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ECOLOGY AND DEMOGRAPHY OF DALL'S SHEEP IN YUKON-CHARLEY RIVERS NATIONAL PRESERVE: IDENTIFYING CRITICAL DALL'S SHEEP HABITAT AND HABITAT USE PATTERNS

YUKON-CHARLEY RIVERS NATIONAL PRESERVE, ALASKA

FINAL REPORT
2001

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EXECUTIVE SUMMARY

Within the goals and objectives of this study, 3 principal questions were asked:

Question 1. Are there seasonal movement patterns of Dall's sheep (*Ovis dalli*) within Yukon-Charley Rivers National Preserve, Alaska (YUCH), and could knowledge of these movements be used to improve the timing of sheep surveys and the sightability of sheep during those surveys?

Answer 1. No. While some general movement of sheep from mountains to bluffs along the Charley River occurred during late April and May, movements were not ubiquitous or predictable. Sheep moved back and forth between mountains and river bluffs throughout the year and this was true for sheep of all sex and age classes studied. Sheep numbers and the sex composition of surveyed sheep in late June and early July (during the annual sheep surveys) showed great annual variation within each of the 7 survey units (Figure 2) but not over the entire

survey area. Therefore, realistic values for sheep demographic parameters for YUCH can only be obtained through surveys that include all 7 survey units.

Question 2. How extensive is interchange between the patches of known sheep habitat in YUCH?

Answer 2. Interchange was documented between every adjacent survey area (Figure 3). When consecutive pairs of sheep locations are analyzed, a mean of 18% (range 7% – 39%) of those locations were an interchange from one survey unit to another. This indicates a substantial degree of interchange because a small sample of sheep were radiocollared ($n = 23$) and relatively few radiolocations (mean = 48) were acquired for each sheep. The movement of 1 ewe out of the entire study area of YUCH was documented when a GPS collared sheep, from a concurrent Dall's sheep/military overflight study, moved from the Cirque Lake Mountain survey unit west to the Puzzle Gulch/ Big Windy Creek area (30 miles (50 kilometers) outside the preserve). Because of the degree of interchange, trend areas smaller than the 7 survey units may produce substantial variation in results and would therefore function poorly for tracking population trends for sheep throughout YUCH. In this regard, it would be preferable to survey all units every other year rather than survey portions or sub-samples of the 7 units every year. The 3 years of surveys we completed with a helicopter averaged approximately $10,000 per survey.

Question 3. Are there seasonally concentrated use areas for Dall's sheep in YUCH such as those for lambing or rutting?

Answer 3. Throughout the study we did not document seasonally concentrated use. Lambing and rutting occurred throughout the suitable habitat in the study area (Figures 4 and 5,

respectively). Although there was a tendency for ewes to occupy bluffs along the Charley and upper Seventymile Rivers during the lambing season (Figure 4), this trend was not universal.

Although the primary focus of this project was investigating Dall's sheep movement patterns, other information useful for examining Dall's sheep ecology was gleaned from this data set. This information includes a comparison of home range estimates based on adaptive kernels and minimum convex polygons (MCP), capture-mark-resight population estimates, capture methodology, physical measurements from captured sheep, natural mortality data, harvest data, results from aerial surveys, and other demographic data. Additional information will come from an ongoing project using GPS collars to determine the effects of military aircraft overflights on Dall's sheep. This 2nd Dall's sheep project was initiated mid-way through this project and compares a group of GPS radiocollared ewes at Cirque Lake Mountain in YUCH to a sample of sheep 30 miles (50 km) west of the preserve. We summarize some preliminary capture data from the military overflight/Dall's sheep study in this report.

SUMMARY STATISTICS

Dates of the study	March 1997 – October 1999.
Number of sheep radiocollared:	23 (VHF transmitters)
Mean $\pm$ SE weight (lbs.)(kg):	ewes = 127 $\pm$ 3.4 (n = 14) (58 kg), young rams = 147 $\pm$ 22.5 (n = 4) (67 kg).
Mean $\pm$ SE age (yrs) at capture:	ewes = 6.8 $\pm$ 0.53 (n = 20), young rams (adult rams were not captured) = 3.0 $\pm$ 0.6 (n = 4)

Mean $\pm$ SE home range size (km^2):	MPC:	all sheep = 280 $\pm$ 67.4 (n = 21) ewes = 266 $\pm$ 76.8 (n = 18) rams = 367 $\pm$ 110.7 (n = 3)
	95% kernel:	all sheep =157 $\pm$ 34.9 (n = 21) ewes=127 $\pm$ 26.4 (n = 18) rams=339 $\pm$ 173.8 (n = 3)
Total area of sheep range (km^2)		735 km^2 (50% kernel HR on all survey locations) 1528 km^2 (75% kernel HR on all survey locations) 2638 km^2 (95% kernel HR on all survey locations)
Survey sightability correction factor		1997 = 1.123, 1998 = 1.67, 1999 = 1.164 3 years combined = 1.351
Population size: counted (corrected)		1997 = 309 (417), 1998 = 282 (381), 1999 = 329 (444) 3 year mean = 414, 95% confidence interval = +/-82.3
Sheep density		~414 sheep/1528 km^2 = 271 sheep/1000km^2 = 0.70 sheep/mi^2 (in the Charley River watershed)
(3 year mean) Sex/age ratios		lambs=46:100 ewes, yrls=25:100 ewes, rams=67:100 ewes
Legal rams observed (full curl or larger)		1997 = 18, 1998 = 24, 1999 = 24
Reported preserve harvest		1997 = 6 rams, 1998 = 5 rams, 1999 = 6 rams

INTRODUCTION

Aerial surveys of Dall's sheep were initiated in Yukon-Charley Rivers National Preserve (YUCH) (Figure 1) beginning in 1973. Sheep habitat within YUCH was divided into 5 survey units: Mount Sorenson, Copper Mountain, Twin Mountain, Cirque Lakes, and Diamond Fork Mountain (Alaska Department of Fish and Game, unpublished data, 1973 – 75; Alaska Department of Fish and Game, unpublished data 1980; Alaska Department of Fish and Game, unpublished data 1981; Kellyhouse 1982; Ulvi 1983; Ulvi and Knuckles 1990; Ulvi 1991; Fox 1993) (Figure 2). Two units, Cirque Lakes and Mt. Sorenson, were utilized as trend areas in years when all units were not surveyed because they had been included in most of the previous surveys and were known to harbor numerous sheep. Results from past surveys (particularly trend areas), however, varied considerably among years and do not appear to accurately reflect real changes in the sheep population (Fox 1993; National Park Service, unpublished data). To address the problem of sheep survey variability, the National Park Service (NPS) initiated a study in 1997 to investigate movement patterns of Dall's sheep inhabiting YUCH.

Dall's sheep inhabit the mountains in the southwestern area of the preserve, the bluffs along the Charley River, the hills and bluffs in the upper Seventymile River, and the hills and bluffs in upper Woodchopper Creek. Sheep also occur in the northeastern portion of the preserve in the Ogilvie Mountains which straddle the Alaska-Canada border. It is in the Ogilvies that the darker 'fannin' phase of Dall's sheep are found within the preserve. Sheep in the northeast portion of the preserve are a small part of a much larger population contained primarily within Canada and were not included in this study (Ulvi 1991).

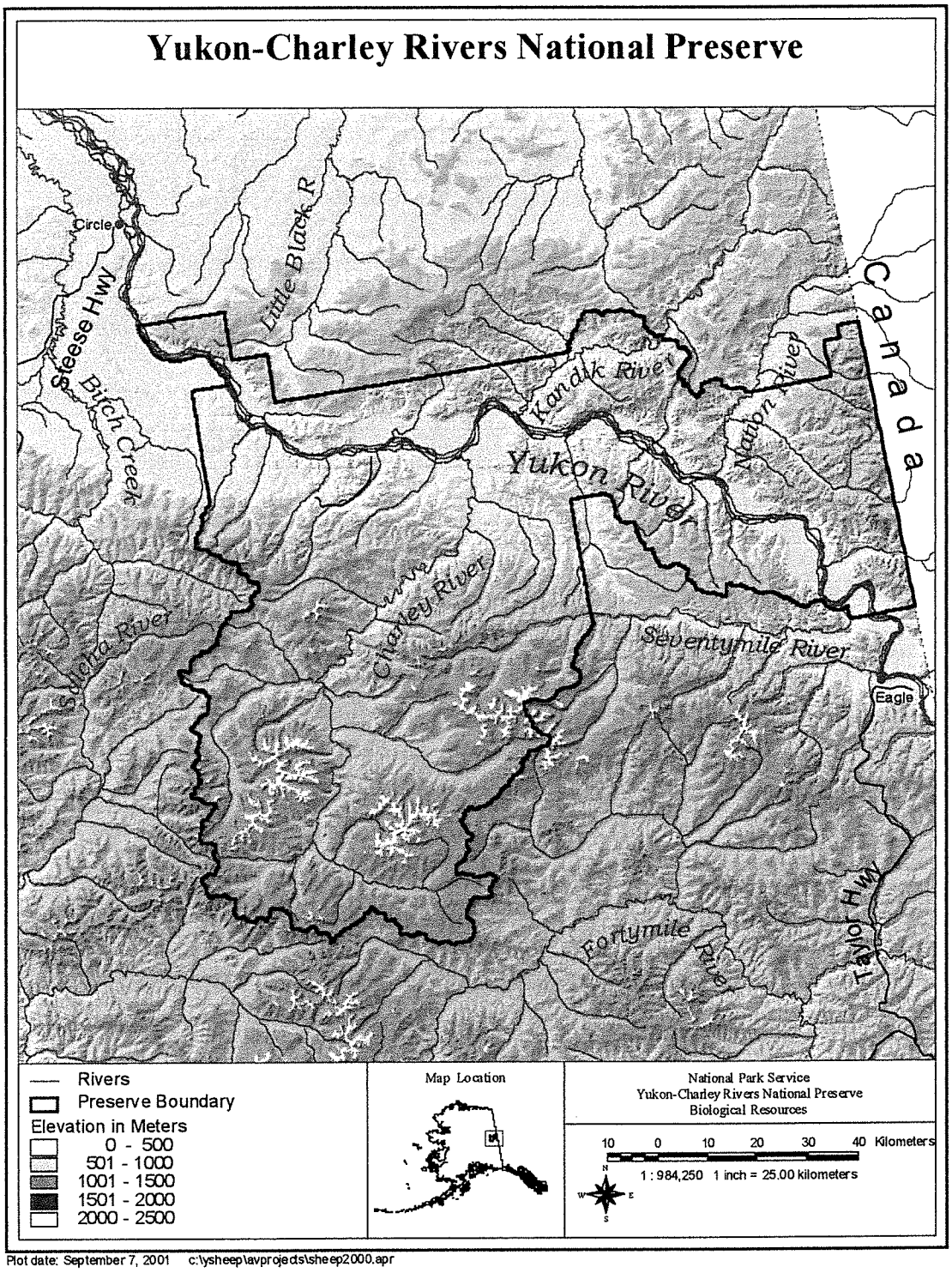


Figure 1. Location of Yukon-Charley Rivers National Preserve, Alaska.

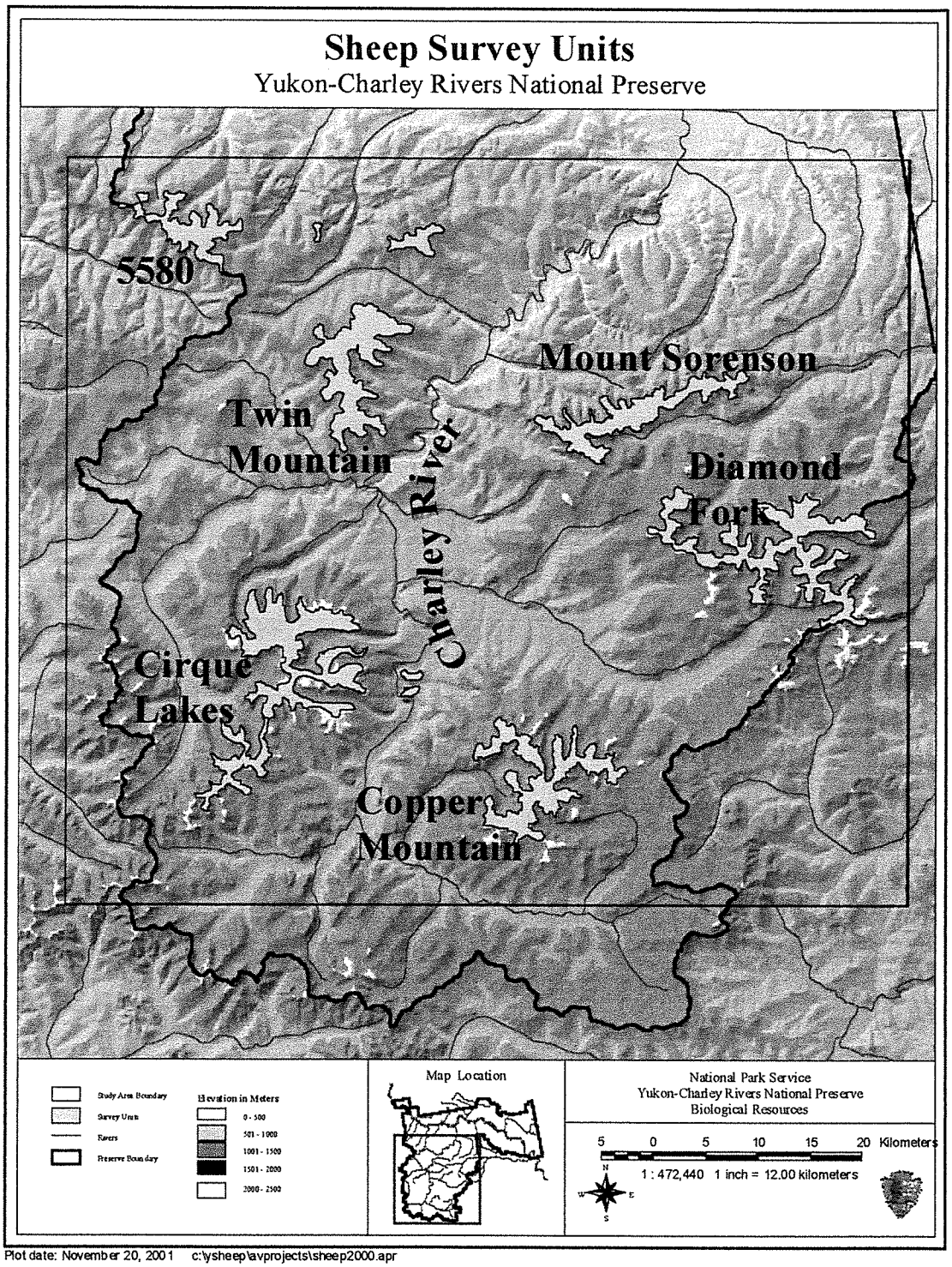


Figure 2. Location of the Sheep Survey Units and the study area boundary, Yukon-Charley Rivers National Preserve, Alaska.

Historical data for Dall's sheep in YUCH includes sheep surveys, incidental sheep sightings, and historical accounts from local gold miners. Observers have reported seeing sheep traveling between mountainous terrain and river bluffs through atypical habitat such as dense spruce forests and large expanses of open tussock tundra. These movements are unusual since escape terrain is nonexistent along many of these travel corridors. In this study, we sought to provide information on the extent and timing of these movements and identify temporal use of different habitats. In addition, we sought to develop a suitable survey technique for YUCH that will provide reliable long-term monitoring of the YUCH sheep population and allow managers to assess changes due to natural and human forces.

An important management concern for this sheep population is low-level military overflights. The U.S. Air Force uses the air space over YUCH as a Military Operations Area (MOA), with authorization to fly military jets at subsonic speeds as low as 100 feet above ground level (AGL), and supersonic flights (producing sonic booms) as low as 5,000 feet AGL. Currently, there are an estimated 50,000 overflights of military aircraft per year in the preserve, up from 25,000 in 1994 (Hostman 1995). Low-level military aircraft overflights have the potential to induce strong panic responses in sheep (Lenarz 1974). The National Park Service is concerned that frequent disturbance by low-flying military jets may alter natural behaviors such as feeding, movements, breeding, and predator avoidance activities. Disruption of sheep populations from low-level flights would likely be evident as a decrease in lamb production or survival, because reproductive success is one of the better measures of population health (Ricklefs 1979).

The US Air Force (USAF) has requested information on Dall's sheep, including areas of critical habitat and seasonal home ranges. The USAF has expressed a willingness to avoid sensitive areas to protect wildlife, but is reluctant to exclude the entire area occupied by sheep. To effectively participate in planning efforts to mitigate impacts to preserve resources, park managers need to understand sheep habitat use and movement patterns. This information is required to support altitude restrictions and to otherwise mitigate the impacts of military overflights. In October 1998 the National Park Service received funding from the USAF to focus intensively on the effects of military overflights on Dall's sheep. Results from that study will be reported on separately (Lawler 2000). This report provides a summary of field activities and data collected during the 3-year study on Dall's sheep ecology and demography in YUCH utilizing VHF radiotelemetry and post-lambing aerial surveys.

GOALS and OBJECTIVES

The goals of this project were to determine the population status, movements, home ranges, and distribution of Dall's sheep inhabiting Yukon-Charley Rivers National Preserve. The objectives of the project were as follows:

1. Determine seasonal movement patterns of Dall's sheep. Sheep surveys in YUCH could be timed to maximize sheep sightability and thereby improve the accuracy and comparability of sheep population estimates.
2. Determine the extent of Dall's sheep interchange between habitat patches in the upper Charley River drainage, and determine the extent to which sheep use atypical habitat.
3. Identify sensitive sheep habitat (i.e., lambing/rutting areas and mineral licks) and temporal use of these areas, to mitigate the impacts of low-level military flight operations.

4. Develop a long term monitoring plan for Dall's sheep in YUCH.

STUDY AREA

Yukon-Charley Rivers National Preserve encompasses 2.5 million acres (1.1 million hectares) and is located in the eastern portion of interior Alaska known as the Yukon-Tanana Uplands. The Yukon River traverses the northern portion of the preserve and the entire Charley River watershed is contained within the preserve boundaries. The terrain rises gradually from the Yukon River to a mountainous area in the southern portion of the preserve where mountains reach 6400 ft (2000 m). The climate is continental, with annual precipitation averaging 10 inches (25.4 cm). The mean annual temperature is 42 °F (5.6 °C), with a July mean of 60 °F (15.6 °C) and a January mean of -13 °F (-25 °C).

Vegetation in the preserve is typical of boreal forests, dominated by black spruce (*Picea mariana*) and several species of deciduous hardwoods including aspen (*Populus tremuloides*) and birch (*Betula papyrifera*). Lowlands and drainages within YUCH are heavily forested. Uplands become more thinly forested with increasing elevation, and most areas above 2000 feet (610 meters) are treeless tundra. Large areas of open tundra occur below 2000 feet where drainage is poor or some other condition inhibits tree growth. The primary shrub species are willow (*Salix spp.*), alder (*Alnus spp.*), and dwarf birch (*Betula spp.*). Shrubs are found along streams and lakeshores, and occur as "stringers" in drainage bottoms extending into subalpine tundra.

The primary habitat for Dall's sheep within the preserve is in the upper reaches of the tributaries to the Charley River drainage generally above 4000 feet (1200 meters), and along the bluffs of the Charley River from 1500 to 2500 feet (450 – 750 meters). Vegetation in the alpine areas is typical tundra plants including dryas (*Dryas spp.*), dwarf willow (*Salix spp.*), and bearberry (*Arctostaphylos spp.*). More detailed descriptions of the physiography and vegetation of the preserve can be found in Knuckles and Wesser (1992), Cook et al. (1993), Ducks Unlimited (1998), and Swanson (1999).

METHODS

Dall's sheep movements and distribution were investigated by capturing and radiocollaring sheep and then radiotracking these individuals from aircraft. Population surveys in YUCH, covering all obvious patches of Dall's sheep habitat south of the Yukon River, were conducted with a helicopter in late June or early July from 1997 through 1999.

Sheep capture and handling

Sheep captures were distributed throughout known sheep habitat. Piper PA-18 Super Cubs were used to locate sheep and assess distribution within the preserve during the capture operations, and collars were deployed on sheep based on that information. Using a helicopter, sheep were captured with a netgun or chemical immobilization by darting. Safety of sheep and of the capture crews was monitored by observers in the Super Cubs.

Dall's sheep were netgunned either with a skid-mounted or a hand-held netgun using the helicopter as a capture platform. Immediately following the netting, an animal handler would

exit the helicopter and subdue the animal by placing a blindfold over its eyes and hobbling the feet. While the animal handler subdued the animal, the helicopter would shuttle another biologist to the captured sheep. Netted sheep were not drugged during handling.

Sheep were also captured by chemical immobilization. An immobilizing dart was fired into a large muscle mass of the sheep with a dart gun. The Immobilizing agents carfentanil citrate and xylazine hydrochloride were administered together in a single dart. Dosages were 0.03 mg/kg of carfentanil and 0.81 mg/kg of xylazine hydrochloride. The carfentanil citrate and xylazine hydrochloride were antagonized using naltrexone hydrochloride (150 mg/mg of carfentanil) and yohimbine hydrochloride (0.25 mg/kg of body weight), respectively. We minimized heat stress to animals by conducting sheep captures during early November and late March when ambient air temperatures and day length were moderate in comparison to the extremes of winter and summer.

Following capture, sheep were processed by affixing a radiocollar, weighing the animal, counting annuli on horns to determine age, measuring horns (length and base circumference), measuring the body (total length, chest girth, and hind foot length), collecting blood, and administering antagonists (if drugged). Sheep were monitored until fully ambulatory and moving without distress (immediately upon release if netgunned and within 1-2 minutes of administering the antagonist if chemically immobilized). Blood samples were centrifuged and serum collected. A progesterone assay was conducted on serum samples by the Institute of Arctic Biology, University of Alaska Fairbanks to evaluate pregnancy rates for ewes captured in March and April. Additional serum is stored in the Alaska Wildlife Serum Bank managed by the Alaska

Department of Fish and Game. Whole blood and red blood cells (clots) were frozen and stored for future analyses.

Routine monitoring of radiocollared sheep

Radiocollared sheep were located from fixed-wing aircraft (primarily Piper Super Cubs and a Cessna 185) weekly, except when weather or budget constraints prevented flights. Telemetry flights were scheduled at least 5 days apart in order to maintain independence between consecutive locations (White and Garrott 1990). Sheep were located by using standard aerial radiotelemetry techniques (Mech 1974). During radiotracking flights, data collected for each sheep included: date, time, coordinates (from aircraft's GPS unit), descriptive location, number and sex-age composition of the group, activity of sheep when first observed, distance to escape terrain, vegetation type (Viereck et al. 1992), slope, elevation, terrain descriptor, and snow characteristics when applicable. Sheep mortalities were investigated from the aircraft when initially detected, and from the ground as soon as possible. Cause of death and condition of sheep at the time of death were investigated. Teeth were collected from mortalities to allow for comparison of techniques for aging Dall's sheep (horn annuli and tooth wear compared to tooth cementum annuli). Home ranges of individual sheep were calculated using minimum convex polygon (MCP) (Odem and Kuenzler 1955) and Adaptive Kernel analyses (Worton 1989).

Sheep population surveys

Sheep population surveys were conducted in early July using a helicopter to locate groups of sheep by flying elevational contours within Dall's sheep habitat. In particularly steep, rugged, or complex terrain, two or three passes were made at different altitudes to ensure complete

coverage. Survey routes and techniques were chosen to replicate those of past surveys (Kellyhouse 1982, Ulvi 1983, Ulvi and Knuckles 1990, Ulvi 1991, Ulvi 1984, Fox 1993). Sheep were counted and classified into sex and age groups.

Sheep were classified into 1 of 8 categories: 'ewe-like' (ewes and yearling rams), lambs, yearlings (yearling ewes), and rams by degree of horn curl (1/4, 1/2, 3/4, full, or full+). Ewes could not be differentiated from yearling rams, because of similarities in body and horn size, resulting in both being classified as 'ewe-like.'

During population surveys, a Super Cub was used to determine locations of all radiocollared sheep. The helicopter crew was not informed of the locations of the collared animals during the surveys. Radiocollared sheep were noted when sighted from the helicopter and compared to the total radiocollared sample to generate a mark-resight correction factor for each survey.

RESULTS AND DISCUSSION

Sheep captures

Capture events during late March-early April and late September of 1997, late March and early November of 1998, and late September of 1999 resulted in a total of 28 sheep captured (20 ewes, 8 rams; 3 rams were recaptured to remove radiocollars). Seventeen sheep were captured using a helicopter skid-mounted netgun, 8 were darted from a helicopter and 3 were captured with a hand-held netgun fired from a helicopter. An additional 22 sheep were captured with a hand-held netgun in 1999 and 2000 for the military overflight/Dall's sheep project in the Cirque Lake survey area.

