Galbraith Lake, and the Atigun Canyon mineral licks. These areas could be promoted and interpretive possibilities enhanced through cooperation with other agencies.

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Prepared by:

Robert O. Stephenson
Wildlife Biologist

Submitted by:

Kenton P. Taylor
Management Coordinator

Reviewed by:

Kenneth R. Whitten
Wildlife Biologist

Table 1. Atigun drainage, Subunit 26B, ground sheep composition counts and estimated population size, June 1985-91.

Regulatory year	Rams				Ewes[a]	Lambs (%)	Sheep/ hour	Total sheep observed	Estimated population size
	Full curl(%)	3/4-full curl	1/2-3/4 curl	<1/2 curl					
1985-86	1 (0.4)	10	18	18	165	42 (17.0)	--	254	--
1986-87	0 (0.0)	19	20	13	137	47 (20.0)	--	236	--
1987-88	3 (0.8)	16	29	11	221	80 (21.0)	--	360	--
1988-89	0 (0.0)	19	37	15	253	40 (11.0)	--	364	--
1989-90[b]	0 (0.0)	18	23	8	165	69 (24.0)	--	283	--
1990-91	2 (0.0)	22	19	10	318	122 (25.0)	--	493	--
1991-92	0 (0.0)	12	15	7	309	39 (10.0)	--	382	--

[a] Includes yearlings and 2-year-olds of both sexes and rams of 1/4 curl or less.
[b] Counts prior to 1990 occurred in Atigun Gorge; during and after 1990 counts along the Dalton Highway were included.

Table 2. Sheep composition counts in the Hulahula and East Fork Chandalar drainages, June 1992.

Regulatory year	Rams				Ewes[a]	Lambs (%)	Sheep/ hour	Total sheep observed	Estimated population size
	Full curl(%)	3/4-full curl	1/2-3/4 curl	<1/2 curl					
Hulahula	1 (0.2)	28	26	4	318	10 (3.0)	n/a	387	
East Fork	4 (1.8)	17	6	0	155	34 (16.0)	n/a	216	

[a] Includes yearlings and 2-year-olds of both sexes and rams of 1/4 curl or less.

Table 3. Subunits 25A, 26B (excluding Dalton Highway corridor), and 26C sheep harvest[a], 1985-91.

Regulatory year	Rams	x Horn length (inches)	% ≥40"	Ewes[b]	Total sheep
1985-86	170	34.9	n/a	n/a	170
1986-87	185	35.4	n/a	n/a	185
1987-88	223	34.8	n/a	n/a	223
1988-89	208	35.1	n/a	n/a	208
1989-90	258	35.0	10	1	259
1990-91	265	34.6	9	3	268
1991-92	234	34.3	7	0	234

[a] Excludes permit hunt harvest.

[b] There was no legal harvest of ewes except in Permit Hunt 1195. Presumably, these ewes were incorrectly reported.

Table 4. Average Dall ram horn size and age of rams harvested from eastern Unit 24 and Subunits 25A, 26B, and 26C, 1985-91.

Year	Area	Average length (in)	Average base circumference (in)	Average age (yrs)	Harvest n
1985	Subunit 25A	35.3	13.1	9	46
	Subunit 26B (remainder)[a]	34.4	13.3	8	34
	Subunit 26C	34.9	13.0	9	90
	Dalton Highway[b]	34.1	13.4	8	25
1986	Subunit 25A	36.5	13.1	11	48
	Subunit 26B (remainder)[a]	35.4	13.0	9	51
	Subunit 26C	34.8	13.9	10	86
	Dalton Highway[b]	34.1	13.2	8	29
1987	Subunit 25A	34.6	13.7	9	49
	Subunit 26B (remainder)[a]	35.3	13.2	9	57
	Subunit 26C	34.6	12.8	9	117
	Dalton Highway[b]	33.6	13.0	9	51
1988	Subunit 25A	35.6	13.0	9	64
	Subunit 26B (remainder)[a]	34.9	12.9	9	42
	Subunit 26C	34.8	13.1	10	102
	Dalton Highway[b]	35.3	13.2	9	32
1989	Subunit 25A	36.4	13.3	9.7	62
	Subunit 26B (remainder)[a]	34.3	13.0	9.1	100
	Subunit 26C	34.8	12.8	9.6	96
	Dalton Highway[b]	36.0	13.3	8.8	19
1990	Subunit 25A	35.6	13.1	9.6	72
	Subunit 26B (remainder)[a]	34.7	13.3	9.1	94
	Subunit 26C	34.0	12.7	8.9	99
	Dalton Highway[b]	33.1	13.1	9.0	17
1991	Subunit 25A	35.2	13.3	9.8	58
	Subunit 26B (remainder)[a]	34.3	13.2	9.0	97
	Subunit 26C	33.7	13.0	8.9	79
	Dalton Highway[b]	33.9	13.5	8.0	17

[a] Those portions of Subunit 26B not adjacent to the Dalton Highway.