Of the 3 methods used for capturing sheep, we preferred the hand-held netgun. The hand-held netgun resulted in shorter chase times and greater capture success in comparison to the skid-mounted netgun. An advantage of the netgun in comparison to chemical immobilization by darting is the immediate immobilization of the sheep by the net. This alleviates the problem of drugged sheep wandering into steep, dangerous terrain prior to drug induction. Furthermore, problems associated with chemical immobilization, such as compromised thermoregulation or drug re-cycling, are eliminated. Upon release, a netted sheep is fully functional and without residual drug effects. This is not to say that netgunning sheep is without risks. Rapid immobilization of a moving sheep via entanglement in a net has the potential to injure or kill the animal. Animals also may be injured if struck by the weights used to carry the nets through the air. Because of this latter possibility, closely packed groups of sheep were not netgunned. During this project, sheep were not injured or killed as a result of being captured with a netgun.

For sheep that were darted, the dosage of 0.03 mg/kg of carfentanil and 0.81 mg/kg xylazine hydrochloride used for chemical immobilization worked well. Induction times were usually 5-10 minutes. Two sheep required an additional dart. Darts with failed or weak internal charges were suspected to be the problem in both instances. Most darted sheep could be 'gently herded' with the helicopter by keeping a distance of ¼ to ½ mile (400 – 800 meters) away, or in some cases much farther, to ensure they stayed in safe terrain. We feared that if darted sheep were herded too closely, sheep would become exhausted, overheat, or experience capture related stress (capture myopothy; 1 capture mortality was attributed to this after being drugged).

Physical characteristics for all captured sheep appear in Table 1. Mean (± SE) weight of adult ewes 4 years or older (n = 20) was 126 (± 3.0) lbs. (57 kg) (Table 1). Mean (± SE) weight of adult rams 4 years or older (n = 4) was 147 (± 22.5) lbs. (67 kg) (Table 1). Sheep were aged by counting horn annuli. Mean (± SE) age at capture of adult ewes (n=20) was 6.8 (±0.5) and mean (± SE) age for the few rams we captured (n=4) was 3.0 (±0.6). Annuli were much more defined in the rams in comparison to the ewes. The difficulty in distinguishing horn annuli in live ewes makes this technique for determining age of Dall's sheep ewes uncertain even when combined with incisor wear. Analysis of cementum annuli of extracted teeth is required for an accurate age.

Movements and home ranges

Home range sizes of 21 radiocollared Dall's sheep (18 ewes, 3 rams) with at least 30 telemetry locations were calculated. Mean MCP for all sheep was 280 km^2 (n = 21, range 32-1308, SE = 67.4). Mean MCPs for ewes were 266 km^2 (n = 18, SE = 309) and rams were 367 km^2 (n = 3, SE=309). Because the minimum convex polygons (MCPs) often include large areas of non-sheep habitat, such as creek bottoms and forested slopes, 75% Adaptive Kernel estimates may be more applicable than the MCP. Adaptive Kernel (Worton 1989) home ranges of 50%, 75%, and 95% utilization were calculated for all sheep with ≥ 30 or more telemetry locations. The 95% kernel home range estimate for ewes and rams combined averaged 157 km^2 (n=21, range=16-658, SE=34.9) (Table 2). The 95% kernel home ranges of radiocollared ewes with at least 30 locations averaged 127 km^2 (n=18, range 16-493, SE=26.4). Mean home range size of young, radiocollared rams (ages 3-5 years) averaged 339 km^2 (n=3, range 60-658, SE=173.8) or 2.5 times the size of the ewes.

Table 1. Physical characteristics and capture methods for sheep captured in Yukon-Charley Rivers National Preserve, Alaska.

Capture Date	Sheep Id	Weight (lbs)	Sex	Age	Method	Horn Length		Base Circum.		Annuli		Body Length	Chest Girth	Neck Circum.	Pregnant? Progesterone	Fate
						Right	Left	Right	Left	Right	Left					
3/29/97	97001	101	F	5	NETGUN					5					? no blood	Dead-unknown predator 4/10/97
3/29/97	137	71	M	0	NETGUN	6.0	5.0			1	1				- male	Unknown (not collared)
3/29/97	97002	110	F	11	NETGUN	33.5	31.0	11.7	12.3		11	159.0	91.0	32.5	No	Dead-unknown predator 2/9/98
3/29/97	97003	120	M	2	NETGUN	26.0	26.0	14.5	14.0	2	2	153.0	101.0	36.0	- male	Recaptured
9/21/99	97003		M	5	NETGUN	65.5	65	32	32	5	5		120.5	58.0	- male	Collar removed
3/29/97	97004	128	F	7	NETGUN	25.0	26.0	12.0	12.0		7	163.0	103.0	37.0	Yes	Still present
3/30/97	97005	120	F	5	NETGUN	24.5	25.5	12.3	12.3	5		165.5	100.0	35.0	Yes	Dead-unknown predator 4/26/97
3/30/97	97006	140	F	11	NETGUN	28.0	26.0	12.0	12.0	11	11	157.0	102.0	39.0	? no blood	Still present
3/31/97	97007	125	F	9	NETGUN	30.0	29.0	11.0	11.0	9	9	158.0	103.0		Yes	Dead-unknown causes 6/6/98
4/1/97	97008	120	F	7	NETGUN	21.0	23.0	10.5	11.0	7	7			42.0	Yes	Still present
4/1/97	97009	125	F	4	NETGUN	23.0	21.5	12.5		4	5				Yes	Still present
4/1/97	97010		M	4	NETGUN	27.5	27.5	17.0	17.0	4	4			40.0	- male	Recaptured
9/21/99	97010	210	M	5	NETGUN	71.5	71	34	34	5	5		128	62	- male	Collar removed
4/3/97	97011		F	10	DART	24.0	12.5	12.2	12.1	10		134.0	105.0	47.0	Yes	Dead-unknown predator 1/24/98
9/21/97	97012		F	4	DART					4					- fall capture	Still present
9/21/97	97013	147	M	4	NETGUN	38.6	36.1	19.9	20.6	3	3	157.5	106.2	38.5	- male	Recaptured
9/21/99	97013		M	5	NETGUN	66	64.1	29.5	30.0	5	5		114.0	46.0	- male	Collar removed
9/21/97	97014	140	F	4	NETGUN	22.8	21.8	12.9	13.1	3	3	165.8	104.4	42.1	- fall capture	Still present
9/21/97	97015		F	8	NETGUN	27.3		12.4		8					- fall capture	Dead – unknown predator 2/99
9/22/97	97016	138	F	6	NETGUN	24.7	25.4	13.4	13.3	5	5	156.7	106.2	37.6	- fall capture	Collar failure 4/99
9/22/97	97017	147	F	7	NETGUN	28.4	27.3	12.1	12.3	6	6	157.6	109.2	38.4	- fall capture	Still present
9/22/97	97018	110	M	2	NETGUN	21.6	19.7	14.0	14.0	1	1	149.0	93.5	33.5	- fall capture	Unknown (not collared)
3/29/98	98001	125	F	10	DART	31.9	30.7	13.7	13.5	10	10			40.7	? no blood	Dead unknown predator 11/99
3/29/98	98002	125	F	7	DART	29.9	30.6	12.6	12.8	7	7			43.4	? no blood	Dead unknown predator 12/99
3/29/98	98003	138	F	6	DART	28.1	31.2	13.3	13.5	6	6			42.2	Yes	Dead broken leg 1/00
3/30/98	98004	110*	F	4	DART					4	4				Yes	Still present
3/31/98	98005	120*	F	6	DART					6	6				? no blood	Still present
11/06/98	98006	130*	F	5	DART					5	5	162.0	101.0	45.5	- fall capture	Still present

- * estimated, some data was not collected on sheep captured in unfavorable terrain, or those with elevated temperatures, as these sheep were released as quickly as possible.
- Measurements in centimeters unless otherwise noted.

Table 1. (Continued.)

Capture Date	Sheep Id	Weight (lbs.)	Sex	Est. Age	Method	R Horn Length	L Horn Length	R.Annuli	L.Annuli	Body Length	Chest Girth	Neck Circ.	Pregnant? progesterone
03/20/99	99003	105	F	5	NETGUN	25.5	25		5	150	95	44	No
03/20/99	99004	120	F	6	NETGUN	18	25	5	6		102	41	Yes
03/20/99	99005	120	F	7	NETGUN	29	21	7	7		100	40	Yes
03/21/99	99006	115	F	6	NETGUN	Broken	28		6		96.5	37	Yes
03/21/99	99007	100	F	7	NETGUN	20	25	7	7		98	37	No
03/21/99	99008	110	F	5	NETGUN	20	21	5	5		98	40	Yes
03/21/99	99009	145	F	6	NETGUN	27.5	30	6	6		100	42	Yes
03/21/99	99010	105	F	5	NETGUN	18	18	6	5		96	37.5	Yes
03/21/99	99011	95	F	7	NETGUN	27	28	7	7		92	38	Yes
03/21/99	99012	130	F	6	NETGUN	21	Broken	6			100	38	Yes
03/14/00	00-178	110	F	5	NETGUN	25	22.5	4	4		100	40.5	Yes
03/14/00	00-175	110	F	9	NETGUN	22	29	9	8		104	39	No
03/14/00	00-180	115	F	6	NETGUN	23	22	5	5		102	36	No
03/15/00	00-172	110	F	10	NETGUN	28	31	9	9		109	41	Yes
03/15/00	00-171	120	F	7	NETGUN	18.5	21	6	6	158	101	37	No
03/15/00	00-176	125	F	10	NETGUN	34	33.5	9	9	149	102	43	Yes
03/15/00	00-179	115	F	?	NETGUN	10.5	28	Broken	Broken	154	105	39	No
03/15/00	00-174	120	F	10	NETGUN	30	22.5	9	7	152	104	40	? no blood
03/15/00	00-177	95	F	6	NETGUN	24	24	6	5	149	101	43	Yes
03/17/00	00-173	80	F	3	NETGUN	16	15	2	1	141	100	38	No

Table 2. Home range area and number of telemetry locations of radiocollared Dall's sheep in Yukon-Charley Rivers National Preserve, Alaska.

Sheep Id	Sex	Age At Capture	Home Range Area (km^2) Kernel Home Range				Locations	Mountain Name	Comments
			MCP	95%	75%	50%			
97001	F	5	---	---	---	---	4	Cirque Lakes	killed by unknown predator within 1 month of capture
97002	F	11	371	68	38	19	33	Cirque Lakes	
97003	M	2	533	658	261	67	65	Diamond Fork Mountain	
97004	F	7	235	493	279	128	76	Mount Sorenson	
97005	F	5	---	---	---	---	5	Cirque Lakes	killed by unknown predator within 1 month of capture
97006	F	11	102	66	20	6	77	Twin Mountain	
97007	F	9	155	197	85	45	40	Cirque Lakes	
97008	F	7	254	82	38	17	78	5580 Mountain	
97009	F	4	128	66	30	18	76	5580 Mountain	
97010	M	4	411	299	106	45	72	5580 Mountain	
97011	F	10	48	16	8	4	31	Sheep Bluff	
97012	F	4	397	160	58	30	57	5580 Mountain	
97013	M	4	157	60	17	8	56	Cirque Lakes	
97014	F	4	127	46	14	7	58	Cirque Lakes	
97015	F	8	108	56	17	9	38	Cirque Lakes	
97016	F	6	155	141	51	26	33	Diamond Fork Mountain	
97017	F	7	877	173	65	33	52	Diamond Fork Mountain	
98001	F	10	74	66	28	12	42	Cirque Lakes	
98002	F	7	234	163	60	22	45	Cirque Lakes	
98003	F	6	128	137	67	35	41	Cirque Lakes	
98004	F	4	58	70	29	13	42	Twin Mountain	
98005	F	6	1308	254	130	53	41	Mount Sorenson	
98006	F	5	32	25	11	5	31	Sheep Bluff	

Examination of Dall's sheep home ranges illustrates the use by sheep of a variety of habitats including alpine habitat, bluffs along rivers or creeks, and the small forested ridges that join them (Appendix A).

Within Yukon Charley Rivers National Preserve are several distinct areas utilized by sheep that we have delineated as survey units (Figure 2). These areas consist of isolated mountains or river bluffs separated from one another by low rolling hills, rivers or creeks that are not used (or use very infrequently) by sheep. Movements of radiocollared sheep between these discrete areas were noted throughout the study. We documented some interchange between every adjacent survey unit (Figure 3). When consecutive pairs of radiolocations for each sheep are evaluated for movements between survey units we find that an average of 18% of the radiolocation pairs show sheep moving from one survey unit to another (range 7% - 39%). It is interesting to note that the 3 young, male sheep in the sample had fewer than average (13%) interchanges between survey units even though they had larger home ranges, indicating they must move less frequently but farther. This small analysis indicates a great deal of interchange as there was a small sample of sheep radiocollared and relatively few radiolocations for each sheep. Therefore, any documented interchange is significant. In one instance, we documented a move (of a GPS-collared sheep) of 25 – 30 miles (40 – 50 kilometers) from Cirque Lake Mountain within the study area to an area west of the preserve. However, most of the movements were shorter in distance and/or duration and usually involved neighboring areas. Sheep usually showed fidelity to sets of areas and would move back and forth between adjacent areas (Figure 3).

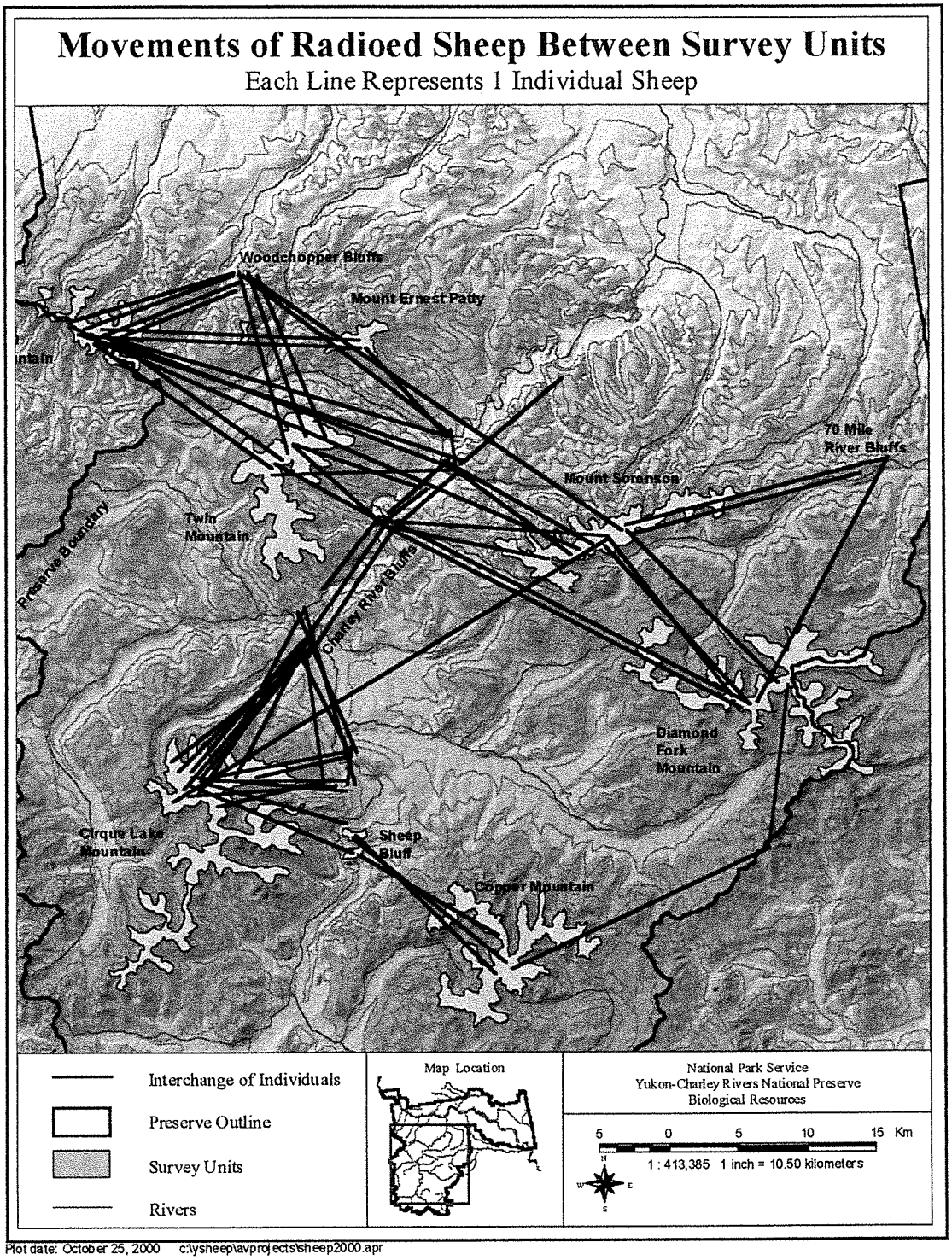


Figure 3. Movements of individual sheep between survey units. Each line represents the movements of one individual sheep. Yukon-Charley Rivers National Preserve, Alaska, 1997 – 1999.

Use of both alpine and river bluff habitats occurred year-round throughout the study area. Sheep tended to move from alpine areas to river bluffs along the Charley and upper Seventymile Rivers in late April and May but this movement was not consistent. This inconsistency was true of sheep of all sex and age classes and true over the course of the 3 years of this study. During late April and May, vegetation on the bluffs greens-up before this occurs in the alpine areas of the preserve (Carl Roland, NPS botanist, pers. comm.). We speculate that sheep move to lower elevation river bluffs to take advantage of a flush in forage quality associated with green-up and then track this green-up event to higher elevations.

Lambing

The first spring lambs we observed during this study were seen on 19, 10, 11 May for 1997, 1998, and 1999 respectively. In a Bureau of Land Management (BLM) study of Dall's sheep in the White Mountains-Tanana Hills west of YUCH, the earliest record of lambing was 10 May, with most lambs being born between 15 May and 30 May (Durtsche et. al. 1990).

Prior to this study it was commonly assumed that most ewes in the study area had their lambs on the Charley River bluffs. Although there appears to be some preponderance of lambing along the Charley River bluffs, lambing was documented throughout the study area (except Copper Mountain) in mountainous areas as well as along river bluffs (Figure 4). Not only were lambs born in both alpine areas and river bluffs each year but individual ewes varied as to where they lambed each year. Of 11 radiocollared ewes that spent time in May (lambing) at the Charley River bluffs during the 3 years of the study, we confirmed 4 had lambs for 2 consecutive years. In all 4 cases, these ewes were observed with a lamb during May in alpine areas 1 year and



Figure 4. Lambing locations. All May locations for adult ewes for 3 years, 1997 – 1999. Yukon-Charley Rivers National Preserve, Alaska.

On the Charley River bluffs another year. Two additional radiocollared ewes may have lambed in both areas, but we did not observe them with a lamb in 1 of the 2 years. Given the high pregnancy rate of 88% (Tables 1 and 2) during 1997 – 1999, there is a strong possibility that these ewes lambed, and we failed to detect it. Our infrequent radiotracking schedule, the difficulty of seeing sheep groups on mottled snow, and the difficulty of determining which lamb belongs to which ewe in a group, greatly affected the detectability of lambs. Given the variation in lambing locations for any given ewe, we did not find evidence for lambing site fidelity as has been noted in other studies (Geist 1971, Rachlow and Bowyer 1998, Valdez and Krauseman 1999).

Rutting

The number of locations we were able to gather during the rut (October-December) was limited by poor flying weather resulting in about half of the planned flights being successful. Poor weather combined with the short days of early winter prevented us from determining the timing of pre-rut movements. Sheep were first observed in large groups containing ewes and mature rams in mid-November. The location of sheep during telemetry flights during November and December indicated that rutting activities occurred throughout the study area (Figure 5).



Figure 5. Rutting locations. All November and December locations of adult sheep for 3 years, 1997 – 1999. Yukon-Charley Rivers National Preserve, Alaska.

Sheep population surveys

Aerial population surveys of the study area were conducted during July 10-11, 1997; July 5-6, 1998; June 28-July 1, 1999; and July 13–14, 2000. A Hughes 500D (Soloy Helicopters, Wasilla, Alaska) was used to conduct the 1997 survey, whereas a Robinson R-44 helicopter (Quicksilver Air, Fairbanks, Alaska) was used for all other surveys. Areas surveyed included known and likely sheep habitat in mountainous areas, in addition to the bluffs along the Charley and upper Seventymile Rivers.

1997 Survey A total of 12.1 hours of survey time were flown in 1997, and 309 sheep were counted with 40.4 lambs per 100 ewes, 22.4 yearlings per 100 ewes, and 35.3 rams per 100 ewes overall (Table 3). Mount Sorenson and Cirque Lakes Mountain had the greatest numbers of sheep during the survey, comprising 79 and 77 sheep, respectively (Table 3). A substantial number of sheep were counted along the bluffs of the Charley River (39) and on 5580 Mountain (24); 2 areas that had not been included on previous surveys. Sheep were not observed along the bluffs of the upper Seventymile River or on Mount Ernest Patty.

The 1997 survey was the first to include the entire length of bluffs along the Charley River. In previous years, this portion of sheep habitat was avoided to prevent disturbance of nesting peregrine falcons. Following consultation with Skip Ambrose (USFWS), a biologist with 20 years of experience with peregrine falcons in the Charley River drainage, we felt a single pass of a helicopter at low-level would not adversely affect the falcons and therefore included these bluffs into our survey effort.

The weather conditions were good to excellent during the 1997 survey. During the first portion of the Cirque Lakes unit survey, we experienced small patches of low clouds, fog and light rain on the upper peaks that potentially hid sheep from view. Otherwise, we experienced high overcast conditions with good light and few dark shadows, temperatures in the 50s and 60s, and calm to light winds. A few small patches of snow remained in the sheltered areas of the upper elevations. Particular attention was given to these patches of snow given the difficulty of observing white sheep against a white background, but we do not feel that this additional attention added substantially to the survey time.

Table 3. Results of 1997 sheep survey Yukon-Charley Rivers National Preserve, Alaska.

Survey Area	Survey Time (hrs)	Total Sheep	Ewes	Lambs	Yrlngs	Rams	Lambs/ 100ewes	Yrlngs/ 100ewes	Rams/ 100ewes	Legal Rams*	Sub-legal Rams	% Legal Rams
Cirque Lakes Mountain	3.2	77	42	13	3	19	31.0	7.1	45.2	5	14	26
Mount Sorenson	1.1	79	46	17	15	1	37.0	32.6	2.2	1	0	100
Seventymile River Bluffs	0.9	0**										
Mount Ernest Patty	1.2	0**										
Twin Mountain	1.2	54	23	11	4	16	47.8	17.4	69.6	4	12	25
5580 Mountain	0.5	24	10	6	5	3	60.0	50.0	30.0	0	3	0
Charley River Bluffs	1.4	39	25	11	3	0	44.0	12.0	0	0	0	0
Diamond Fork Mountain	1.8	11	1	0	2	8	0	200.0**	800.0**	4	4	50
Copper Mountain	0.8	25	9	5	3	8	55.5	33.3	88.9	4	4	50
TOTALS	12.1	309	156	63	35	55	40.4	22.4	35.3	18	37	33.0
MEANS	1.34	44.1	22.3	9.0	5.0	7.9	39.3	25.4	39.3	2.6	5.3	35.9

* Legal Ram = full curl ram

** Not included in means or totals

Table 4. Results of 1998 sheep survey Yukon-Charley Rivers National Preserve, Alaska.

Survey Area	Survey Time (hrs)	Total Sheep	Ewes	Lambs	Yrlngs	Rams	Lambs/ 100ewes	Yrlngs/ 100ewes	Rams/ 100ewes	Legal Rams*	Sub-legal Rams	% Legal Rams
Cirque Lakes Mountain	2.1	62	18	9	3	32	50	17	178	7	25	22
Mount Sorenson	1.0	35	15	7	2	11	47	13	73	7	4	64
Twin Mountain	0.8	49	23	10	6	10	43	26	43	3	7	30
5580 Mountain	0.4	35	17	11	3	4	65	18	24	0	4	0
Charley River Bluffs	1.0	53	27	19	6	1	70	22	4	0	1	0
Diamond Fork Mountain	2.0	37	11	5	5	16	45	45	145	6	10	38
Copper Mountain	0.7	11	5	2	1	3	40	20	60	1	2	33
TOTALS	8.0	282	116	63	26	77	54.0	22.4	66.4	24	53	31.0
MEANS	1.1	40.3	16.6	9.0	3.7	11	51.4	23.0	75.3	3.4	7.6	26.7

* Legal Ram = full curl ram

** Not included in means or totals

1998 Survey A total of 282 sheep were counted during 8.0 hours of survey time with 54.0 lambs per 100 ewes, 22.4 yearlings per 100 ewes, and 66.4 rams per 100 ewes overall (Table 4). Cirque Lakes Mountain had the greatest numbers of sheep during the survey (62), with Copper Mountain having the least (11) (Table 4). We did not survey the bluffs of the upper Seventymile River or Mount Ernest Patty due to absence of sheep during the 1997 survey and lack of telemetry locations of radiocollared sheep during 1998 in these areas.

The weather conditions during the 1998 survey were excellent. High clouds and a light haze of smoke from wildfires seemed to improve sightability by reducing contrast in areas of shadows. Small patches of snow existed on the north and west facing slopes of some ridges, but this likely did not affect sightability.

A cursory flight to locate sheep was conducted in the extreme southwestern portion of YUCH. The area appears to have similar vegetation and terrain characteristics as known sheep habitat in other areas of YUCH, but has never been surveyed for sheep. We flew contours along the southwestern boundary of YUCH which divides the west fork of the Charley River and the upper Goodpaster and Salcha Rivers. We saw 1 young ram during approximately 1 hour of survey time in the area. Weather conditions were poor with high winds and moderate turbulence on the lee side of ridges, and clouds obscuring peaks above 5000 feet (1500 meters). The use of this area by sheep is unknown, but appears to be minimal but due to the poor survey conditions during 1998, more sheep may utilize this area than were evident. It may be used primarily as a travel corridor between areas of higher quality habitat (i.e., Cirque Lakes to the north and Mount Harper to the south). Radiocollared sheep have never been found in this area.

1999 Survey During the 1999 survey, 329 sheep were counted over 12.0 hours of survey time with 43.6 lambs per 100 ewes, 30.2 yearlings per 100 ewes, and 47.0 rams per 100 ewes overall (Table 5). Mount Sorenson had the greatest numbers of sheep during the survey (98), with Copper Mountain having the least (10) (Table 5). The same 7 survey units flown in 1998 were flown in 1999. Comparing the 1999 survey to the 1998 survey, 33 more ewes and 7 fewer rams were seen during 1999. Approximately the same number of lambs were seen both years (63 in 1998 and 65 in 1999). Nineteen more yearlings were seen during 1999 in comparison to 1998.

Weather conditions for the 1999 survey were good to fair with high broken clouds and 10 – 25 knots (18 – 46 km/hr) of wind for most survey units. Temperatures at survey altitudes were much colder than usual at 35° - 50° F (2° – 10° C). Some smoke was in the air from wildland fires in and near the preserve but this likely did not affect sightability. More problematic than smoke were the mostly clear skies and direct sunshine that reduced visibility by creating contrasting shadows. Small patches of snow still persisted on the lee side of some ridges.

The flying technique for the survey changed in1999 from flying contours completely around the mountain until the starting point was reached to surveying the unit from end to end by flying each mountainside then the ridge top above, then the next mountain side, etc. Mixing this technique with contour flying seemed to provide faster coverage of individual drainages, thereby reducing the chance of double counting or overlooking sheep moving in response to the helicopter. In all survey units except the Charley River Unit, survey efforts focused above shrub-line. Usually a

single pass was flown through an area, but in steep or broken terrain, or in areas with patches of snow or shadow, 2 or 3 passes were made.

2000 Survey The weather for the 2000 survey was very poor and the survey could not be completed. On July 13 & 14, 2000, only 3 units were flown; Twin Mountain, Charley River bluffs, and 5580 Mountain. We counted 120 sheep in 3 hours of flight time; Ratios were 33.0 lambs 100 ewes, 29.6 yearlings 100 ewes, and 59.2 rams per 100 ewes (Table 6). Low clouds, rain, and fog prevented surveying the other 4 units.

Based on our experience conducting the past 4 surveys and reviewing past sheep survey reports, it is our opinion that survey techniques utilizing small trend-count areas are inadequate in YUCH because sheep: 1) occur at low densities in scattered groups, 2) frequent forested areas and river bluffs where sightability is much lower than typical mountainous sheep habitat, and 3) commonly move between survey units and habitat types throughout the year and these movements are not predictable. Therefore, survey data from just a few trend areas is not representative of the population within the preserve. Utilizing all 7 survey units would provide the most representative survey of Dall's sheep in YUCH. It would be preferable to forgo an annual sheep survey and survey all 7 units in alternate years rather than eliminate survey units from an annual survey.

Table 5. Results of 1999 sheep survey Yukon-Charley Rivers National Preserve, Alaska.

Survey Area	Survey Time (hrs)	Total Sheep	Ewes	Lambs	Yrlngs	Rams	Lambs/ 100ewes	Yrlngs/ 100ewes	Rams/ 100ewes	Legal Rams*	Sub-legal Rams	% Legal Rams
Cirque Lakes Mountain	3.65	69	33	13	15	8	39.4	45.5	24.2	3	5	37.5
Mount Sorenson	1.33	98	55	21	9	13	38.2	16.4	23.6	6	7	46.2
Twin Mountain	0.53	62	22	10	6	24	45.5	27.3	109.1	6	18	25.0
5580 Mountain	0.52	20	10	5	5	0	50.0	50.0	0.0	0	0	0.0
Charley River Bluffs	2.08	52	25	16	10	1	64.0	40.0	4.0	0	1	0.0
Diamond Fork Mountain	2.7	18	0	0	0	18	0.0	0.0	0.0	7	11	38.9
Copper Mountain	1.43	10	4	0	0	6	0.0	0.0	150.0	2	4	33.3
TOTALS	12.24	329	149	65	45	70	43.6	30.2	47.0	24	46	34.3
MEANS	1.75	47.0	21.3	9.3	6.4	10	33.9	25.6	44.4	3.4	6.6	25.8

* Legal Ram = full curl ram

** Not included in means or totals

Table 6. Results of 2000 sheep survey Yukon-Charley Rivers National Preserve, Alaska. The survey was cut short due to bad weather.

Survey Area	Survey Time (hrs)	Total Sheep	Ewes	Lambs	Yrlngs	Rams	Lambs/ 100ewes	Yrlngs/ 100ewes	Rams/ 100ewes	Legal Rams*	Sub-legal Rams	% Legal Rams
Cirque Lakes Mountain												
Mount Sorenson												
Twin Mountain	1.03	62	22	8	4	28	36	18	127	6	22	21.4
5580 Mountain	0.47	27	12	4	7	4	33	58	33	1	3	25.0
Charley River Bluffs	1.63	31	20	6	5	0	30	25	0	0	0	0
Diamond Fork Mountain												
Copper Mountain												
TOTALS	3.13	120	54	18	16	32	33	30	59	7	25	21.8
MEANS	1.04	40	18	6	5.3	10.7	33	33.7	53.3	2.3	8.3	15.47

* Legal Ram = full curl ram

** Not included in means or totals

Mark-resight population estimates

By utilizing radiocollared sheep as a marked sample and locating those sheep during, but independent of, a population survey, it is possible to estimate the number of sheep missed during the survey (Neal et al. 1993) by calculating a sightability correction factor.

There are two considerations regarding sightability for developing sightability correction factors for aerial sheep surveys. The first consideration is the number of sheep missed that should have been seen. These are sheep that were in a survey unit and were missed during the survey. The second consideration is the number of sheep missed because they were in areas that were not surveyed but are clearly members of the study population.

Our attempts to use radiocollared sheep to develop a sheep sightability correction factor were varied. During the 1997 survey, 8 of 9 radiocollared sheep were observed by the helicopter crew, resulting in a sightability correction factor of 1.125 (90% CI = 1.01-1.75). The only sheep not observed during that survey, a young ram, was located in atypical forested habitat outside any survey unit. Applying this sightability to the 309 sheep seen within the survey units in 1997 resulted in a total population estimate of 348 sheep within the study area.

During the 1998 survey, the helicopter crew observed only 9 of 17 radiocollared sheep. Two of the 8 missing sheep were located outside any survey unit and 6 were within. Using the 9 collared sheep observed within the survey units resulted in a sightability correction factor of 1.667 (90% CI = 1.24-2.78) (9 of 15 marked sheep observed in survey units). Applying this sightability correction to the 282 sheep observed during the survey resulted in an estimate of 470 sheep

within the survey units. Developing a correction factor for the 2 radiocollared sheep that were outside of the survey units resulted in a correction factor of 1.133 (15 of 17 marked sheep within the survey units). Applying this additional sightability correction factor to the estimated 470 sheep in the survey units provided a total estimate of 533 sheep. Based on population estimates in 1997 (348) and 1999 (395), an estimate of 533 sheep seems unreasonably high. A variety of factors may have impeded the detection of such a high percentage of radiocollared sheep. During 1998, the survey was flown faster than in past years, potentially missing more sheep. Of the 8 sheep missed during the survey, 2 were in the same group in a forested area outside of any survey units. Also, 3 radiocollared sheep that were not detected within the Charley River unit were single ewes or ewe-lamb pairs that are more difficult to see than larger groups. Finally, sightability in the Charley River unit is poor in comparison to the other units due to the continuous spruce forest adjacent to the river bluffs and the tendency of sheep to run into the trees as the helicopter approaches. Perhaps there was a preponderance of radiocollared sheep along the Charley River bluff in that particular year and the distribution of marked sheep was not representative of the population. We do not believe that we missed seeing nearly half of the population during this particular survey as indicated by the total estimate corrected for sightability and presence within the sample units.

During the 1999 survey 20 of the 24 radiocollared sheep in the study area were seen during the survey. Two of the missed sheep were not in any survey unit and the other 2 missed were both ewes within the Charley River unit. Similar to the 1998 survey, the overlooked marked animals within the Charley Rivers unit were a single animal and a ewe-lamb pair. The 1999 survey was flown more slowly than was the 1998 survey and sightability of collared sheep improved. The

sightability correction factor derived from the sample of radiocollared sheep for sheep missed within sample units was 1.100 (90% CI = 1.02-1.35) (20 of 22 marked sheep). Applying this correction factor to the 329 sheep seen gives an estimate of 362 sheep in the areas surveyed. When considering the 2 sheep missed because they were outside of surveyed sample units, an additional correction factor of 1.091 (22 of 24 marked sheep) is needed. Applying this correction to the estimated 362 sheep in the survey units results in a total study area estimate of 395 sheep.

An alternative means by which to develop a sightability correction factor is to combine radiocollared sheep sightability for all years and calculate a single correction, which is then applied to all 3 years of surveys. Using the results from the total collared sheep seen and available (37 out of 50) resulted in an overall sightability correction factor of 1.351 (90% CI = 1.19-1.62), or 1.216 for sheep missed that were in survey units, and 1.111 for sheep outside the survey units (Table 7). When the overall correction is applied (1.351) to the 3 years of survey data the following estimates are derived: 1997 = 417, 1998 = 381, 1999 = 444.

Table 7. Numbers of collared sheep seen and present, sightability correction factors, % of marked sheep seen, and number and % outside of any survey unit but still within the population. Sheep surveys conducted within Yukon-Charley Rivers National Preserve, Alaska, 1997 – 1999.

Year	# collared sheep seen	Total # collared sheep present	#collars within survey units	#collars out of survey units	Total population. Correction (%seen)[1]	Sheep within survey units. Correction (%seen)[2]	Sheep outside of survey units (%outside)[3]
1997	8	9	8/8	1/9	1.125 (89%)	1.000 (100%)	1.125 (11%)
1998	9	17	9/15	2/17	1.888 (53%)	1.667 (60%)	1.133 (12%)
1999	20	24	20/22	2/24	1.200 (83%)	1.100 (91%)	1.091 (8%)
Total	37	50	37/45	5/50	1.351 (74%)	1.216 (82%)	1.111 (10%)

[1] For example (in the total row) 74% of all the sheep in the population are seen on a survey.
[2] For example (in the total row) 82% of the sheep within the survey units are seen.
[3] For example (in the total row) 10% of the sheep are outside the sample units during a survey.

We wish to clarify that development of sightability indices for Dall's sheep was not the intent of this work. Correction factors presented here have not been subjected to the rigor of repeated sampling effort in a given year and as a result, we do not have a measure of the repeatability of our survey findings. In addition, to appropriately develop a sightability index, a representative sample of the population should be marked. Our marked sample was heavily skewed towards adult ewes. Adult rams typically have larger home ranges, move longer distances, and presumably have a greater chance of being outside 'typical' sheep habitat and survey units (Whitten 1975, Ayres 1986). Our observations indicate that some young rams also have larger home ranges than do adult ewes (Table 2). Therefore, confidence in yearly estimates of Dall's sheep population size using the sightability correction factors we present is poor. Mark-resight techniques for estimating Dall's sheep population size should not be abandoned however. Rigorous testing and application of mark-resight techniques to accurately estimate populations of Dall's sheep holds great promise, particularly in locations where sheep habitat is fragmented and sheep are occurring in unexpected locations.

Natality and recruitment

Blood from 28 adult ewes (19 of which came from the military overflight/Dall's sheep study) was analyzed for progesterone levels as a test for pregnancy. Only ewes captured in March were tested. Over 4 years, 19 of the 28 (68%) tested ewes were found to be pregnant (Tables 1 and 10). Pregnancy rates averaged 88% for the first 3 years (1997 – 1999), but dropped considerably in 2000 to 44% (Table 8). This reduction in pregnancy rate may be due to winter conditions, as winter 1999–2000 had above average snowfall and an icy glaze was seen covering most

mountains when viewed from an airplane. In addition, lamb production and survival during and after winter 1999-2000 were lower.

Table 8. Known ewe pregnancies base on blood levels of progesterone. Yukon-Charley Rivers National Preserve, Alaska.

Year	Total sample	Pregnant	Not pregnant	% Pregnant
1997	7	6	1	85.7
1998	2	2	0	100
1999	10	7	3	70.0
2000	9	4	5	44.4
Total	28	19	9	67.8

During the 1997 survey, lamb:ewe ratios for the entire study area averaged 40 lambs:100 ewes (range 31-60). Yearling recruitment over the study area averaged 22 yrls:100 ewes (range 7-50). These numbers are generally lower when compared to historical data from 1987 and 1990 where the ratios were 50 lambs:100 ewes and 13 yearlings per hundred ewes in 1987 and 48 lambs:100 ewes and 39 yearlings per hundred ewes in 1990 (Ulvi and Knuckles 1990). The 1998 survey ratio of 54 lambs:100 ewes was the highest overall lamb:ewe ratio detected for all population surveys in YUCH dating back to 1983. Yearling recruitment during 1998 was the same as 1997 with a survey area average of 22 yrls:100 ewes. The 1999 survey produced ratios of 44 lambs:100 ewes and 30 yrls:100 ewes.

Because it is difficult to differentiate yearling rams from ewes, and most yearling rams are typically counted as ewes (inflating the count of ewes), yearlings and lambs are under-represented in these ratios. As a result, the yrl:ewe and lamb:ewe ratios should be considered a

minimum. However, because the same methods were used for all surveys the numbers are comparable between surveys.

A lamb:100 ewes ratio can also be calculated from the sample of collared ewes. A count of individual, collared ewes seen with a lamb through at least mid-July (i.e. when most sheep surveys are completed) was compared to the total number of collared ewes. When this was done for 1997, 6 of 8 collared ewes were seen with a lamb through at least mid July giving a ratio of 75 lambs:100 ewes. In 1998, 9 of 15 ewes had lambs through mid-July for a ratio of 60 lambs:100 ewes, and in 1999, 7 of 12 ewes had lambs resulting in 58 lambs:100 ewes. These ratios calculated from the radiocollared sample may be more representative of lamb production by breeding ewes than are the values from the aerial survey because yearling males and young females (2-3 old year) are excluded from these results.

Mortality

Causes of mortality for Dall's sheep were investigated by 2 means during the course of this study. One method was to investigate dead, radiocollared sheep as soon as was practical following their detection. The second was to examine the frequency of Dall's sheep kills from a sample of radiocollared wolves in YUCH because we assumed wolves would be an important cause of death for sheep in our study area. Funding and logistical constraints often limited our ability to investigate dead sheep in a timely manner. Occasionally, weeks went by before a mortality signal could be investigated on the ground, and usually little could be seen from the airplane when the mortality signal was first heard. This time delay created an uncertainty as to the cause of death for many of the mortalities in this study. Regardless of this uncertainty,

observations made during this study are insightful for exploring causes of mortality in Dall's sheep.

Mortality of radiocollared sheep

From 1997 to 2000, 23 sheep were marked with conventional collars and 20 were marked with GPS collars (from the military overflight study). Of the 43 marked sheep, 18 died during the course of this study (Figure 6). Twelve sheep were likely killed by a predator based on blood-soaked snow or radiocollars. We reasoned that bleeding and oxygenated blood (i.e. bright red) would require a pumping heart and, therefore substantial bright-red blood would be consistent with a violent death, presumably an attack from a predator. One sheep death was due to the capture operation (a drugged ewe). Two sheep deaths were possibly accidents or falls, and causes of death for 3 sheep are unknown.

Of the 12 sheep mortalities that appeared to be from predation, we found wolf tracks at one site and bear tracks and digging/raking at another. Four appeared to be killed by unidentifiable predators. Extensive wolverine (*Gulo gulo*) tracks and scats were the only predator sign found at the remaining 6. On 3 of the 6 occasions where wolverine sign was evident, we were able to get to the kill site fairly quickly after detecting the mortality signal and before any substantial snowfall or wind events, and found sign of only wolverines. This led us to the conclusion that wolverines were killing adult sheep (all sheep killed by wolverines were ewes). It is possible that 1 or 2 individual wolverines were responsible for these mortalities as all 6 were in close proximity (Figure 6). If wolves (or some other predator) had killed these 3 sheep we would have seen tracks or other sign in the snow.

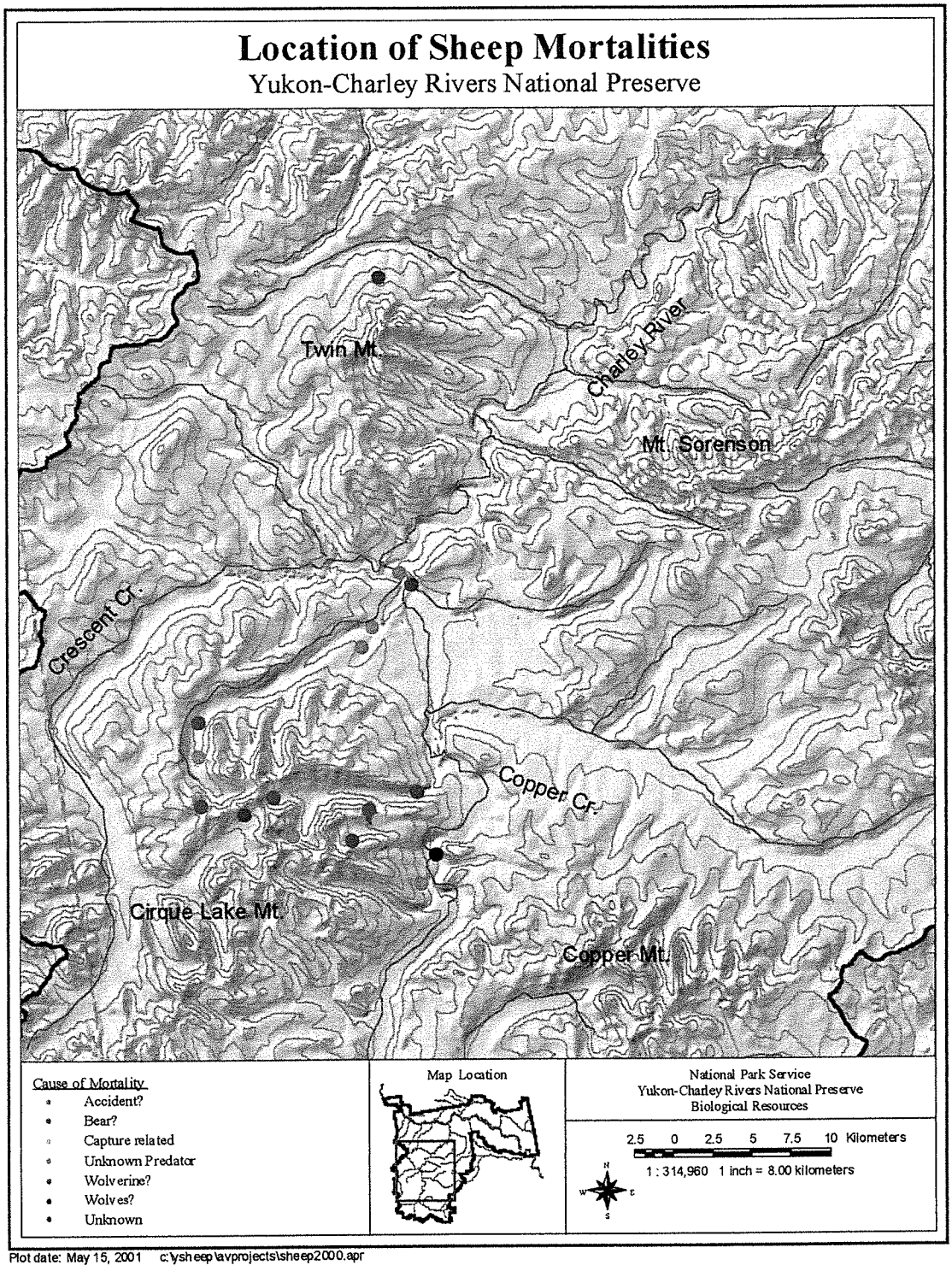


Figure 6. Locations and possible causes of collared sheep mortalities. Yukon-Charley Rivers National Preserve, Alaska, 1997 - 1999.

Wolverines are not often viewed as major predators of sheep, but the circumstantial evidence is compelling. Hoefs and Cowen (1979) reported one 8 year old ram killed by a wolverine in Kluane, and a sheep study in Gates of the Arctic National Park and Preserve has also suggested wolverines kill sheep (Lawler 2001). Other references to wolverines killing sheep can be found in Murie (1944), Dixon (1938), and Heimer (1973). Although few direct references to wolverines killing sheep were found in the literature, various hunters, trappers and pilots, when questioned on this topic remember seeing some evidence of wolverines killing sheep. Jim Rood a pilot and hunter from Kotzebue recalled seeing 3 specific instances.

Wolf Predation

One radiocollared sheep was killed by wolves. However, there were 8 mortalities of completely unknown causes or by unidentifiable predators, and some of these certainly could have been killed by wolves. However, the concurrent radiotelemetry study of wolves supports the finding that few sheep are killed by wolves in YUCH (Burch 2000).

Wolves inhabiting YUCH have been monitored via radiotelemetry since 1993 (Demma et al. 1997, Burch 2000). During three separate month-long efforts to calculate winter wolf predation rates in 1994 and 1995, Dall's sheep were not found to be a significant prey of radiocollared wolf packs inhabiting YUCH (Demma et. al. 1997). During the predation surveys wolves were located daily and back-tracked to find kills, resulting in a total of 55 kills. Fifty-three of the 55 kills were investigated and only 2 were determined to be Dall's sheep.

Many kills are missed when looking for kills from an airplane during routine radiotracking flights for wolves (approx. once per week). However, during routine radiotracking of wolves in YUCH for the past 8 years, 297 kills were found, but none of them were sheep kills (Burch 2000). This is in strong contrast to a wolf study in Denali National Park where over 60 sheep kills (or 12% of all kills) were discovered in 7 years of routine wolf radiotracking employing virtually the same methods (Mech et. al. 1998). Fourteen sheep kills were found while radiotracking wolves in a 2 year study in the Kluane Region of Yukon Territory (Sumanik 1987). Gasaway et al. (1983) and Ballard et al. (1987) both stated that sheep were a minor prey species of wolves in their study areas. In a study in the Alaska Range (Gasaway et al. 1983) only 5% of 65 wolves necropsied contained sheep remains. Wolves can kill and completely consume a sheep in a very short time; sheep kills are difficult to see from aircraft; and wolves don't spend as much time at sheep kills relative to moose or caribou kills (Dale et al. 1994, Mech et al. 1998). As a result, many sheep kills go undetected by routine monitoring of wolves, and sheep are underrepresented in the total sample of kills. Nonetheless, the large difference in number of sheep kills found in Denali compared to YUCH, clearly indicates regional differences in prey selection by wolves, and Dall's sheep appear to be a minor component of the diet of wolves in YUCH. Furthermore, very few wolf locations in YUCH are in typical sheep terrain indicating that YUCH wolves do not spend much time in sheep habitat hunting sheep (Burch 2000).