[b] Includes all harvest reported from eastern Unit 24 and from areas adjacent to the Dalton Highway in Subunit 26B.

Table 5. Subunits 25A and 26C sheep harvest data by permit hunt, 1985-91.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Rams	horn length (inches)	% ≥ 40"	Ewes (%)	Unk	Total harvest
1195	1985-86	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	12-30[a]
	1986-87	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	12-30[a]
	1987-88	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	30-40[b]
	1988-89	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	30-40[b]
	1989-90	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	30-40[b]
	1990-91	69	46.4	66.7	33.3	7	n/a	n/a	6 (46.1)	1	14[c]
	1991-92	9	n/a	n/a	n/a	1	n/a	n/a	1 (50.0)	0	2[c]

[a] Estimates based on interviews with residents of Kaktovik (S. Pedersen, ADF&G, pers. commun.).
[b] Estimates based on interviews with residents of Kaktovik and Arctic Village (S. Pedersen, ADF&G, pers. commun.).
[c] Based on written reports received; does not include most of the 30-40 sheep estimated to have been taken in Kaktovik and Arctic Village.

Table 6. Subunits 25A, 26B, 26C, and eastern Unit 24 sheep hunter[a] residency and success, 1985-91.

	Successful					Unsuccessful					
Regulatory year	Local[b] resident	Nonlocal resident	Nonres.	Unk.	Total (%)	Local[b] resident	Nonlocal resident	Nonres.	Unk.	Total (%)	Total hunters
1985-86	2	109	80	4	195 (62.5)	1	98	13	5	117 (37.5)	312
1986-87	0	126	79	9	214 (60.0)	2	120	14	7	143 (40.0)	357
1987-88	0	156	104	14	274 (67.1)	0	116	10	8	134 (32.9)	408
1988-89	1	109	99	35	244 (63.2)	0	107	18	17	142 (36.8)	386
1989-90	5	154	114	4	277 (59.8)	1	157	24	4	186 (40.2)	463
1990-91	13	138	115	16	282 (55.5)	3	200	16	7	226 (44.5)	508
1991-92	3	138	102	8	251 (53.3)	2	192	25	1	220 (46.7)	471

[a] Excludes hunters in permit hunts.
[b] Local resident is a resident of eastern Unit 24 or Subunits 25A, 26B, or 26C.

Table 7. Subunits 25A, 26B, 26C, and eastern Unit 24 sheep harvest[a] chronology percent by time period, 1985-91.

Regulatory year	Harvest periods									n
	8/1-8/4[b]	8/5-8/11	8/12-8/18	8/19-8/25	8/26-9/1	9/2-9/8	9/9-9/15	9/16-9/22	9/23-9/29[b]	
1985-86	8.8	38.3	22.3	16.5	6.7	4.7	1.0	0.5	1.0	191
1986-87	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1987-88	0	0	41.0	20.9	19.8	7.5	7.5	1.5	1.5	261
1988-89	0.4	35.9	26.4	18.2	6.5	7.3	3.0	0.8	0.8	223
1989-90	0.4	23.0	27.4	24.4	12.8	6.2	2.5	1.8	0.4	268
1990-91	1.2	17.8	42.2	18.2	12.0	6.2	1.9	0.0	0.4	258
1991-92	0.0	23.5	35.4	18.9	12.7	4.1	2.4	2.8	1.2	243

[a] Excludes permit hunt harvest and a few sheep "reported" taken in October or November or where the date was not reported.
[b] Sheep reported taken before 8/10 or after 9/26 were presumably incorrectly reported.

Table 8. Subunits 25A, 26B, 26C, and eastern Unit 24 sheep harvest[a] percent by transport method, 1985-91.

Regulatory year	Percent of harvest								n
	Airplane	Horse	Boat	3-or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	
1985-86	82.6	3.6	1.0	1.0	0.0	0.5	5.6	5.6	195
1986-87	89.7	3.3	0.5	1.5	0.0	0.0	2.3	2.8	214
1987-88	85.6	2.0	0.8	0.0	0.0	0.0	6.0	5.6	250
1988-89	85.4	3.3	1.2	0.0	0.0	0.0	6.2	3.7	240
1989-90	86.0	3.6	1.8	0.0	0.0	0.0	7.6	1.1	277
1990-91	80.8	3.9	1.8	0.0	3.5	0.0	7.4	2.5	282
1991-92	81.3	4.4	1.2	0.0	0.0	0.0	10.0	3.2	251

[a] Excludes permit hunt harvest.