Sheep Mortality Relative to Weather and/or Winter Severity

Mortality of radiocollared sheep from 1997 – 2000 was variable but is difficult to evaluate due to the small sample of collard sheep (Figure 7). Six sheep radiocollared in September of 1997 and 1 sheep in November of 1998 were not included in the analysis because they were radiocollared 6

months after the rest of the sample. In biological year 1997–1998 (1 April 1997 – 30 March 1998) 4 of 11 (36.4%) radiomarked sheep died. In biological year 1998-1999 the number decreased to 1 of 12 (8.3%) radiocollared sheep dying, and in 1999-2000 it increased to 3 of 11 or (27.3%).

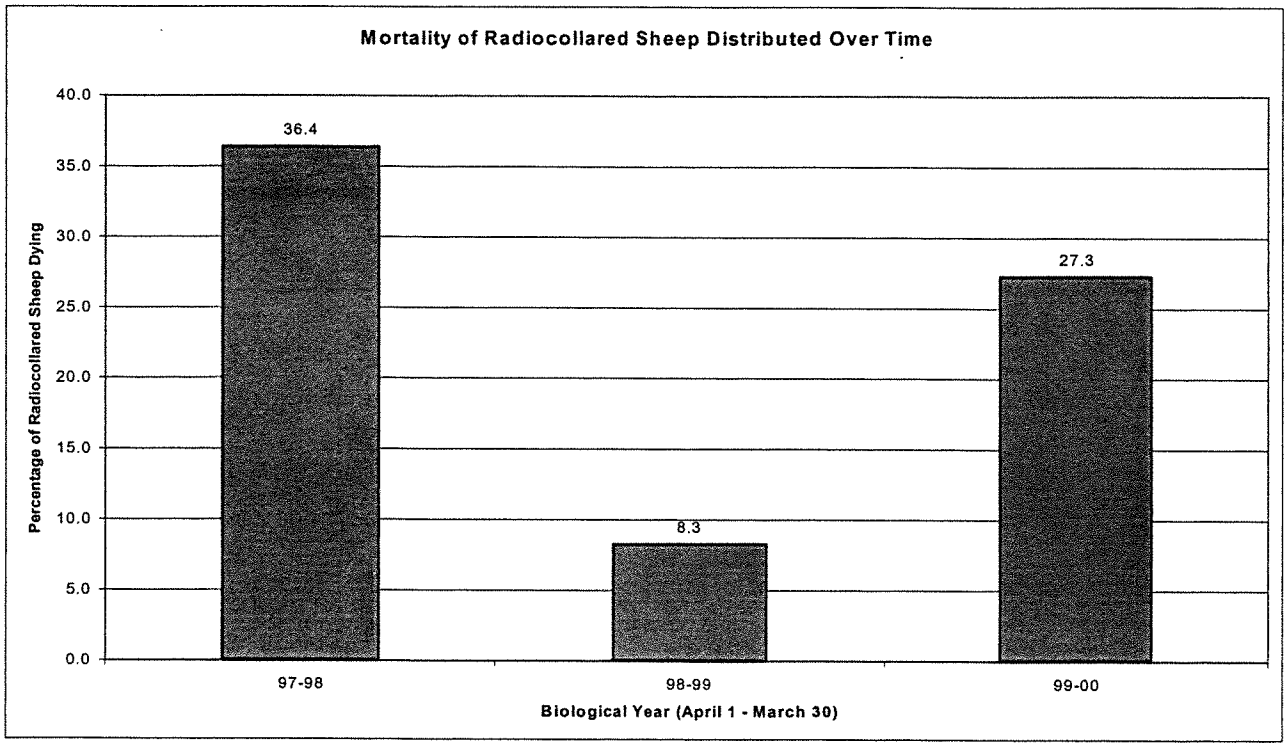


Figure 7. Mortality of radiocollared sheep when weighted for the total sample of collared sheep. 1997-2000 in the Charley River drainage, Yukon–Charley Rivers National Preserve, Alaska.

In winter 1999-2000 an icy crust was observed from aircraft on the mountains in the study area. This icing event may have contributed to mortality of sheep in that year. Although it was not evident in the collared sample, we suspected an increase in sheep mortality during 1999-2000 as the results of a search of the area that was conducted in March 2000 for the purpose of locating sheep to radiocollar. In strong contrast to previous years, very few sheep were observed and

radiocollared ewes comprised a much higher proportion of the population. We attribute the apparent better survivability of radiocollared ewes in comparison to other sheep to our selection process during radiocollaring operations. Sheep selected for capture were mature ewes. Sheep in poor condition were intentionally avoided. Therefore, our sample of primarily middle-aged adult ewes may have survived better than very young or very old sheep, both of which were avoided during capture. The icing event during 1999-2000 suggests that adverse weather conditions likely have stronger impacts on this population of sheep than current levels of human harvest, predation, or human disturbance.

Accidents

In June 1998, an adult radiocollared ewe was found dead at the base of a steep bluff along the Charley River by a preserve visitor. The ewe's spring lamb was alive and remained close to the carcass. The visitor's retrieval of the collar, in addition to their uncertainty as to its exact location, made it impossible for us to locate and necropsy the animal. However, one of the visitors (a medical doctor) provided us with a description of the carcass. According to her, the sheep carcass was wholly intact with no obvious signs of external injury, and she estimated the time of death to be recent, within 24 hours. She speculated that the sheep may have fallen to her death.

In January 2000, a 7 year old ewe that had been captured and radiocollared 2 years previously was found dead and without sign of a predator or scavenger. She had a broken right rear leg, and there was blood in her beds and drag marks in the snow where she had walked, dragging the broken leg. It is assumed the break contributed to her death. Two of the sheep captured for

radiocollaring were found to have healed broken legs, but appeared to be able to walk and run well. One other non-collared sheep was seen with what appeared to be a freshly, broken leg, but its fate is unknown. These observations indicate that accidents resulting in broken bones are not uncommon and some sheep survive these accidents.

Harvest

Human harvest of sheep in the Charley River drainage of the preserve was light from 1980 through 1994. Hunting in the Charley River drainage was restricted to a drawing permit hunt until 1993 when sheep could be legally harvested under general sport hunting regulations. During 1983-1994, 9 rams were reported harvested in the Charley River drainage based on ADF&G's harvest records. No sheep harvest was reported in six out of those 12 years and only 1 or 2 rams had been harvested in the other years, averaging 0.75 rams per year (Figure 8). Beginning in 1995, harvest increased markedly with 7 rams harvested in that year, and averaged 5.2 rams per year for the next 5 years 1995 – 1999 (Figure 8). Hunter effort also increased after the change in regulations. From 1983 – 1994 hunter effort averaged 15.6 hunter days per year, where from 1995 – 1999 hunter effort averaged 71.8 hunter days per year (Figure 8).

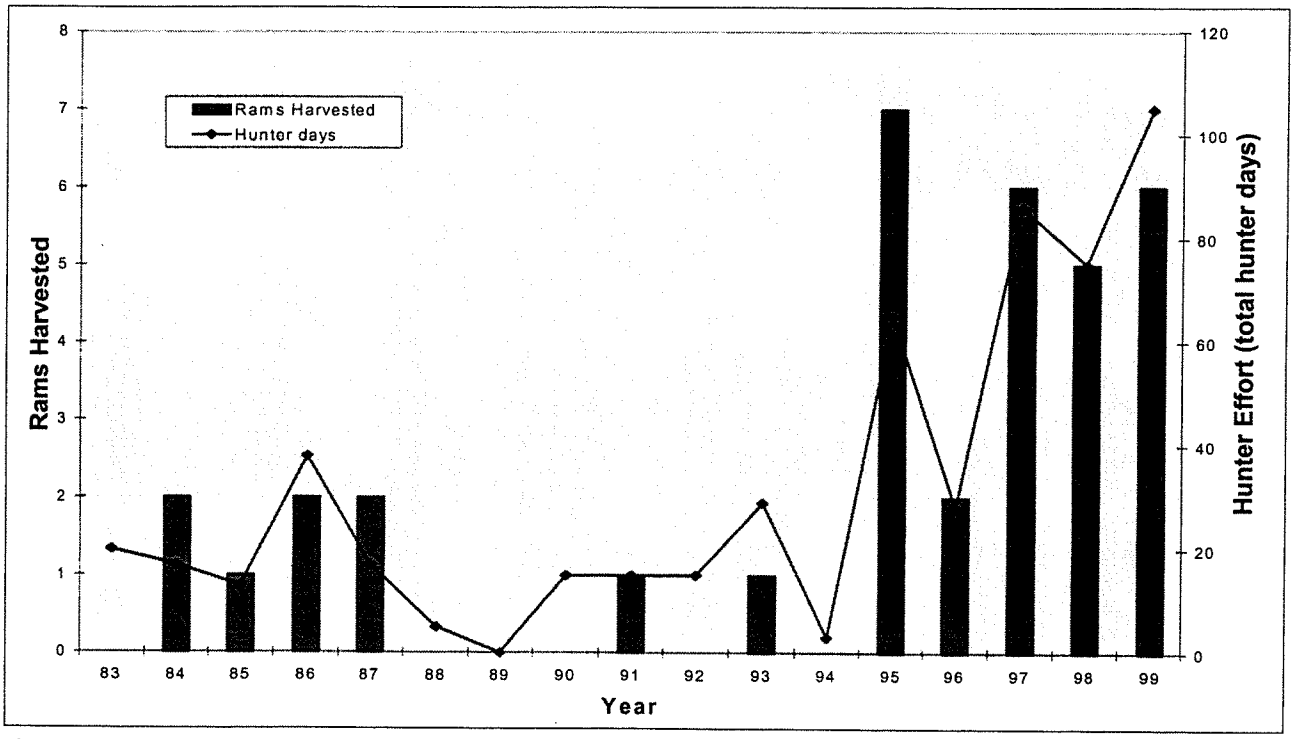


Figure 8. Reported sheep harvest and hunter effort during 1983-1999 in the Charley River drainage, Yukon–Charley Rivers National Preserve, Alaska.

In the 5 years in which most of the 7 survey units in the Charley River drainage were surveyed, 18 - 24 legal rams were seen (Table 9). When the harvest was at an average of 1 or 2 rams per year, the population was not at risk of being over harvested. Although mean harvest increased to over 5 per year starting in 1995, this level of harvest is considered to be consistent with managing a healthy sheep population, assuming there are at least 18 legal rams in the population each year. Harvesting half or fewer of the legal rams (full curl or larger) should not disrupt breeding and social interactions and also allow for the chance of harvesting large, trophy rams (Ken Whitten, ADF&G, pers. comm.). If average harvest increases to 12 rams per year or more (for 2 years) or the average number of legal rams available each year drops to 15 or fewer, harvest regulations should be re-evaluated.

Population Trends

Caution should be used when looking for trends in the YUCH sheep survey data. It is easy to try and make comparisons among years where counts of sheep do not include the same set of survey units. For example, the data summarized in Figure 9 combines data from all 7 survey units, but only for 3 years 1997 – 1999. Whereas the totals in the bottom of Table 9 for years 1983, 1990, and 2000, when all 7 survey units were not surveyed, and are not comparable to 1997-1999. Figure 9 shows little variability from year to year indicating a stable or slowly changing population. A regression of the 3 data points of population size indicates no significant trend (r^2=0.18, P=0.721).

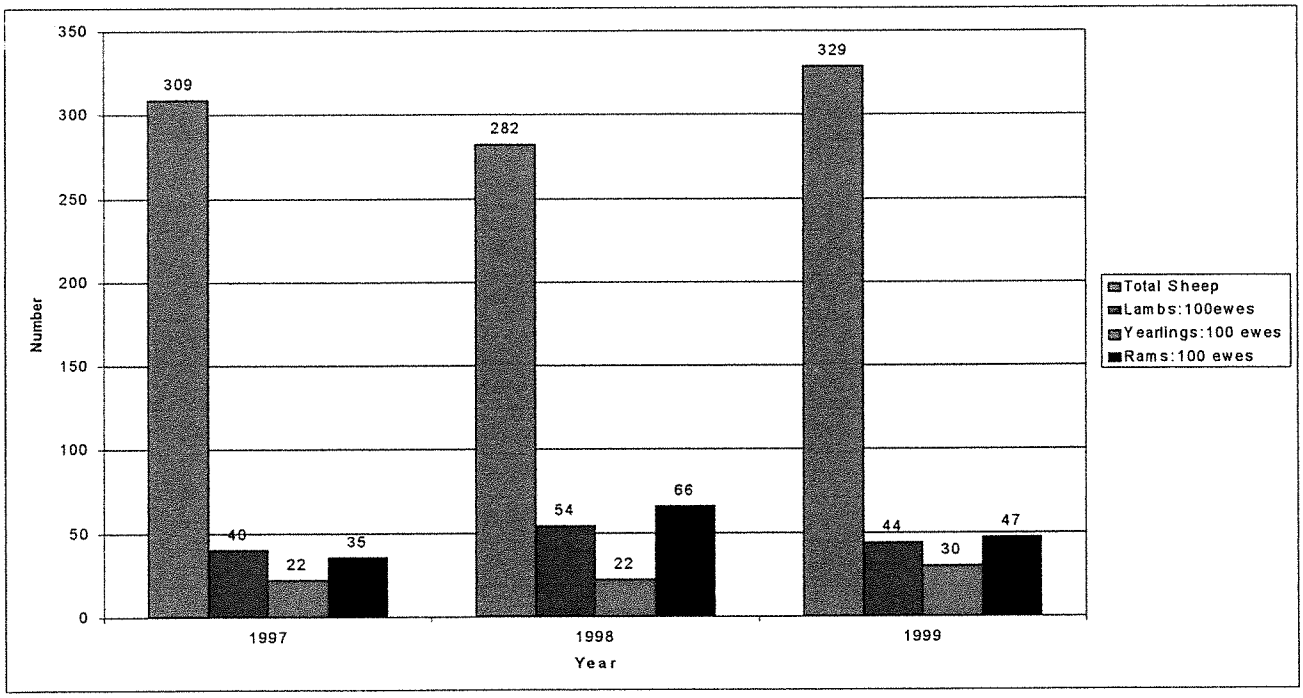


Figure 9. Trends in Overall Sheep population 1997 - 1999, Yukon-Charley Rivers National Preserve, Alaska (combined data from all survey units).

The size of the sheep population within YUCH has showed little variability in those years with comparable data (1997-1999) (Figure 9). However, given the small population of sheep and the patchy nature of their habitat in YUCH, sheep numbers could drop quickly from stochastic events such as deeper than usual snowfall or an icing event. We have some indication that this happened over the winter 1999-2000. Unfortunately the 2000 survey was hampered by poor weather and only 3 of the 7 units were surveyed. Data from those 3 units indicate fairly good age and sex ratios for yearlings and rams, but the 33 lambs:100 ewes would be the lowest overall ratio to date (Tables 7 & 8). During the sheep capture effort for the USAF overflight sheep project in March 2001, very few ewes could be found in the Cirque Lakes unit.

Table 9. Sheep population data during 1983- 1999, Yukon-Charley Rivers National Preserve, Alaska.

Survey Area	Year	Survey Time (hrs)	Tot. Sheep	Ewes	Lambs	Yrlngs	Rams	Lambs/100 Ewes	Yearlings/100 Ewes	Rams/100 Ewes	Legal Rams	Sub-Legal Rams	% Legal Rams
Diamond Fork	1983	N/A	7	0	0	0	7	0	0	0	2	5	29
	1990	1.7	19	2	2	0	15	100	0	750	6	9	60
	1997	1.8	11	1	0	2	8	0	200	800	4	4	50
	1998	2.0	37	11	5	5	16	45	45	145	6	10	38
	1999	2.7	18	0	0	0	18	0	0	0	7	11	39
Cirque Lakes	1983	N/A	66	26	10	9	21	38	35	80	10	11	48
	1984	4.8	27	16	4	8	1	25	50	6	0	1	0
	1990	2.5	107	47	15	19	26	32	40	55	13	13	50
	1993	2.5	58	38	9	1	10	23	2.6	26	0	10	0
	1994	2.9	63	21	9	9	24	43	43	114	3	21	13
	1995	3.2	76	27	9	11	29	33	41	107	7	22	24
	1997	3.2	77	42	13	3	19	31	7	45	5	14	26
	1998	2.1	62	18	9	3	32	50	17	178	7	25	22
	1999	3.7	69	33	13	15	8	39	46	24	3	5	38
Copper Mountain	1983	N/A	13	1	2	1	9	200	100	900	0	9	0
	1990	1.2	27	9	2	9	7	22	100	78	3	4	43
	1997	0.8	25	9	5	3	8	56	33	89	4	4	50
	1998	0.7	11	5	2	1	3	40	20	60	1	2	33
	1999	1.4	10	4	0	0	6	0	0	150	2	4	33
Twin Mountain	1983	N/A	36	12	10	3	11	83	25	92	1	10	9
	1990	1.5	48	15	13	4	16	87	27	107	0	16	0
	1997	1.2	54	23	11	4	16	48	17	70	4	12	25
	1998	0.8	49	23	10	6	10	43	26	44	3	7	30
	1999	0.5	62	22	10	6	24	46	27	109	6	18	25
	2000	1.03	62	22	8	4	28	36	18	127	6	22	21
Mount Sorenson	1983	N/A	31	9	2	0	20	22	0	222	5	15	25
	1984	2.7	32	15	8	2	6	53	13	40	1	5	17
	1987	N/A	35	14	9	2	10	64	14	71	1	9	10
	1990	1.9	58	18	12	7	21	67	39	117	2	19	10
	1993	1.4	16	0	0	0	16	0	0	0	5	11	31
	1994	1.4	48	17	6	0	25	35	0	147	6	19	24
	1995	1.3	57	20	17	6	15	85	30	75	5	10	33
	1997	1.1	79	46	17	15	1	37	33	2	1	0	100
	1998	1.0	35	15	7	2	11	47	13	73	7	4	64
	1999	1.3	98	55	21	9	13	38	16	24	6	7	46

Table 9. continued.

Survey Unit	Year	Flight Hours	Tot. Sheep	Ewes	Lambs	Yrlngs	Rams	Lambs:100 Ewes	Yrlngs:100 Ewes	Rams/100 Ewes	Legal Rams	Sub-Legal Rams	% Legal Rams
5580 Mt.	1997	0.5	24	10	6	5	3	60	50	30	0	3	0
	1998	0.4	35	17	11	3	4	65	18	24	0	4	0
	1999	0.5	20	10	5	5	0	50	50	0	0	0	0
	2000	0.47	27	12	4	7	4	33	58	33	1	3	25
Charley R	1997	1.4	39	25	11	3	0	44	12	0	0	0	0
	1998	1.0	53	27	19	6	1	70	22	4	0	1	0
	1999	2.1	52	25	16	10	1	64	40	4	0	1	0
	2000	1.6	31	20	6	5	0	30	25	0	0	0	0
Summary of All Surveys	1983*	N/A	153	48	24	13	68	50	27	142	18	50	26
	1990*	8.8	259	91	44	39	85	48	43	93	24	61	28
	1997	12.1	309	156	63	35	55	40	22	35	18	37	33
	1998	8.0	282	116	63	26	77	54	22	66	24	53	31
	1999	12.2	329	149	65	45	70	44	30	47	24	46	34
	2000**	3.13	120	54	18	16	32	33	30	59	7	25	22

*Does not include 5580 Mt. or the Charley River.

** Only 3 units: 5580 Mt, Twin Mt, Charley River due to poor weather.

Fannin color phase

The fannin color phase of Dall's sheep (a dark brown or gray saddle and tail, or some fraction of this; Geist 1971) are found in YUCH. Usually fannin sheep in the preserve are seen in the Ogilvie Mountains along the Canadian border north of the Yukon River. Ulvi (1984) states that 7.4% of sheep counted in the Ogilvie Mountains had obvious fannin coloration. There are also fannin sheep seen on Glacier Mountain west of Eagle outside the preserve but usually not in the Charley River drainage (Ulvi 1991, Gardner ADF&G Tok pers. comm.). Indications of partial fannin phase characteristics, such as black tails or black hairs in the tails, were common in the 45 sheep captured during this study in the Charley River. During a radiotracking trip in mid-October of 1997, a fannin ram with a gray saddle was seen on Sheep Bluff along the Charley River. This was the only observation of a fannin sheep in the Charley River during this study. This observation also indicates that adult rams can travel widely in and out of the preserve.

CONCLUSIONS

This study was initiated to investigate 3 primary objectives: 1) investigate the timing of sheep surveys to see if they could be shortened, or otherwise improved; 2) investigate and document interchange between survey units; and 3) locate sensitive use areas for sheep within YUCH. We were unable to improve the timing of the present sheep survey for YUCH. Timing of surveys should remain in late June or early July when most snow has melted and lambs and female yearlings are distinguishable from adult ewes. There is a substantial degree of interchange between survey units and therefore, to get counts representative of the YUCH sheep population, all 7 units should be surveyed in a given sampling period. Specific, definable, sensitive use areas

were not separable from known sheep ranges and both lambing and rutting activities appeared to occur throughout the sheep range within YUCH.

The latest population surveys indicate that lamb and yearling recruitment are consistent with historically stable sheep populations. Since 1983, ram:ewe ratios within the preserve have shown considerable fluctuation (Figure 10). The reasons for these fluctuations are probably a result of mature rams moving in and out of the study area. There are incidental observations to support this hypothesis such as the one observation of a fannin ram at Sheep Bluff, the long movements of collared ram 97017, the dramatic fluctuations in the number of rams seen in 1995 – 1999 on Mt. Sorenson, and 1983 – 1990 on Cirque Lakes (Table 9). Inconsistencies in areas surveyed make it difficult to attribute these changes to real variation in the sheep population within the preserve. An alternative is that in the years of unusually low ram:ewe ratios (1984 & 1997), a significant portion of rams were occupying atypical (forested) habitat during the population surveys.

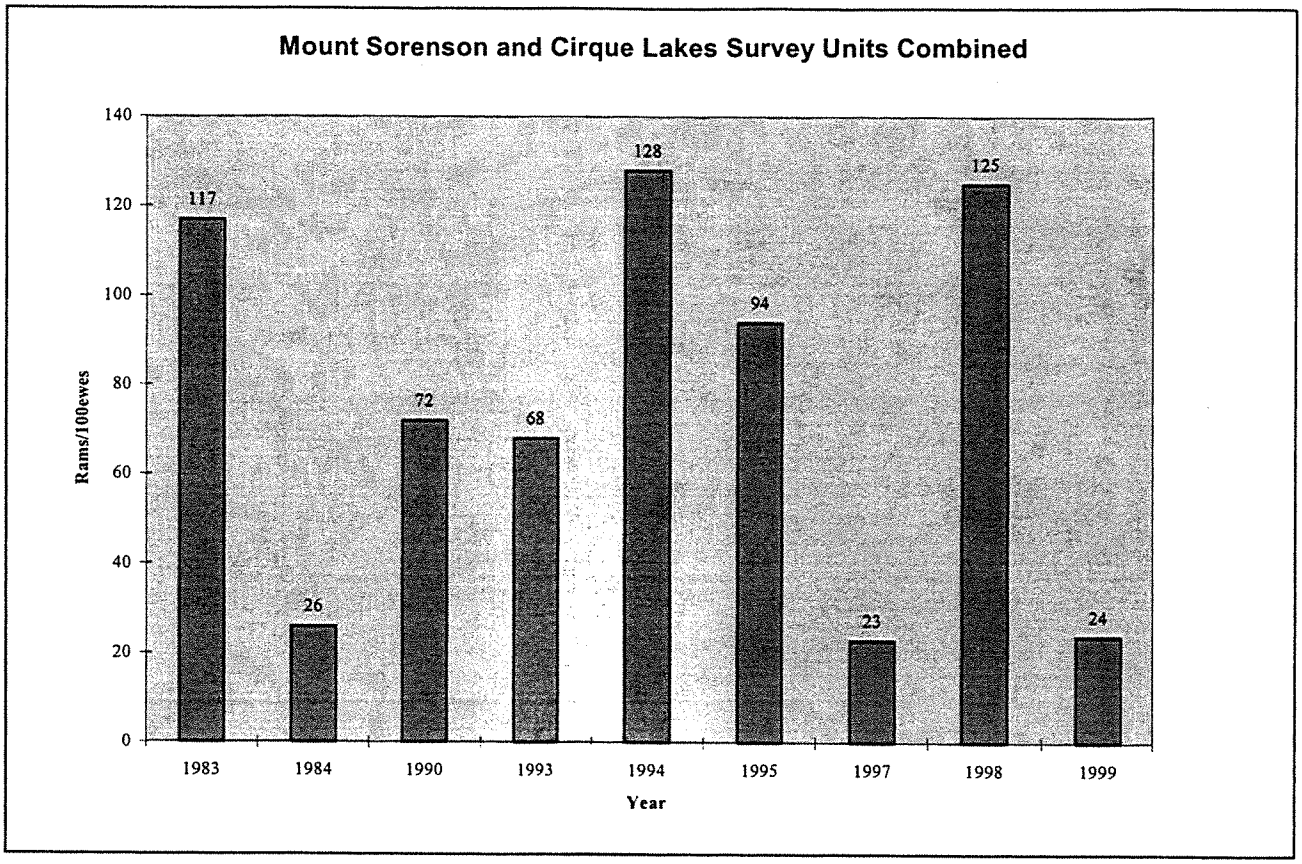


Figure 10. Ram:Ewe ratios for the Mount Sorenson and Cirque Lake survey units combined. 1983 – 1999, Yukon–Charley Rivers National Preserve, Alaska.

The number of legal rams harvested during the last 17 years has been within sustainable levels (Ken Whitten, ADF&G pers. comm.). The low sheep density, remoteness, and poor accessibility of YUCH will probably keep hunting effort low and harvest within sustainable levels. Annual harvest in YUCH should be monitored in light of the low sheep densities. A small increase in hunting pressure could cause harvest to surpasses sustainable levels. Consistent monitoring will allow managers to detect trends in harvest and avoid population declines by restricting the number of rams taken if sustainable harvest levels are exceeded.

Monitoring plan:

Ideally, the sheep population and sheep harvest would be monitored on an annual basis. The preferred method for surveying is with a helicopter, and all 7 survey units should be surveyed to get an accurate estimate of sheep population size in YUCH. At current costs this requires an annual investment of $10,000. If this funding level is not available on an annual basis, an alternative would be to survey every 2 years. Given the small size of the sheep population and the fragmented nature of the sheep habitat in the preserve, this population of sheep is particularly vulnerable to disturbance and locally severe weather events. We recommend a strategy of long-term monitoring to ensure the maintenance of the YUCH sheep population. Harvest levels should be followed and can be tracked using the ADF&G's harvest reporting system. To date the State of Alaska has shared this information with federal agencies. ADF&G has a good system of keeping track of harvest levels of wildlife as well as hunter effort state wide that is generally accepted by the hunting public. Every effort should be made to keep this line of information sharing open. It would be difficult, expensive and a burden to the hunting public for the federal government to try and create a new, additional system of harvest reporting. With both population and harvest information available over the long term, the sheep population of YUCH can be managed to ensure the enjoyment of this unique resource for future generations.

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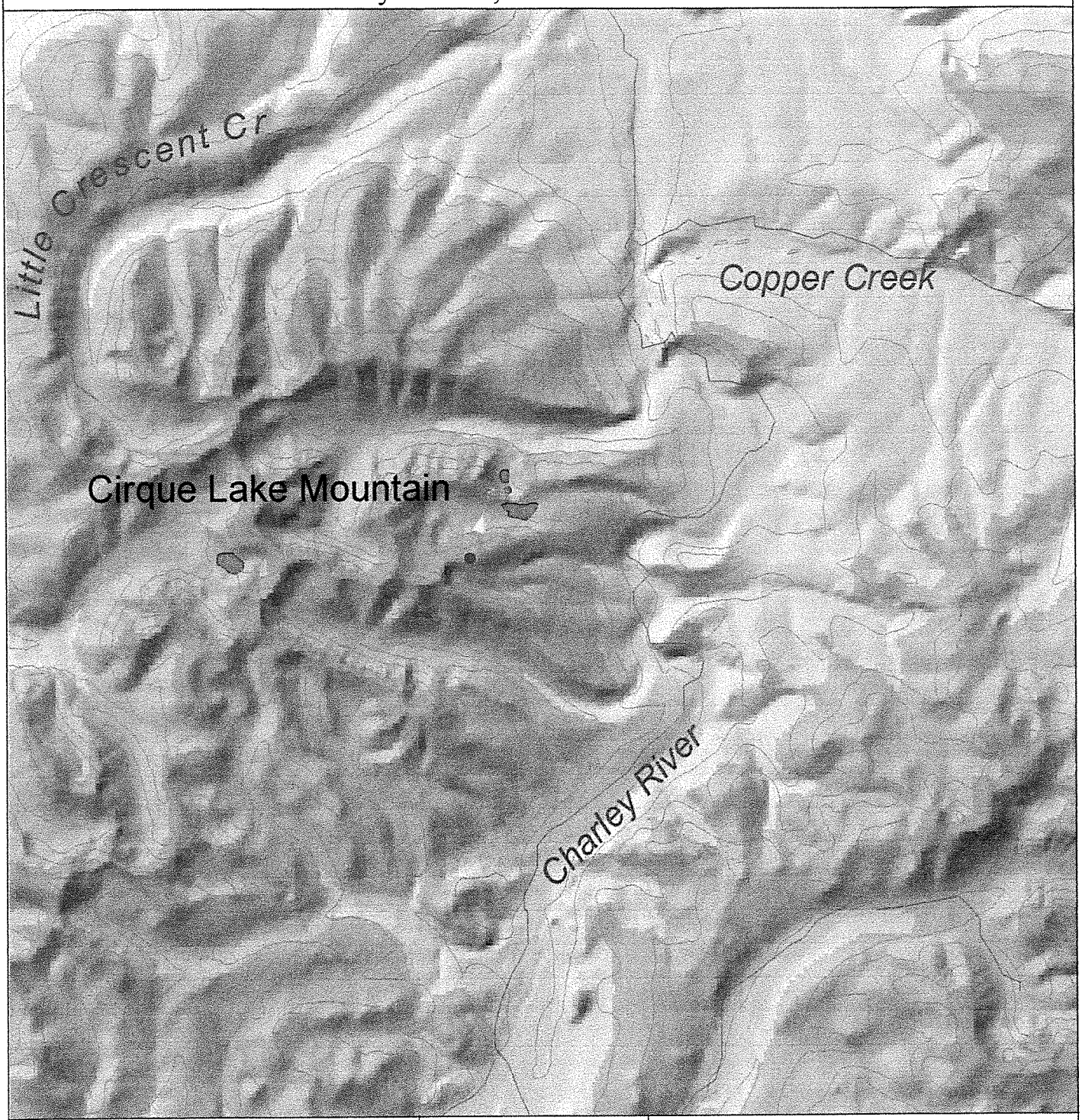
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Appendix A

Maps with locations for each of 23 radiocollared sheep.

Locations of 97001. Adult Ewe

By Season, 3/29/97 - 4/10/97



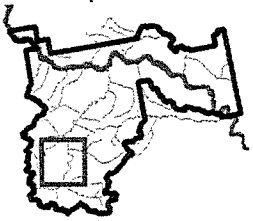
Locations of 97001

- March
- April
- Rivers
- Cirque Lakes

500 meter elevations

- 0 - 500
- 501 - 1000
- 1001 - 1500
- 1501 - 2000
- 2001 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 Kilometers

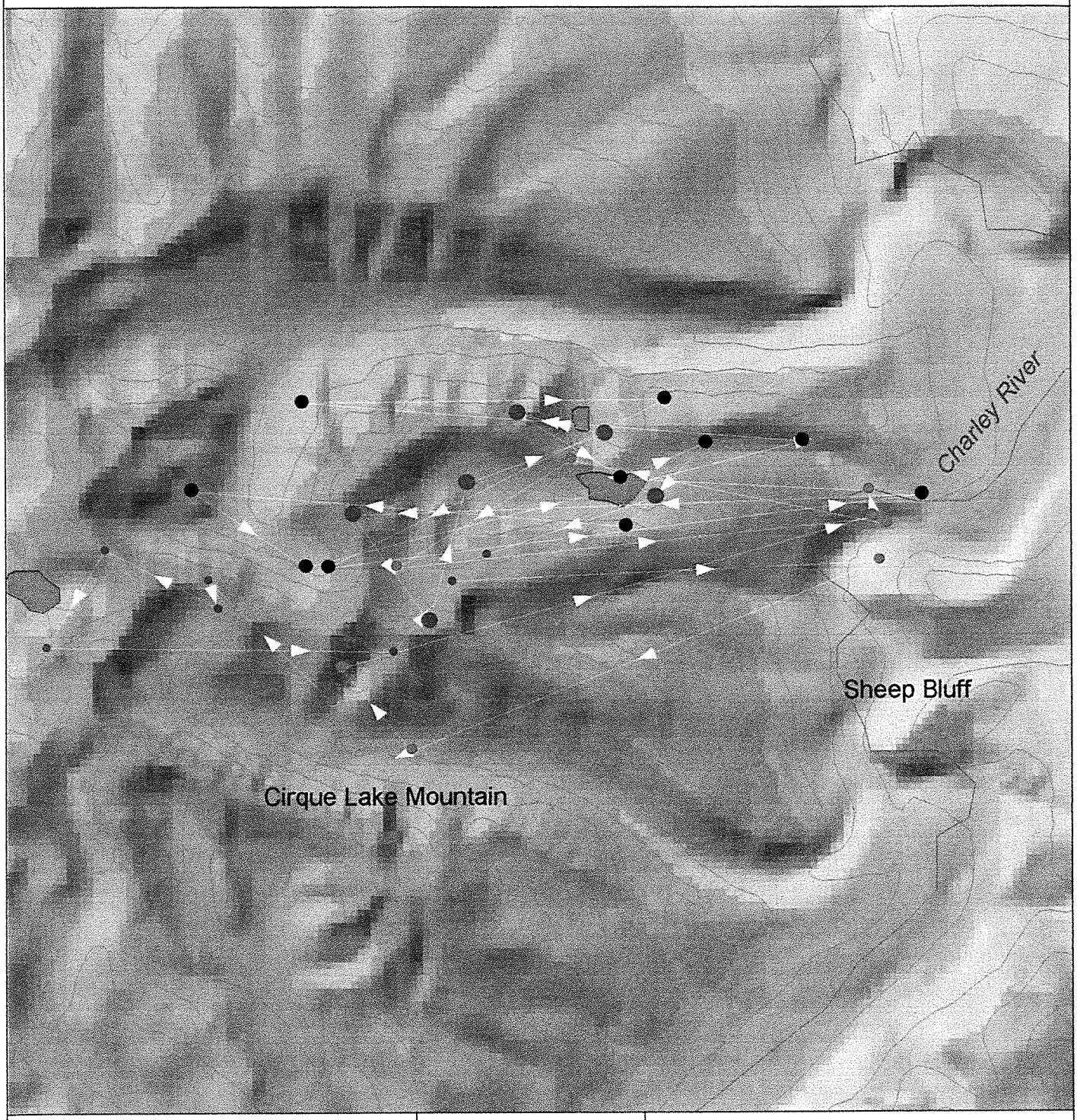
1 : 157,480 1 inch = 4.00 kilometers

N W E S

Plot date: September 7, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97002. Adult Ewe

By Season. 3/97 - 2/98

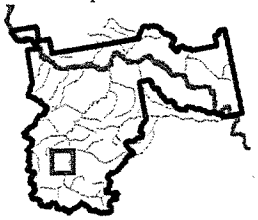


Locations of 97002
- Feb - April
- May - July
- August - Oct
- Nov - Jan
- Travel Route
- Rivers

Cirque Lakes

500 meter elevations
- 0 - 500
- 501 - 1000
- 1001 - 1500
- 1501 - 2000
- 2001 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

1 0 1 2 3 Kilometers

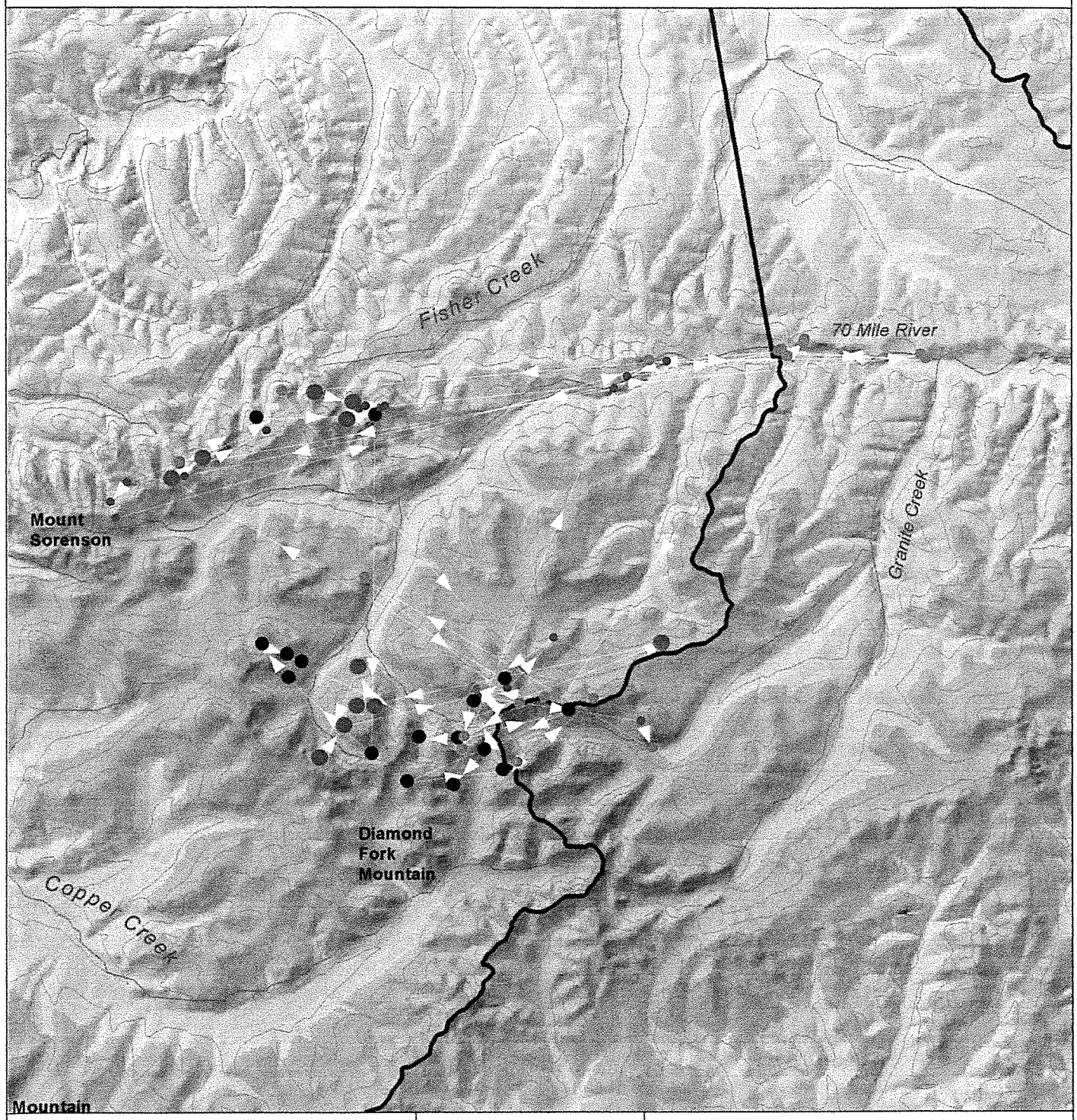
N W E S

1 : 78,740 1 inch = 2.00 kilometers

Plot date: September 10, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97003. Young Ram

By Season. 3/97 - 9/99



97003 Locations
- Feb - April
- May - July
- August - Oct
- Nov - Jan

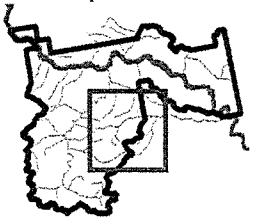
Direction of Travel

Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 7.5 10 Kilometers

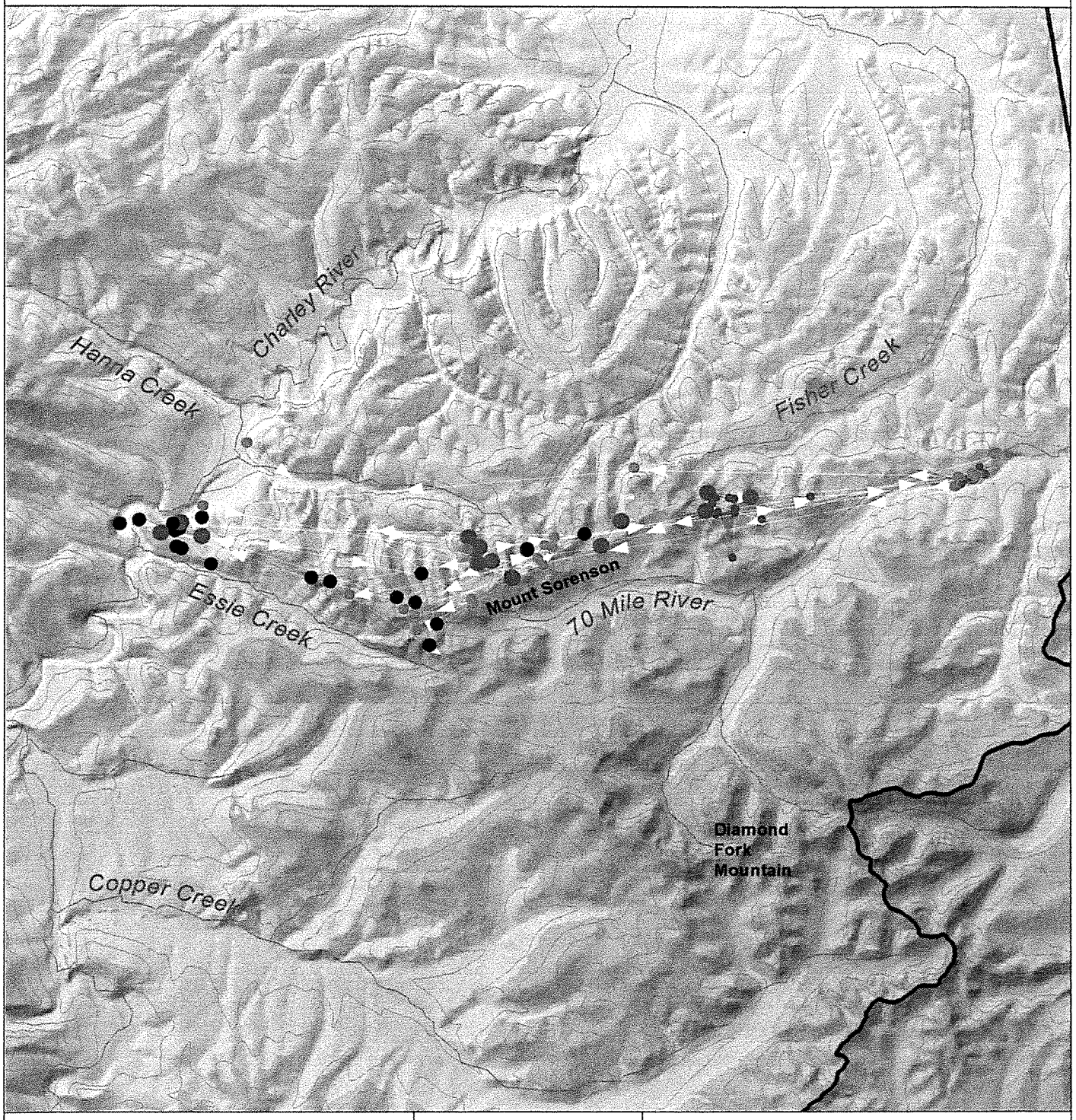
1 : 275,590 1 inch = 7.00 kilometers

N W E S

Plot date: September 10, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97004. Adult Ewe

By Season. 3/97 - 3/00



Locations of 97004
- Feb - April
- May - July
- August - Oct
- Nov - Jan

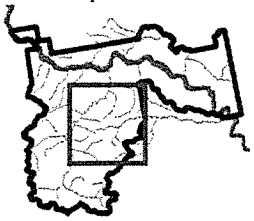
Direction of Travel

Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 7.5 10 Kilometers

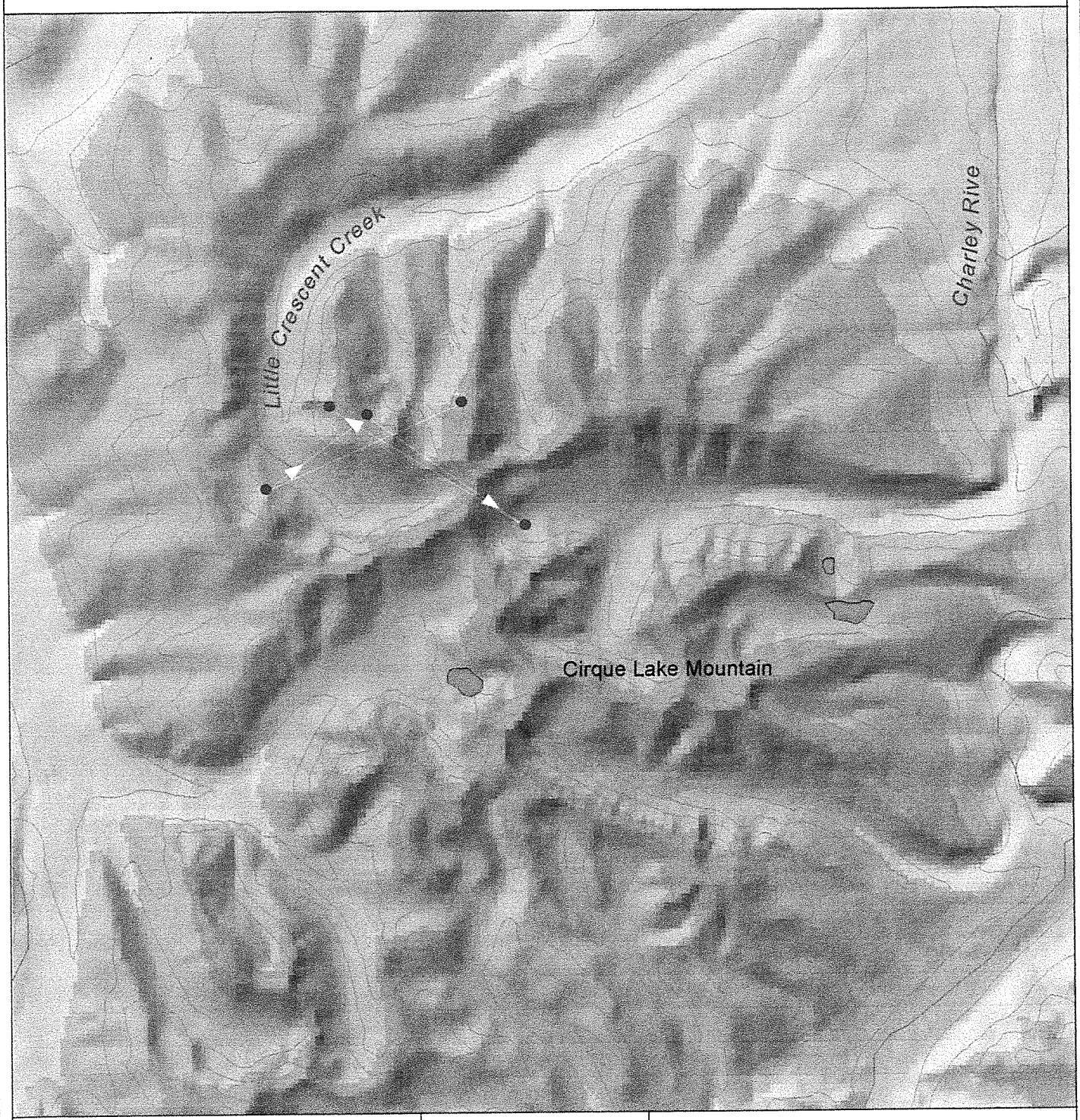
1 : 275,590 1 inch = 7.00 kilometers

N W E S

Plot date: September 10, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97005. Adult Ewe