LOCATION

Game Management Unit: 24 (24,150 mi^2)

Geographical Description: Brooks Range within Gates of the Arctic National Park and west of Dalton Highway Corridor

BACKGROUND

Dall sheep in Gates of the Arctic National Park (GAAR) are managed differently than in most areas of Alaska. Federal law mandates subsistence use as the highest priority consumptive use whenever harvest is allowable. Consumptive use by local residents of GAAR and the defined subsistence zone for this park is presently allowed.

In GAAR, subsistence is the only consumptive human use permitted. As a result, one ADF&G management goal for Dall sheep in GAAR is to provide opportunity for human subsistence use. Still, this goal is secondary to the primary goal of protection, maintenance, and enhancement of the sheep population and its habitat in concert with other components of the ecosystem. Another secondary ADF&G management goal for Dall sheep is to provide opportunity to view and photograph sheep. Attainment of this observation/photography goal is being pursued by the National Park Service.

Before 1981 the unit was open to general hunting with an average harvest of 50 rams. The take by Nunamiut hunters was unrecorded but estimated at less than 50 per year. The current 5-year average for the entire unit (including the eastern part outside GAAR) is 47 sheep. All sheep taken by hunters from Anaktuvuk Pass are reported in this report, but a few of those sheep came from the headwaters of the Anaktuvuk River in Unit 26.

Within Unit 24, distribution of Dall sheep is limited to suitable habitats in the Brooks Range. The population status is assumed to be unchanged, although no surveys have been conducted since 1984. Management goals for sheep that occur in the John, Alatna, and Wild river drainages south of the park are to provide for diversified human recreation. Sheep inhabiting Unit 24 within the Dalton Highway Corridor and east are covered in the Eastern Brooks Range report.

MANAGEMENT DIRECTION

Management Goals

Management goals for area Dall sheep are to: 1) provide an opportunity for subsistence uses of Dall sheep in Gates of the Arctic National Park and general use outside the park,

and 2) provide the opportunity to hunt Dall sheep under aesthetically pleasing conditions in the remainder of Unit 24.

Management Objectives

Management objectives for area Dall sheep are to: 1) maintain an annual subsistence harvest of up to 50 sheep in the GAAR and a general harvest of 7/8-curl rams in the Wild, Alatna, and John River drainages, and 2) maintain or increase the sheep population in Unit 24.

METHODS

Subsistence harvest during this report period was monitored through a registration permit hunt with questionnaires sent out after the close of the hunt. General harvest information was obtained through the statewide harvest ticket system. The National Park Service surveyed sheep in the Itkillik drainage with a Super Cub using standard techniques.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

The most recent sheep population count was 4,417 in a large portion of GAAR reported by Singer (1984). Elsewhere in the Brooks Range sheep populations are reportedly declining, presumably in response to severe winter weather. No data are available to indicate whether the trend is also occurring in Unit 24.

Population Composition:

Population composition varies from year to year depending on lamb production, yearling recruitment, and adult mortality. These parameters are directly influenced by weather, natural predation, and hunting management (Heimer 1988). Elsewhere in the Brooks Range winter weather has reportedly been severe and lamb:100 ewe ratios have been low. The composition surveys flown by the NPS during this report period were of limited value due to a small sample size (n = 77) and aircraft availability problems.

Mortality

Harvest:

The subsistence harvest over the last 5 years has averaged 23 sheep. Most of these sheep have been adults, with rams composing 82% of the harvest (Table 1).

The annual harvest from the lower John, Alatna, and Wild rivers has averaged 8 rams over the past 5 years (Table 2). The average age and horn length appear to be decreasing (Table 3) although the sample size is too small to infer to the general population.

Season and Bag Limit.

Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Units 24 and 26(A), those portions within the Gates of the Arctic National Park		
Three sheep	Aug. 1-Apr. 30	No open season
Remainder of Units 24, 26(A), and 26(B), including the Gates of the Arctic National Preserve		
One ram with 7/8 curl horn or larger	Aug. 10-Sept. 20	Aug. 10-Sept. 20

Board of Game Actions and Emergency Orders. No actions were taken by the Board of Game during the report period.