By Season. 3/30/97 - 4/26/97



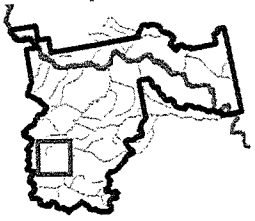
Locations of 97005

- April
- Direction of Travel
- Rivers
- Cirque Lakes

Elevation in Meters

- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 Kilometers

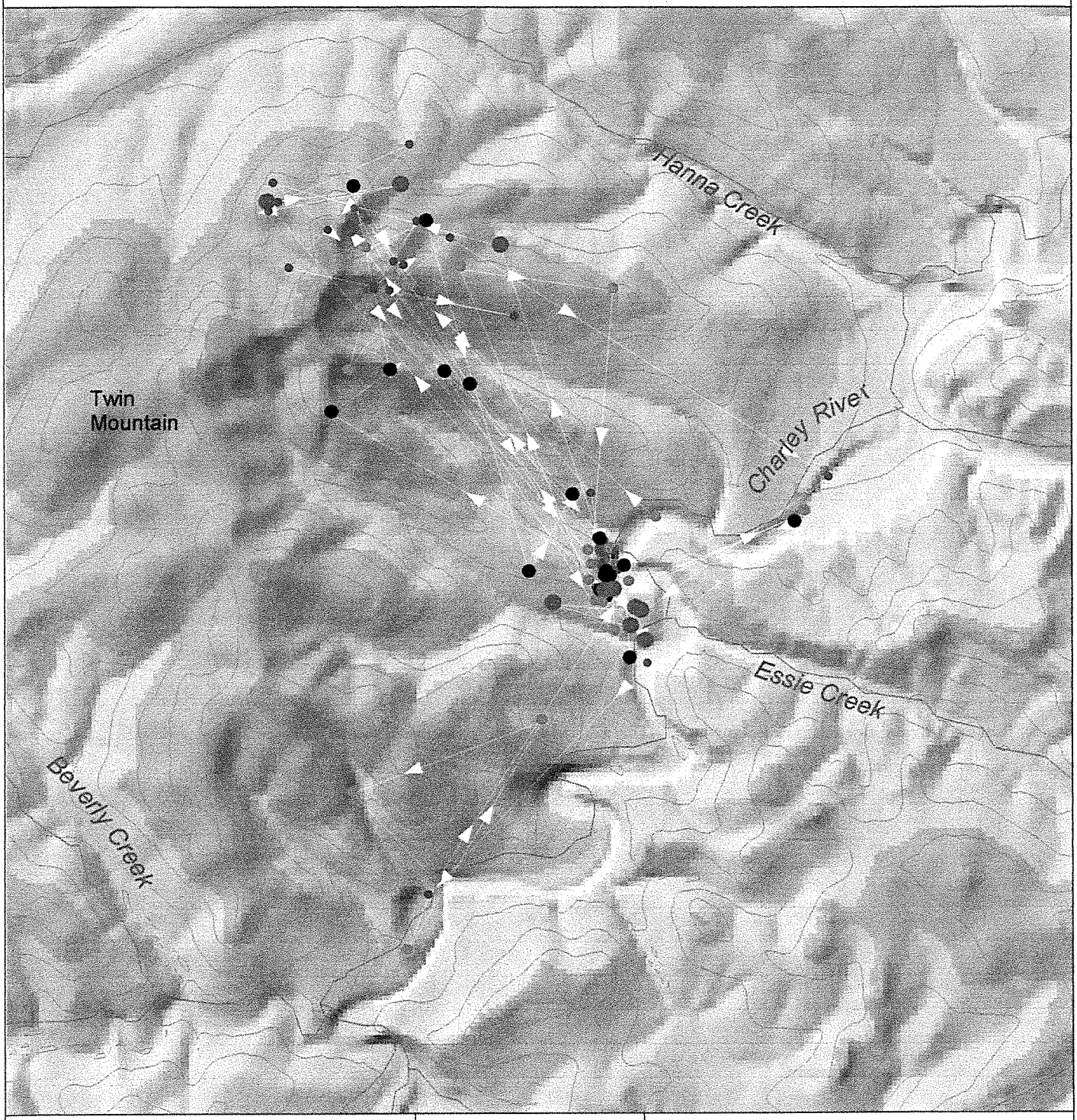
N W E S

1 : 118,110 1 inch = 3.00 kilometers

Plot date: September 10, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97006. Adult Ewe

By Season. 3/97 - 3/00



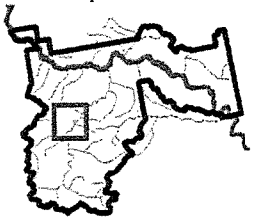
Locations of 97006

- Feb - April
- May - July
- August - Oct
- Nov - Jan
- Direction of Travel
- Rivers

Elevation in Meters

- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 Kilometers

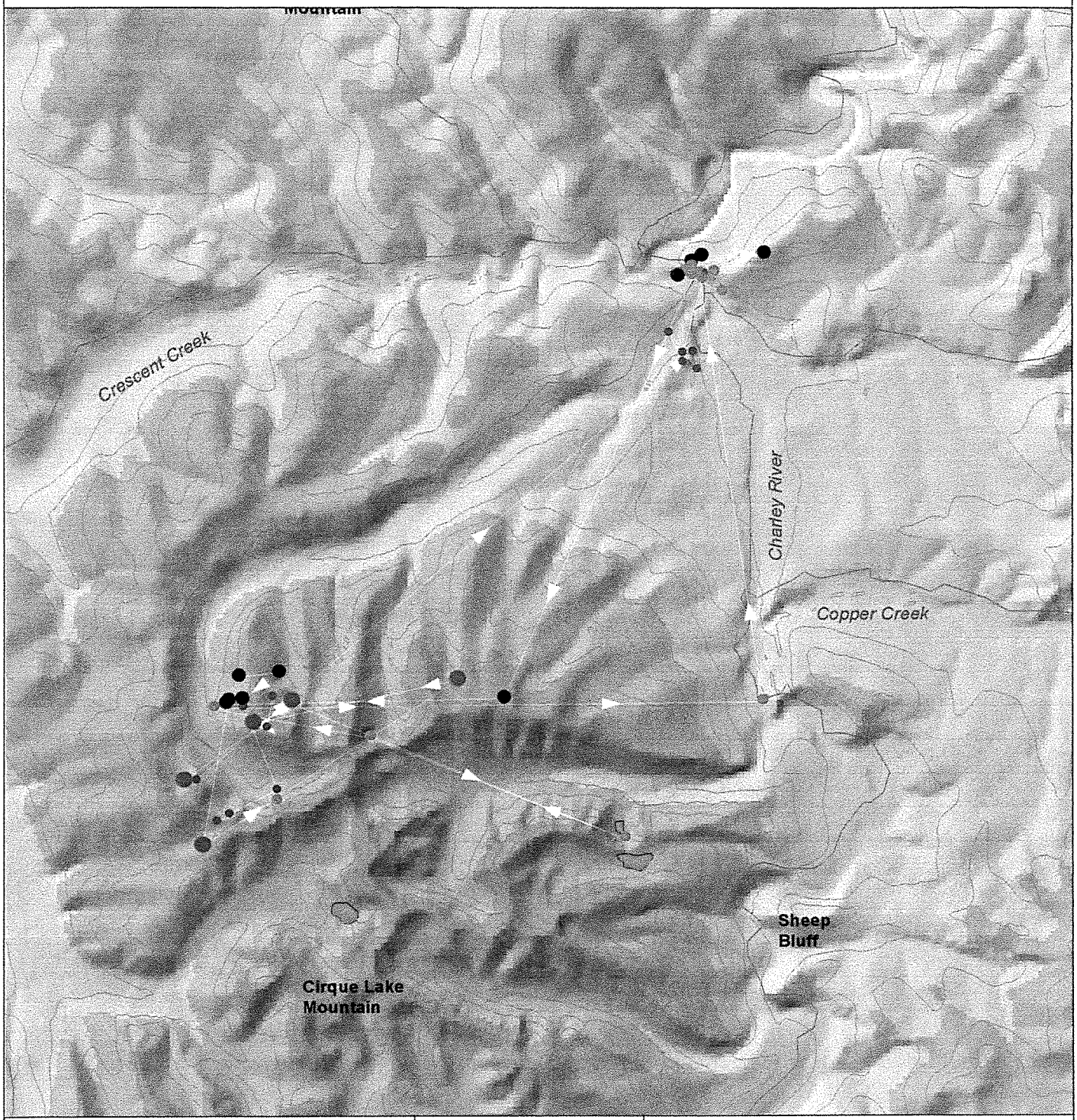
1 : 118,110 1 inch = 3.00 kilometers

N W E S

Plot date: September 10, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97007. Adult Ewe

By Season. 3/97 - 6/98



Locations of 97007
- Feb - April
- May - July
- August - Oct
- Nov - Jan

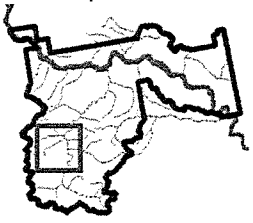
Travel Route

Cirque Lakes

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 Kilometers

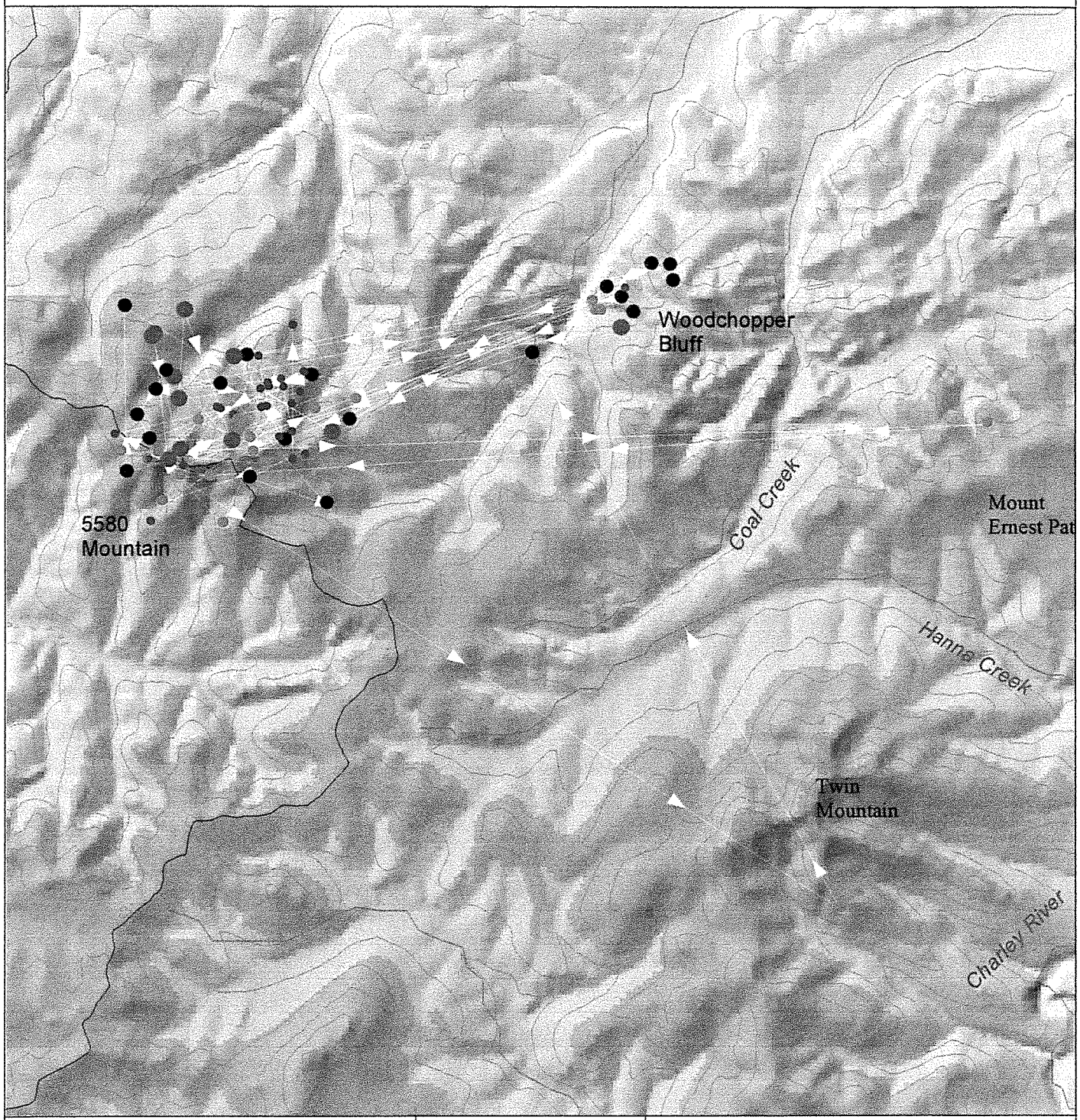
1 : 157,480 1 inch = 4.00 kilometers

N W E S

Plot date: September 10, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97008. Adult Ewe

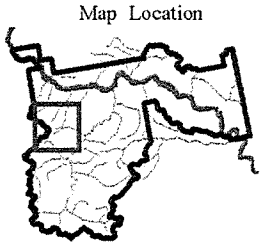
By Season. 4/97 - 4/00



Locations of 97008
- Feb - April
- May - July
- August - Oct
- Nov - Jan
- Travel Route
- Rivers

Elevation in Meters
- 0 - 500
- 501 - 1000
- 1001 - 1500
- 1501 - 2000
- 2001 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

3 0 3 6 Kilometers

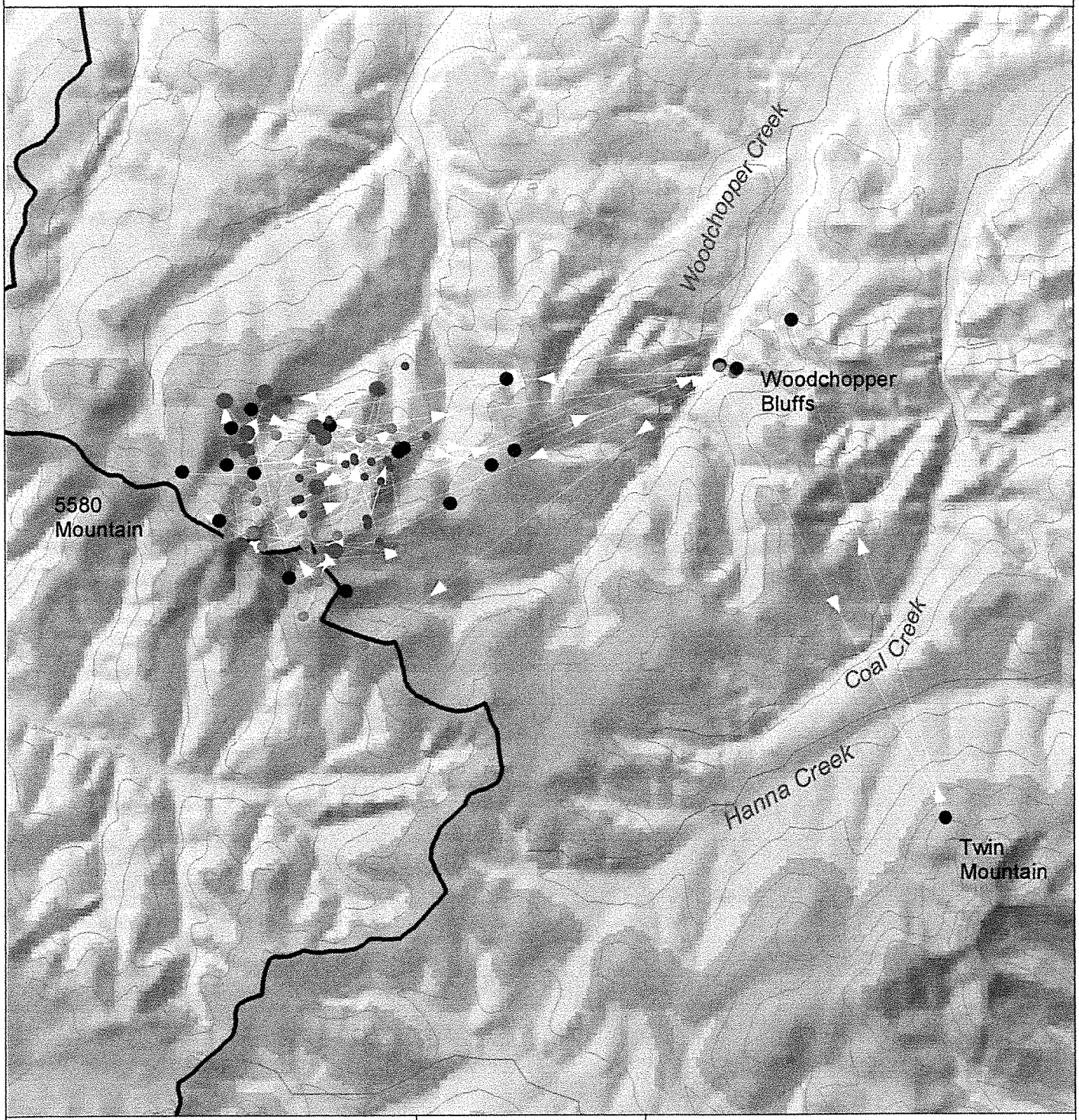
1 : 157,480 1 inch = 4.00 kilometers

N W E S

Plot date: September 7, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97009. Adult Ewe

By Season. 4/97 - 4/00



Locations of 97009
- Feb - April
- May - July
- August - Oct
- Nov - Jan

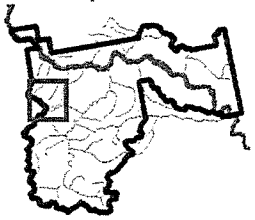
Direction of Travel

Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 Kilometers

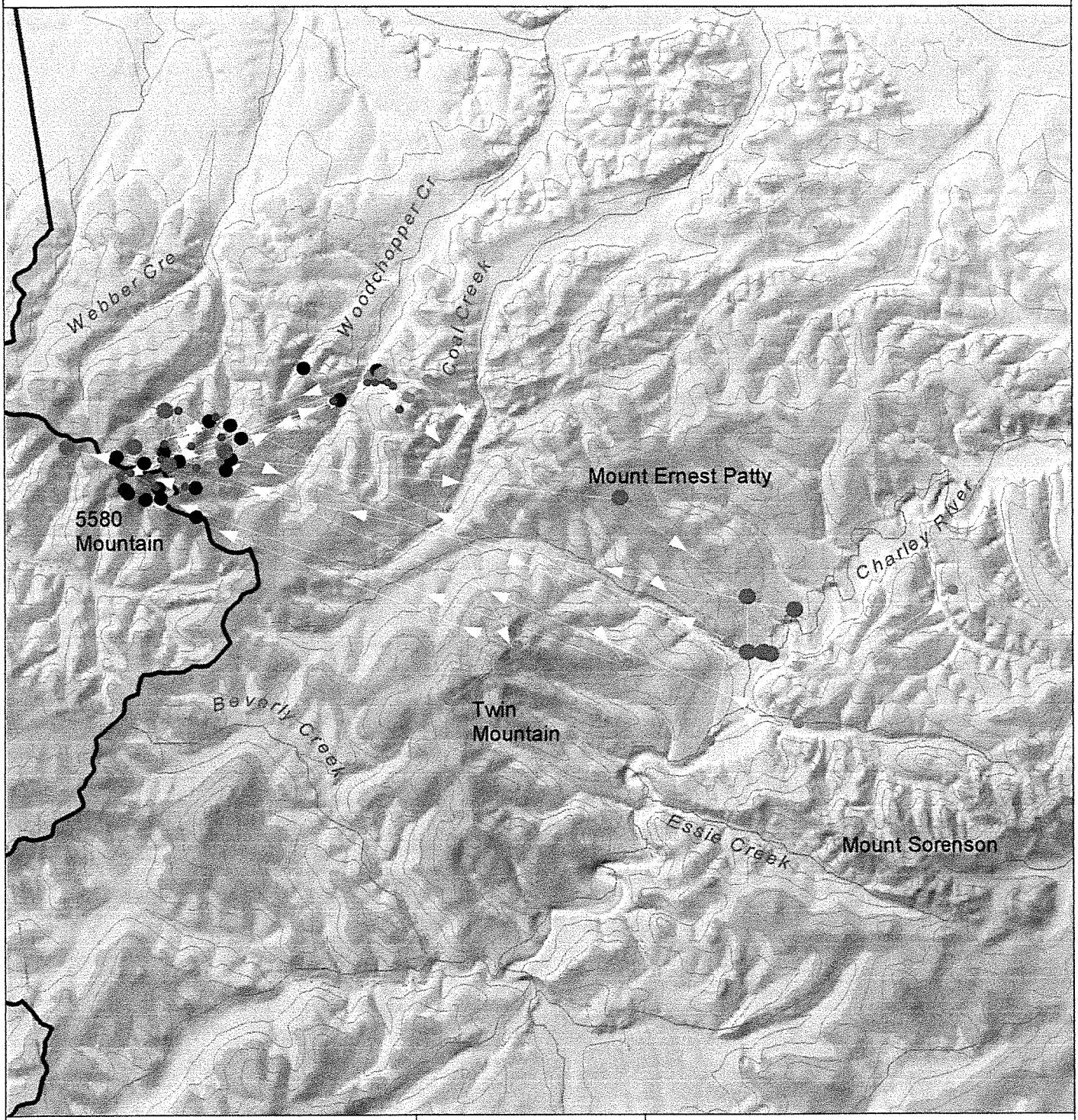
1 : 137,795 1 inch = 3.50 kilometers

N W E S

Plot date: September 10, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97010. 4 Yr Ram

By Season. 4/97 - 9/99



Locations of 97010
- Feb - April
- May - July
- August - Oct
- Nov - Jan

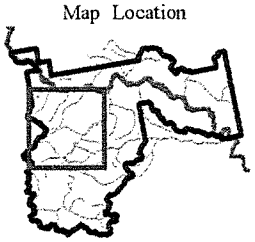
Direction of Travel

Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 7.5 10 Kilometers

1 : 275,590 1 inch = 7.00 kilometers

N W E S

Plot date: September 11, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97011. Adult Ewe

By Season. 4/97 - 1/98



Locations of 97011

- Feb - April
- May - July
- August - Oct
- Nov - Jan

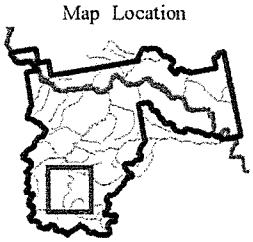
Direction of Travel

Rivers

Elevation in Meters

- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 Kilometers

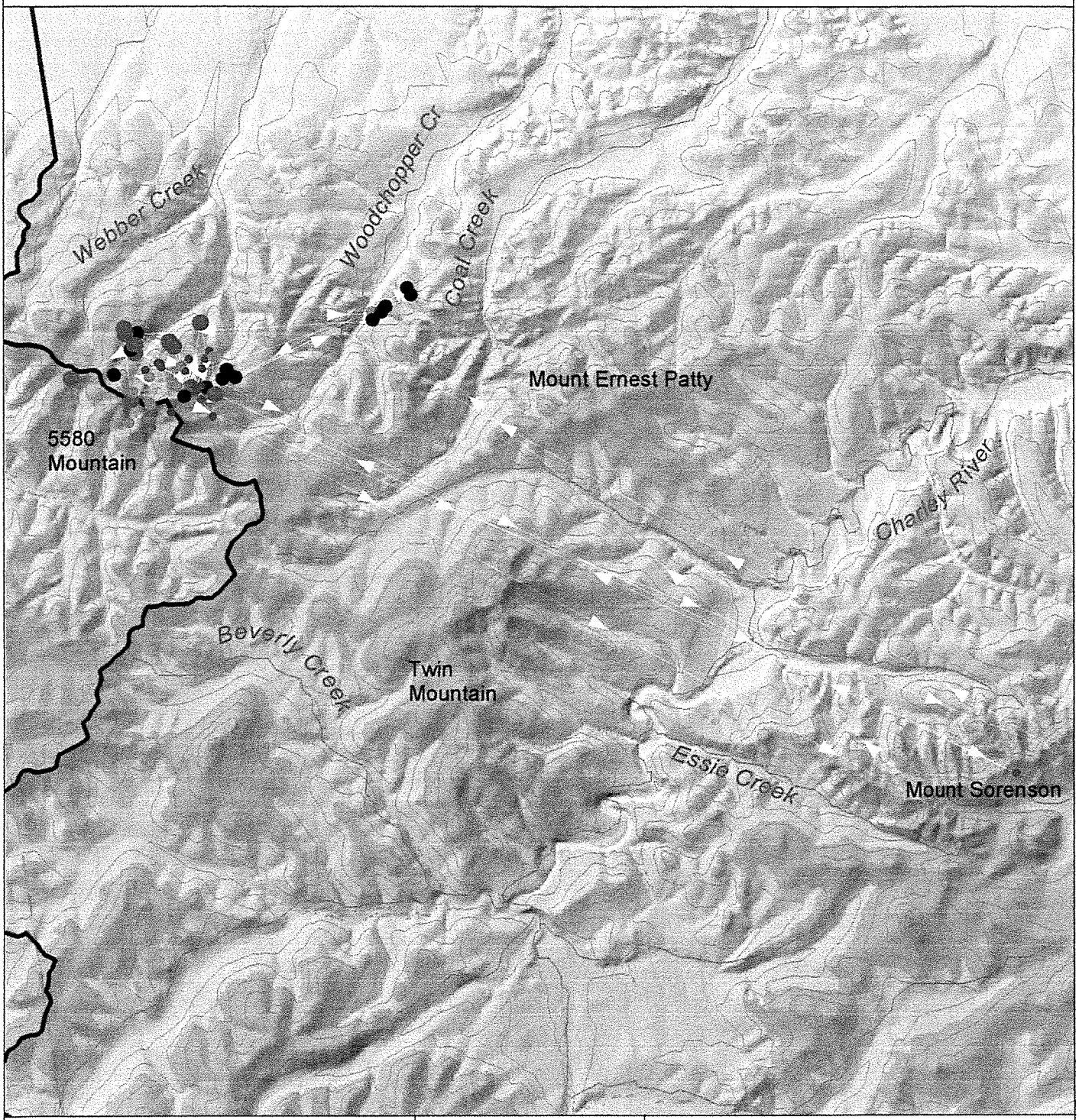
1 : 157,480 1 inch = 4.00 kilometers

N W E S

Plot date: September 11, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97012. Adult Ewe

By Season. 9/97 - 4/00



Locations of 97012
- Feb - April
- May - July
- August - Oct
- Nov - Jan

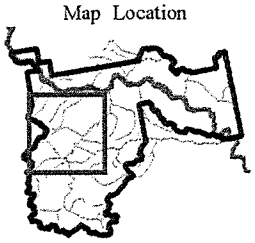
Direction of Travel

Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 7.5 10 Kilometers

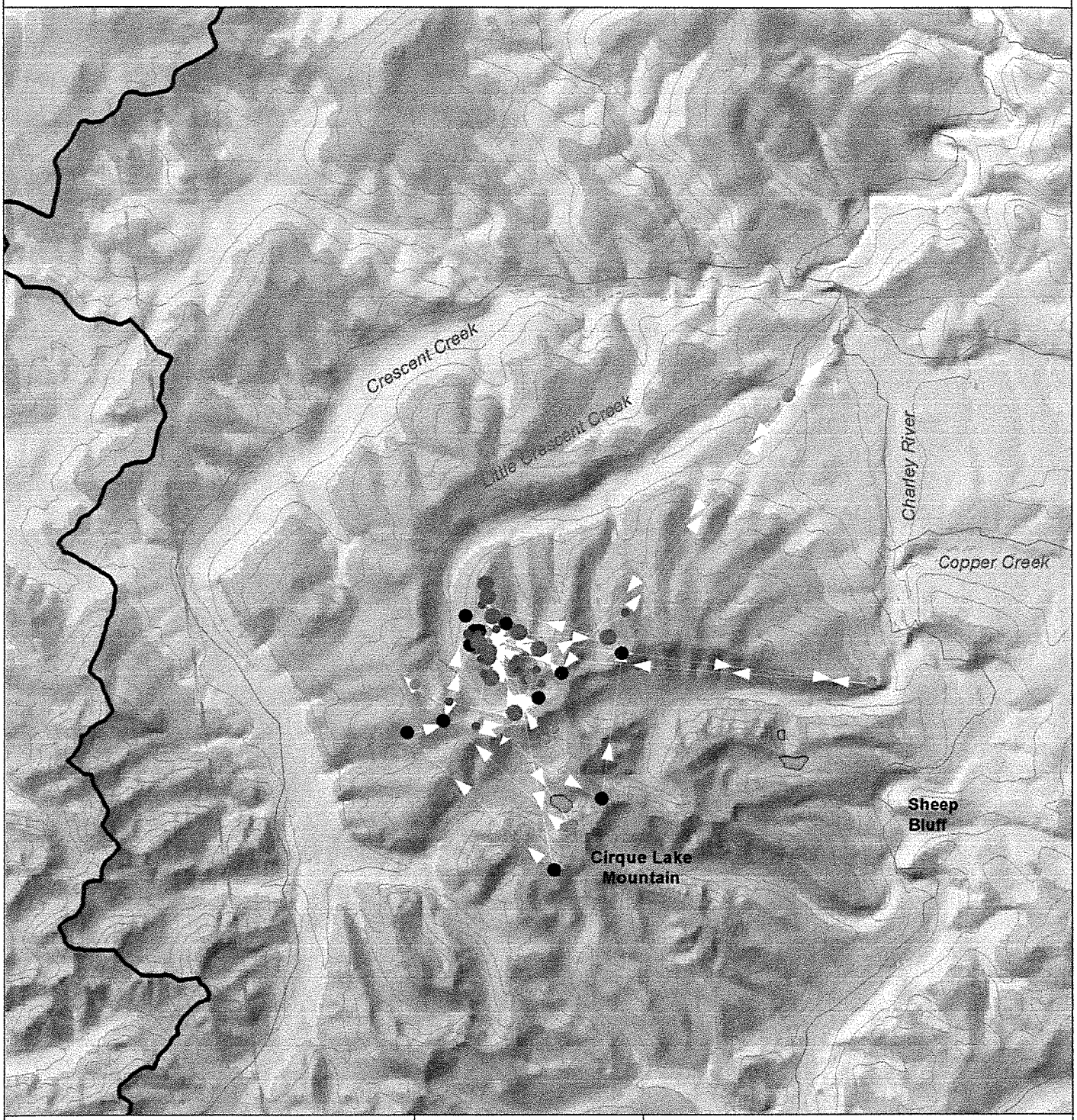
1 : 275,590 1 inch = 7.00 kilometers

N W E S

Plot date: October 11, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97013. 4 Yr Ram

By Seasons. 9/97 - 9/99



Locations of 97013
- Feb - April
- May - July
- August - Oct
- Nov - Jan

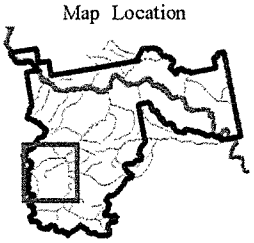
Direction of Travel

Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 Kilometers

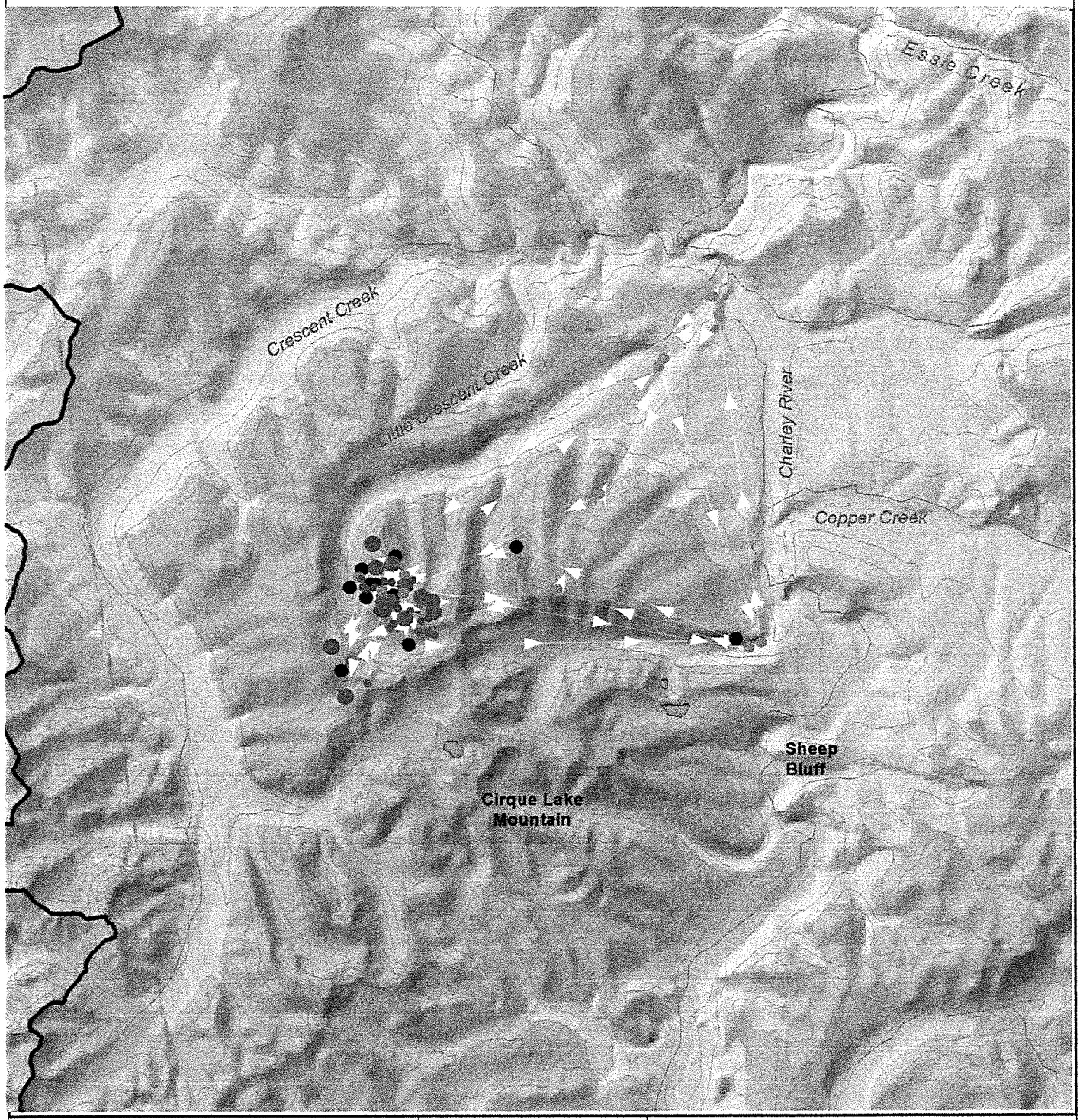
1 : 196,850 1 inch = 5.00 kilometers

N W E S

Plot date: October 12. 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97014. Adult Ewe

By Season. 9/97 - 4/00

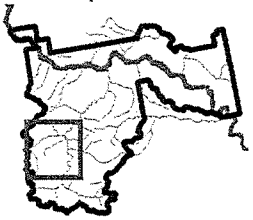


Locations of 97014
- Feb - April
- May - July
- August - Oct.
- Nov - Jan
- Direction of Travel
- Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 Kilometers

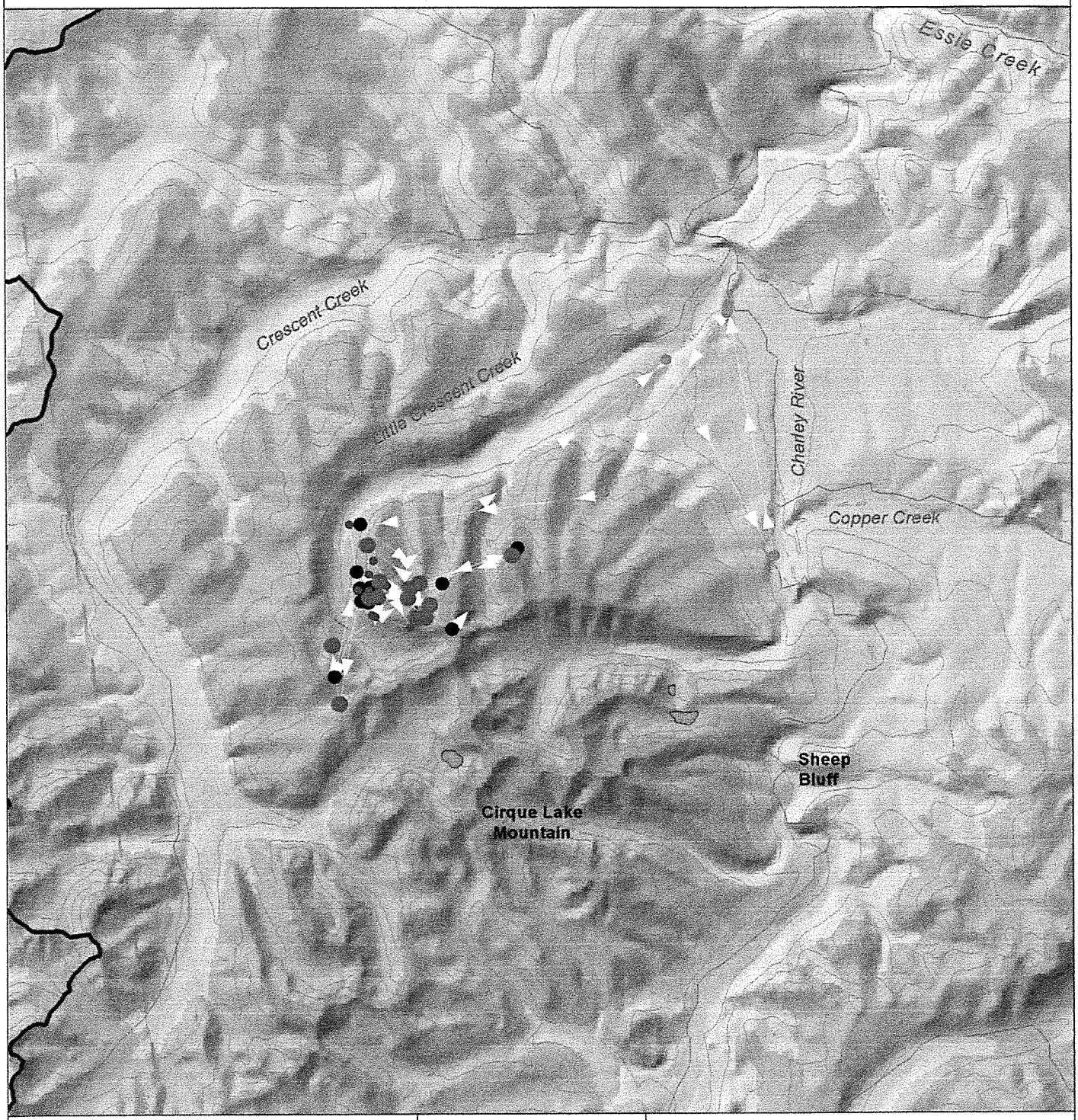
N W E S

1 : 196,850 1 inch = 5.00 kilometers

Plot date: October 12. 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97015. Adult Ewe

By Seasons. 9/97 - 2/99



Locations of 97015
- Feb - April
- May - July
- August - Oct.
- Nov. - Jan.

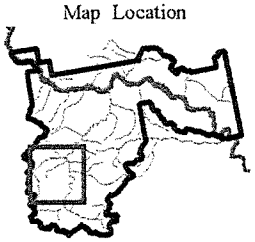
Direction of Travel

Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 Kilometers

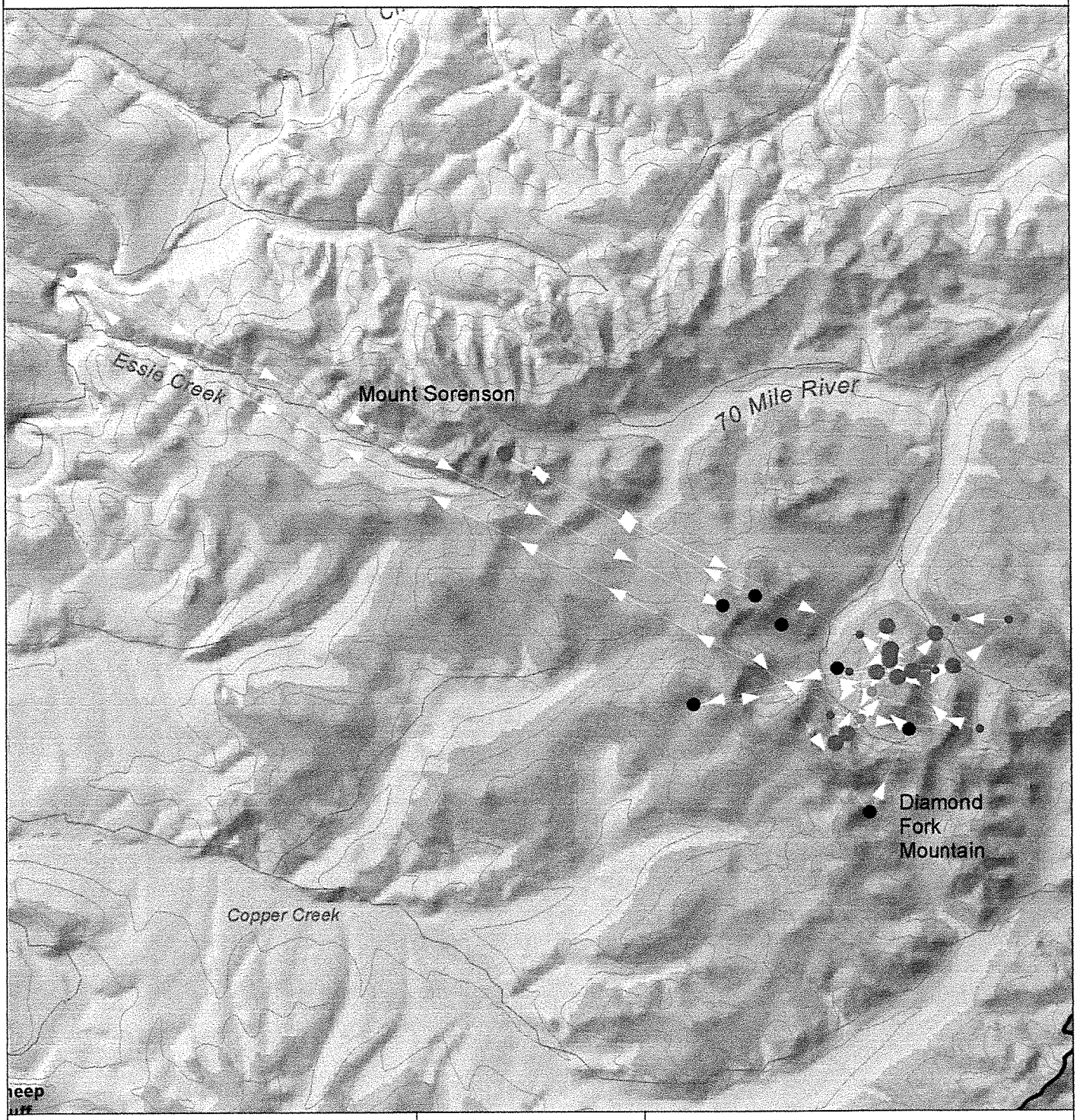
N W E S

1 : 196,850 1 inch = 5.00 kilometers

Plot date: October 12, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97016. Adult Ewe

By Seasons. 9/97 - 4/99



Locations of 97016
- Feb - April
- May - July
- August - Oct.
- Nov. - Jan.

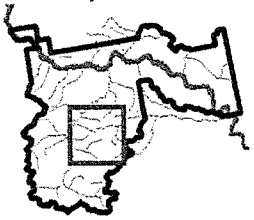
Direction of Travel

Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 Kilometers

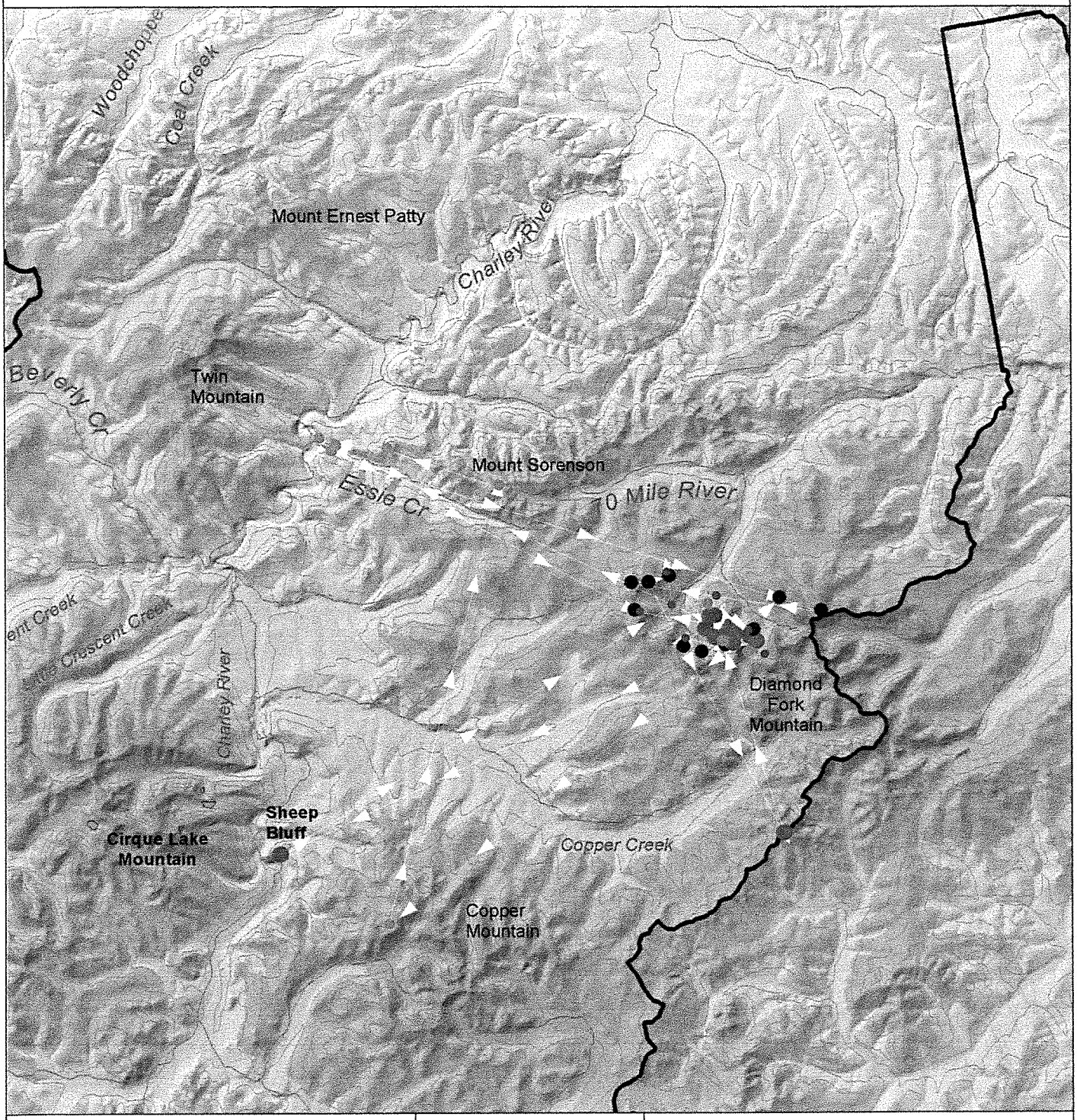
1 : 196,850 1 inch = 5.00 kilometers

N W E S

Plot date: October 12, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 97017. Adult Ewe

By Season. 9/97 - 4/00



Locations of 97017
- Feb. - April
- May - July
- August - Oct.
- Nov. - Jan.