Hunter Residency and Success. Although residents of Anaktuvuk Pass, Bettles/Evansville, Wiseman, Alatna, Allakaket, Ambler, Hughes, Kobuk, Nuiqsut, and Shungnak are allowed to participate in the subsistence hunt, hunters from Anaktuvuk Pass harvest most of the sheep taken. Success rates are not particularly relevant in the subsistence hunt because of community hunting and sharing traditions (Osborne 1989). In the rest of the unit most of the hunting is by state residents (Table 2). The 5-year average success rate for the area is 37% (range 31-46%), which is less than the statewide average.

Permit Hunts. Since 1988 the Gates of the Arctic National Park subsistence hunt has been solely managed by ADF&G. This has allowed us to collect better data than in previous reports (Osborne 1989). The system presently works fairly well and provides good harvest data, but we would be able to collect data cheaper if we could have participants register to hunt rather than use harvest tickets.

Transportation Methods. No roads exist in the area, thus aircraft is the major transportation means outside GAAR (Table 4); occasionally people use boats. Most sheep are taken by snowmachine in the Gates of the Arctic National Park subsistence hunt.

Other Mortality: No data were collected during this report period.

CONCLUSIONS AND RECOMMENDATIONS

The primary ADF&G management goals of protection, maintenance, and enhancement of Dall sheep are presently being achieved throughout most of the sheep habitat in Gates of the Arctic National Park. Most of the park is used sparingly by viewers and photographers and rarely by subsistence hunters. The secondary goal of providing for subsistence uses of Dall sheep is being achieved. There has been no long-term decline in the number of sheep taken by subsistence residents, and no obvious declines in sheep populations due to harvest by humans have been reported. However, no systematic sheep population monitoring program exists in Unit 24, so subtle declines in local populations are not expected to be noticed if they do occur. Joint efforts to establish population monitoring programs for the human-impacted populations should be undertaken cooperatively by the NPS and ADF&G.

To ensure that subsistence harvest information is collected in a less expensive format I recommend the current harvest ticket requirements be replaced with a registration hunt format. I will continue to send a questionnaire letter to all registrants at the end of the season. I plan to work with the National Park Service to establish a harvest monitoring scheme to accurately determine sex and age of all Dall sheep taken over the next 2 years. This in conjunction with a sheep census would allow us to model the population in the main subsistence hunting area.

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Prepared by:

Timothy O. Osborne
Wildlife Biologist III

Submitted by:

Kenton P. Taylor
Management Coordinator

Reviewed by:

Kenneth R. Whitten
Wildlife Biologist III

Table 1. Gates of the Arctic National Park sheep harvest and hunter residency, 1988-92.

	1988	1989	1990	1991	1992[a]
Permits issued	33	32	46	34	39
Permits returned	24	33	47	34	
Successful hunters	9	12	11	12	
Anaktuvuk	23	21	33	27	28
Bettles	3	2	3	2	2
Coldfoot	1	0	5	0	0
Wiseman	5	8	5	5	9
Ambler	1	0	0	0	0
Nuiqsut	0	1	0	0	0
Sex of harvest					
Males	15	19	18	20	5
Females	3	8	2	3	
Yearlings	0	0	2	0	
Total sheep harvest	18	27	22	23	

[a] Season open until April 1993.

Table 2. Unit 24 West hunter[a] residency and success, 1988-92.

Regulatory year	Successful				Unsuccessful				Total hunters
	Unit resident	Nonlocal resident	Nonresident	Total	Unit resident	Nonlocal resident	Nonresident	Total	
1988-89	2	3	0	5	3	8	0	11	16
1989-90	0	7	0	7	2	12	0	14	21
1990-91	1	6	1	8	2	2	2	6	14
1991-92	0	4	7	11	6	17	0	23	34
1992-93	2	9	0	11	1	10	3	14	25

[a] Excludes hunters in Gates of the Arctic National Park.

Table 3. Unit 24 West sheep harvest[a], 1988-92.

Regulatory year	x horn length (inches)	% ≥40"	x Age	Total rams
1988-89	38.8	40	10.4	5
1989-90	37.7	14	10.3	7
1990-91	34.6	0	9.2	8
1991-92	36.5	18	9.7	11
1992-93	35.9	0	9.4	11