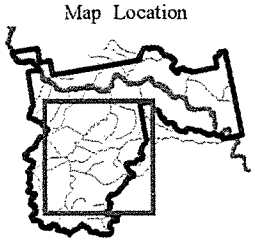
Direction of Travel

Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

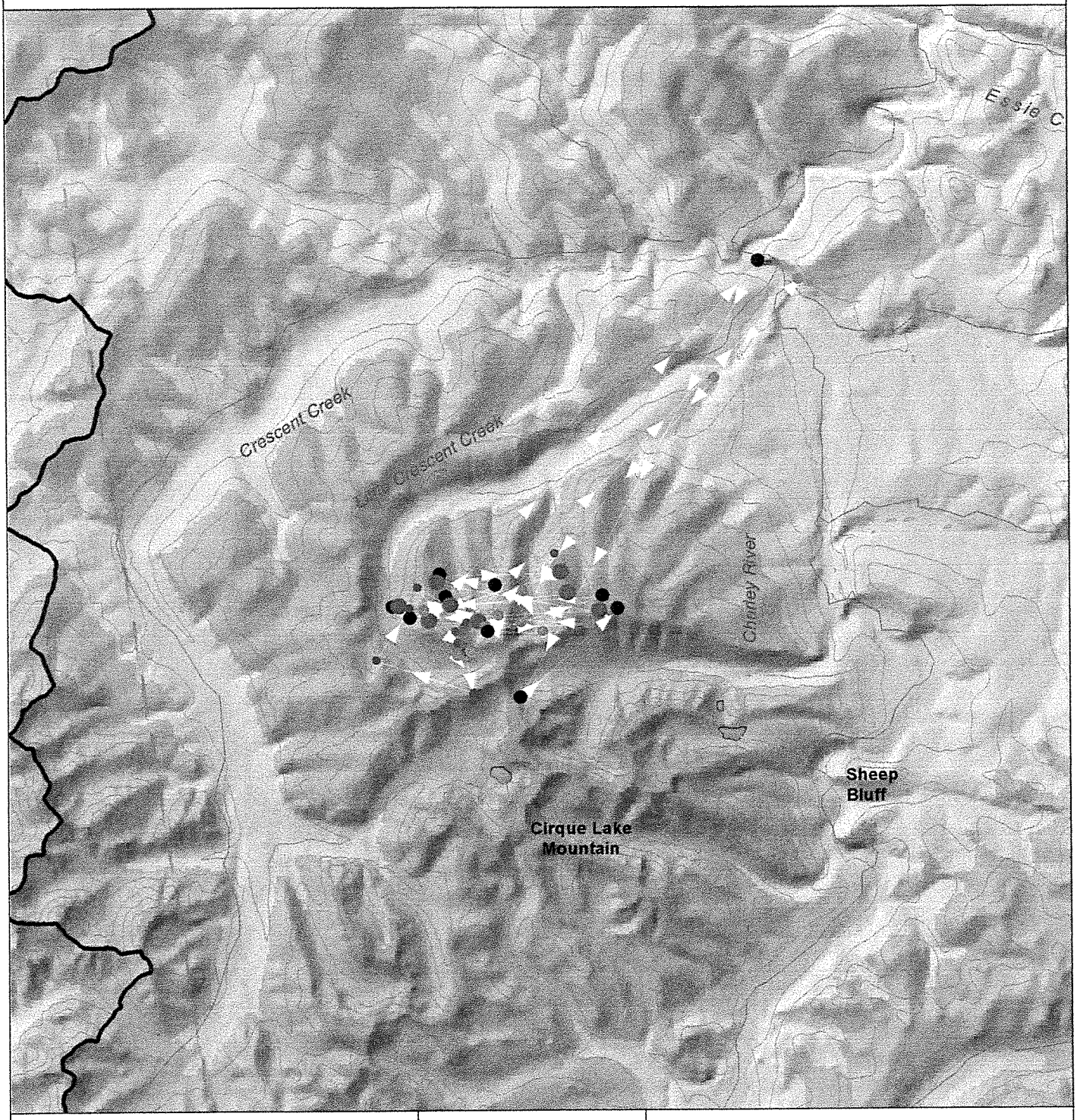
5 0 5 10 15 Kilometers

1 : 393,700 1 inch = 10.00 kilometers

Plot date: October 12, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 98001. Adult Ewe

By Seasons. 3/98 - 11/99

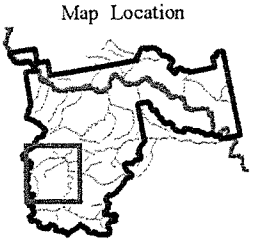


Locations of 98001
- Feb - April
- May - July
- August - Oct.
- Nov. - Jan.
- Direction of Travel
- Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 Kilometers

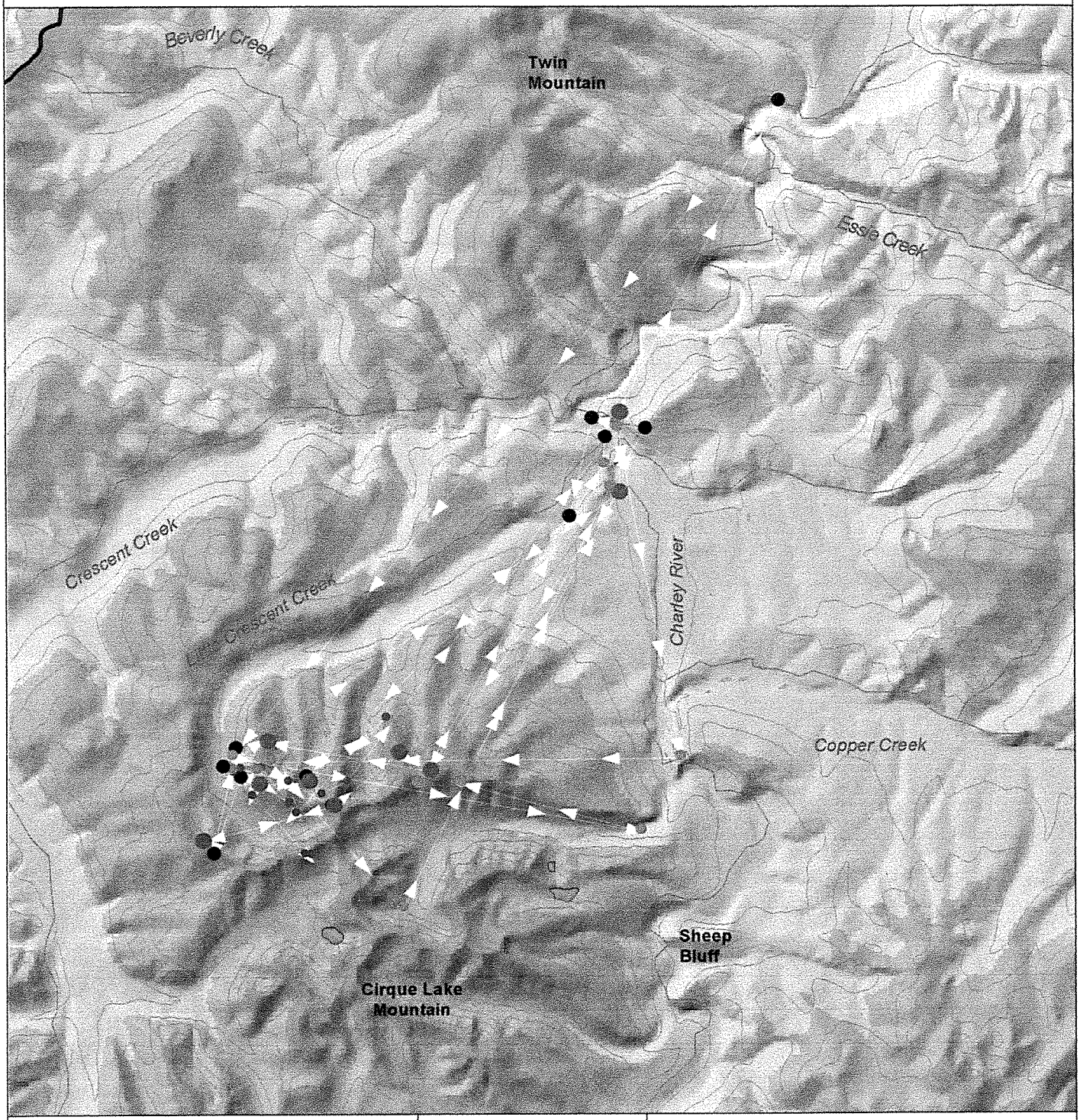
1 : 196,850 1 inch = 5.00 kilometers

N W E S

Plot date: October 12, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 98002. Adult Ewe

By Seasons. 3/98 - 12/99



Locations of 98002
- Feb. - April
- May - July
- August - Oct.
- Nov. - Jan.

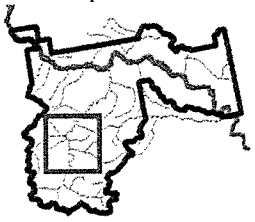
Direction of Travel

Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 Kilometers

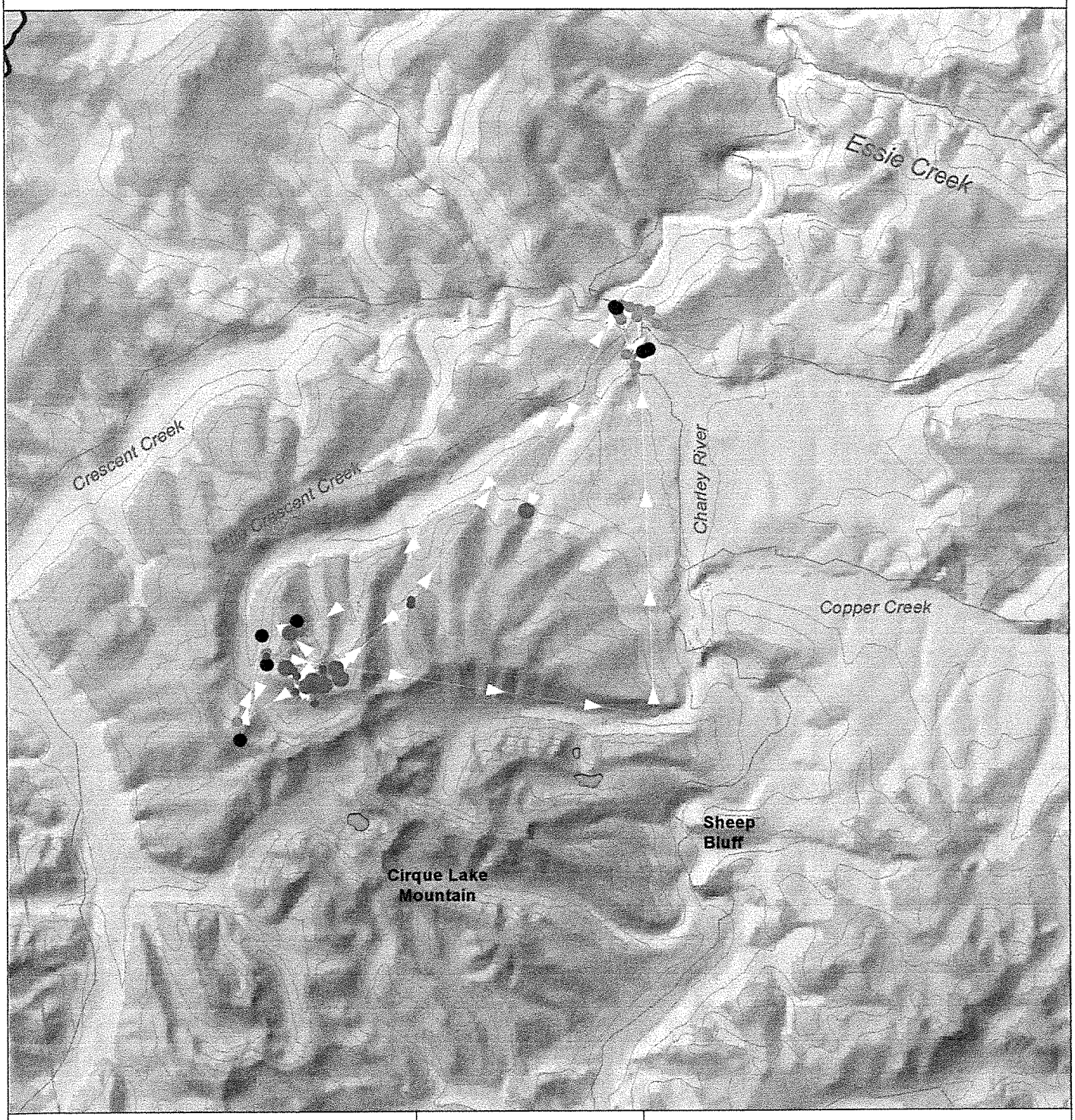
1 : 196,850 1 inch = 5.00 kilometers

N W E S

Plot date: October 15, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 98003. Adult Ewe

By Seasons. 3/98 - 1/00



Locations of 98003
- Feb. - April
- May - July
- August - Oct.
- Nov. - Jan

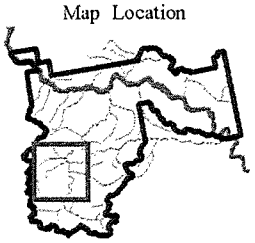
Direction of Travel

Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 Kilometers

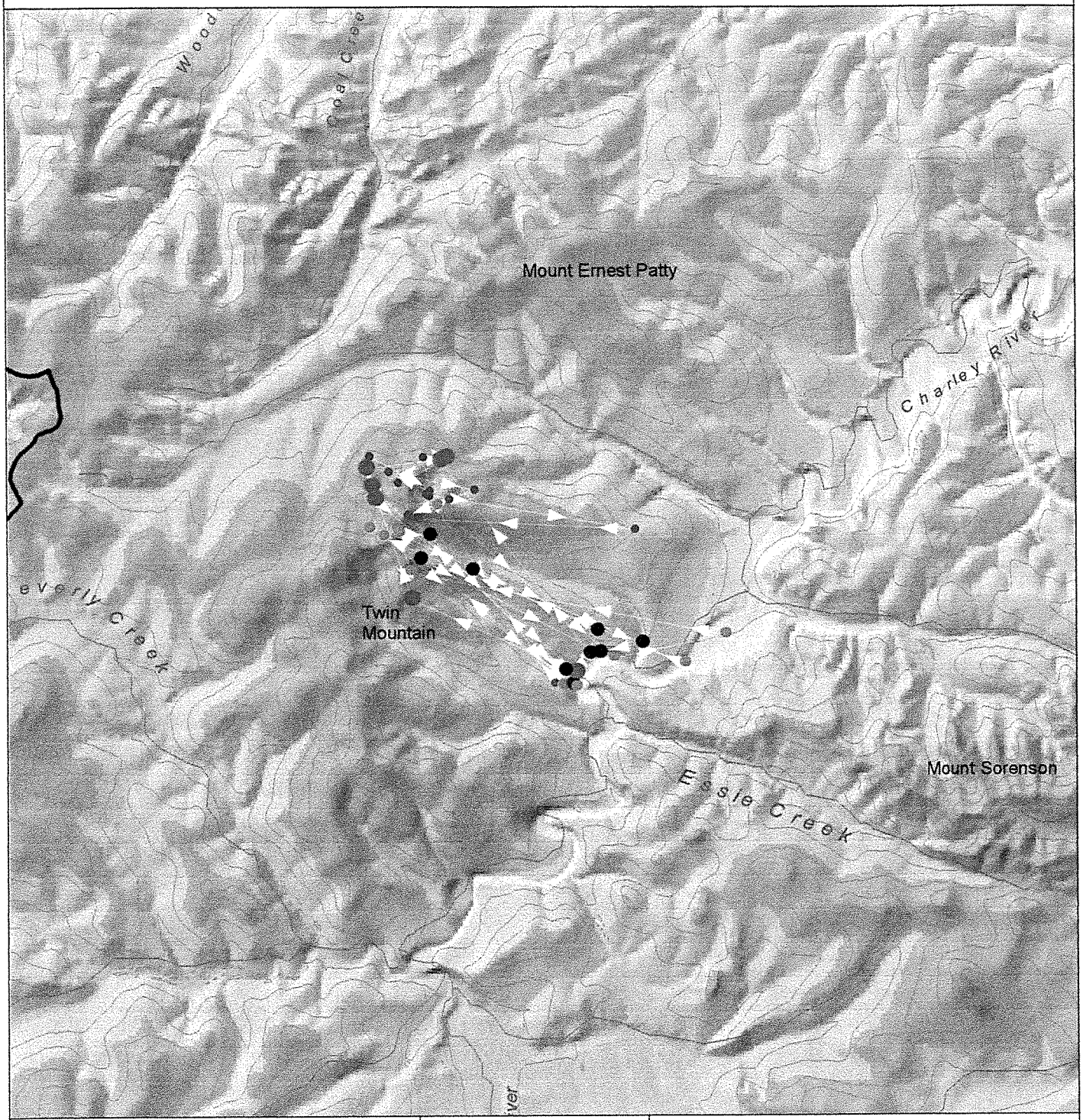
N W E S

1 : 196,850 1 inch = 5.00 kilometers

Plot date: October 15, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 98004. Adut Ewe

By Seasons. 3/98 - 4/00



Locations of 98004
- Feb. - April
- May - July
- August - Oct.
- Nov. - Jan.

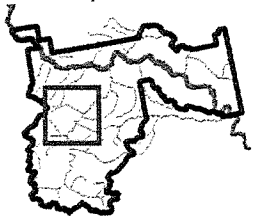
Direction of Travel

Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

2.5 0 2.5 5 Kilometers

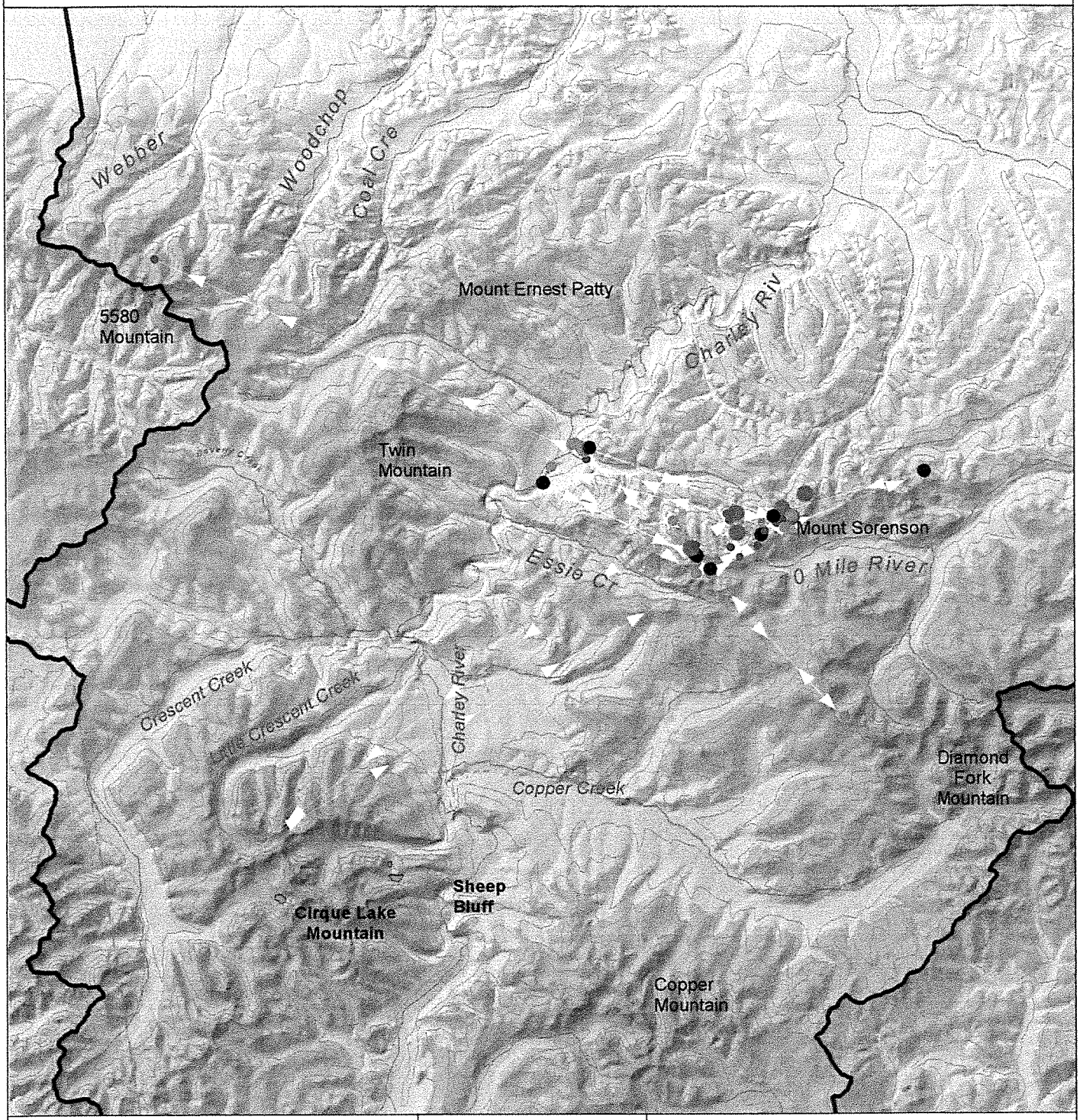
1 : 196,850 1 inch = 5.00 kilometers

N W E S

Plot date: October 15, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 98005. Adult Ewe

By Seasons. 3/98 - 4/00



Locations of 98005
- Feb. - April
- May - July
- August - Oct.
- Nov. - Jan.

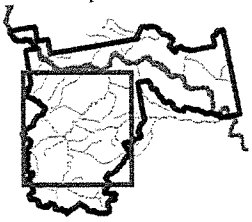
Direction of Travel

Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

5 0 5 10 Kilometers

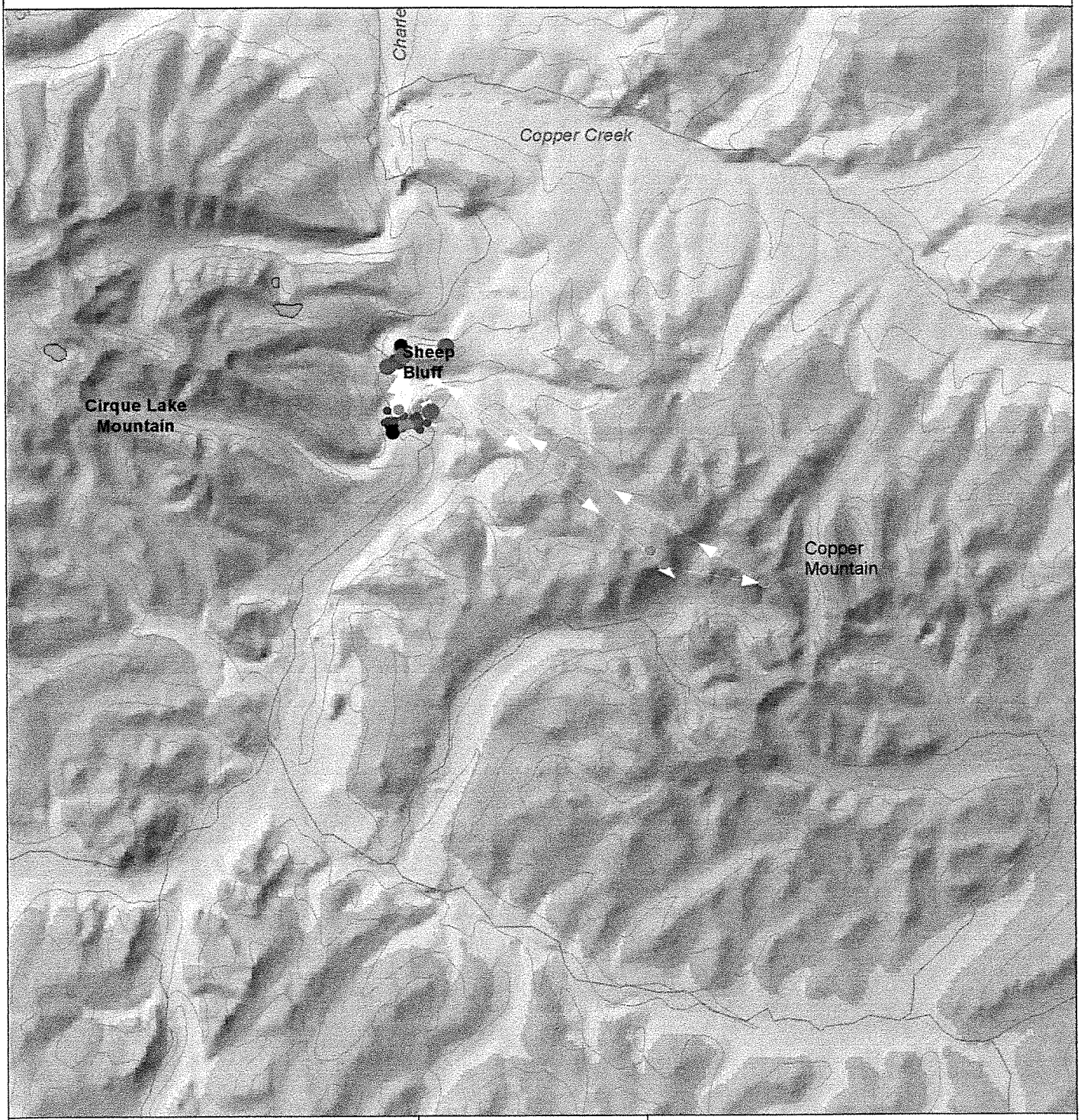
1 : 393,700 1 inch = 10.00 kilometers

N W E S

Plot date: October 15, 2001 c:\vsheep\avprojects\sheep2000.apr

Locations of 98006. Adult Ewe

By Seasons. 3/98 - 4/00



Locations of 98006
- Feb. - April
- May - July
- August - Oct.
- Nov. - Jan.

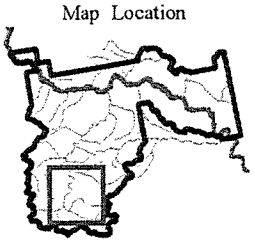
Direction of Travel

Preserve Boundary

Rivers

Elevation in Meters
- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500

Map Location



National Park Service
Yukon-Charley Rivers National Preserve
Biological Resources

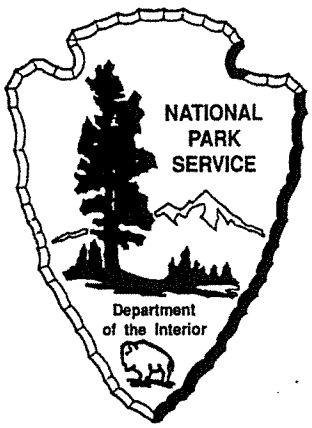
2.5 0 2.5 5 Kilometers

1 : 196,850 1 inch = 5.00 kilometers

N W E S

Plot date: October 15, 2001 c:\vsheep\avprojects\sheep2000.apr





As the nation's principal conservation agency, the Department of Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environment and outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interest of all our people. The department also promotes and encourages stewardship and citizen responsibility for the public lands and promoting citizen participation in their care.

December 2001