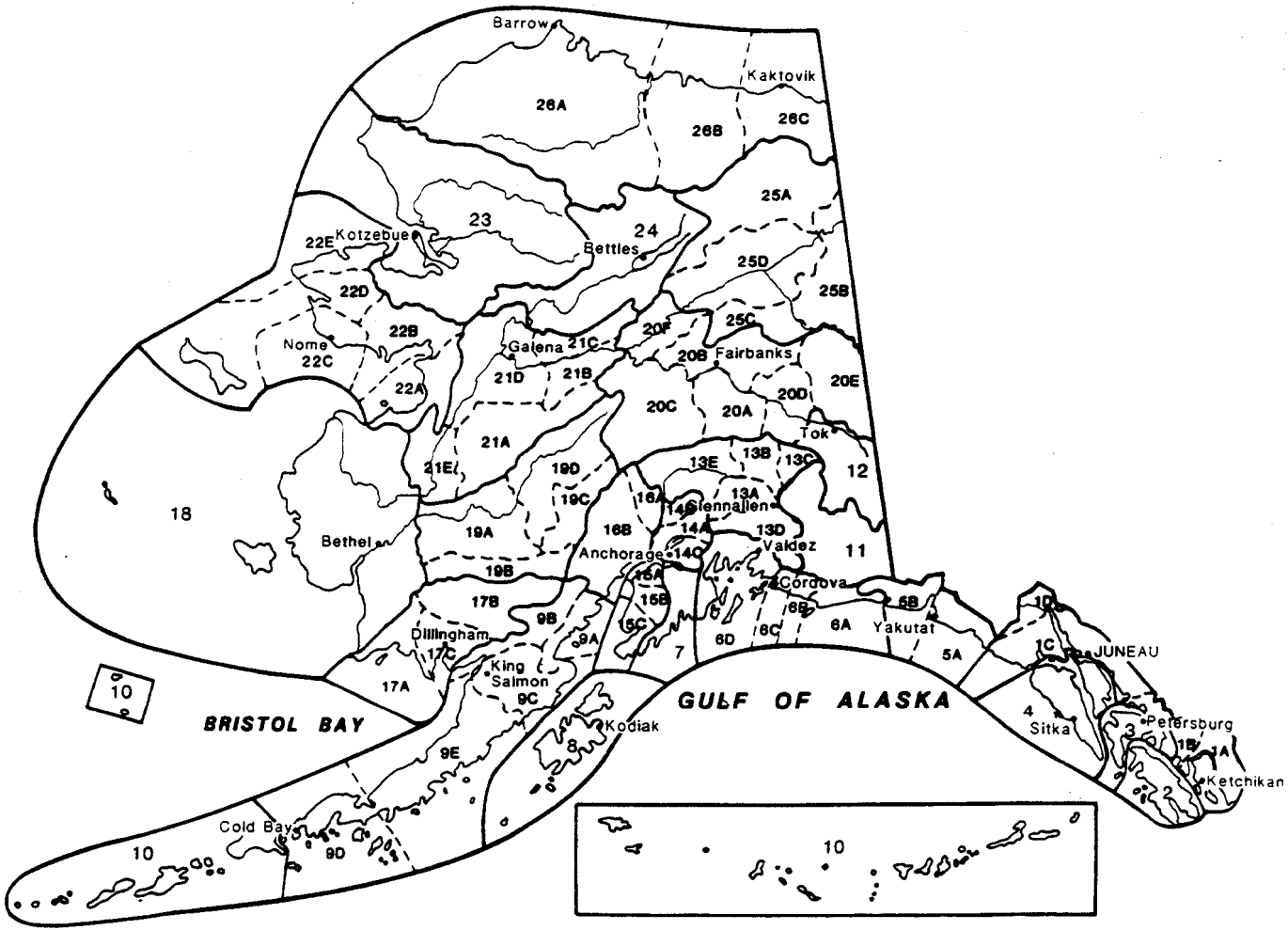
[a] Excludes Gates of the Arctic National Park.

Table 4. Unit 24 West sheep harvest[a] percent by transport method, 1988-92.

Regulatory year	Percent of harvest								n
	Airplane	Horse	Boat	3-or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	
1988-89	60		40						5
1989-90	100		0						7
1990-91	88		12						8
1991-92	100		0						11
1992-93	73		17						11

[a] Excludes Gates of the Arctic National Park.

Alaska's Game Management Units



Federal Aid in Wildlife Restoration

The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manufacturer's excise tax collected from the sales of handguns, sporting rifles, shotguns, ammunition, and archery equipment. The Federal Aid program then allots the funds back to states through a formula based on each state's geographic area and the number of paid hunting license holders in the state. Alaska receives 5% of the revenues collected each year, the maximum allowed. The Alaska Department of Fish and Game uses the funds to help restore, conserve, manage, and enhance wild birds and mammals for the public benefit. These funds are also used to educate hunters to develop the skills, knowledge, and attitudes necessary to be reponsible hunters. Seventy-five percent of the funds for this project are from Federal Aid.