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Buckland River Reindeer/Caribou Conflict Study Final Report

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ANALYSIS OF THE BUCKLAND RIVER REINDEER-CARIBOU CONFLICT

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Conflicts between domestic reindeer and caribou have occurred in Alaska from the first time reindeer herding operations expanded onto ranges used by caribou. In all cases, reindeer have been lost to migrating caribou herds and herders have been put out of business or have been forced to avoid using areas when caribou are present.

The historical development of this particular range conflict is summarized by Adams and Robus (1981). Basically, two factors initiated this conflict. First, the SCS developed questionable stocking rates for the Buckland Valley (Adams and Robus 1981;12-13) that ignored the large numbers of caribou wintering on the area. Second, based on these stocking rates, NANA enthusiastically planned to use the Buckland Valley to increase its reindeer operation from 6,000 animals in 1978 to over 37,000 reindeer by 1986 (Northwest Reindeer Enterprises, Inc. 1978). This was in response to the need for a locally produced red meat supply and to take advantage of the potentially lucrative velvet antler market. In reality, NANA's herd is still around 6,000 animals due to problems with caribou during the 1981-82 winter.

Caribou and domestic reindeer are not and never have been compatible on ranges in Alaska or the Soviet Union (Klein 1980). In Alaska, the domestic reindeer industry has retreated to the Seward Peninsula and offshore islands primarily because of losses to caribou (Stern et al. 1977, Adams and Robus 1981). Losses can be minimized by close herding, but at this time it is unrealistic to believe that enough progress has been made with Alaskan herding strategies or intensities that would allow successful herding of reindeer on caribou range. Because of inaccessibility of Buckland Valley, lack of an established transportation network, and widely fluctuating inclement weather during much of the winter, it is doubtful that reindeer management will ever be intensified enough to allow use of the area as long as wintering caribou are present. The winter of 1981-82 was a perfect example of what can happen when uncooperative weather and the leading edge of the Western Arctic Caribou Herd teamed up to complicate NANA's winter herding plans. An estimated 3,000-4,000 caribou wintered in the Kiwalik River drainage and the weather created difficult conditions for snowmachine operation because of limited snow and severe icing conditions. NANA estimated losses to the migrating caribou as high as 4,000 reindeer (John Schaeffer, NANA Regional Corporation, personal communication). This amounts to 40-50% of their herd prior to the winter. It is open to speculation what would happen under similar circumstances in the Buckland Valley where up to 10 times as many caribou are present in some winters.

The importance of the Buckland River drainage as caribou winter range cannot be overstressed. Caribou have consistently used the area for over 30 years in large numbers. As many as 40,000 animals have been estimated in the area in recent winters (Jim Davis, ADF&G, personal communication). This area was used by large numbers of caribou even during the mid-1970's when the Western Arctic Herd crashed to around 70,000 animals (Davis and Valkenburg 1978). Davis et al. (1982) stated that for the Western Arctic Herd "...the most important wintering areas consistently included the Selawik and Buckland drainages, the arctic coastal plain, and the central Brooks Range." Undoubtedly, caribou will continue to winter in the Buckland Valley for the forseeable future.

The possibility of fencing caribou out of the Buckland Valley or harassing them away from reindeer herds in the area has been brought up many times by the reindeer industry through the course of the analysis of this conflict. Even though both options are unrealistic, infeasible, and impractical, it is worthy to note some of the biological considerations of such strategies. Excluding caribou from an area like the Buckland Valley would place greater grazing pressure on other winter ranges and/or would force caribou into other habitats where they are less secure from predators or that would provide a lower plane of nutrition. The combined affect of such an action would ultimately result in deterioration of other winter ranges and a decline in productivity and overall "health" of the Western Arctic Herd.

Harassment of caribou, with aircraft or snowmachines, also has serious biological impacts. During winter, caribou must survive on limited stored energy reserves and limited energy attained from available forage. Anything that requires them to use additional energy, such as running from snowmachines, ultimately reduces their energy reserves, which limits their chances for surviving the winter or reproducing successfully in the spring. These impacts may be minimal when each harassment bout is looked at individually but ultimate effects are cumulative. Herding reindeer on ranges supporting large numbers of caribou would require constant harassment of the caribou and therefore the impacts discussed here may be significant.

From a range management standpoint, it is difficult to say what the Buckland River Valley can support. There is not enough information to calculate some sort of reasonable carrying capacity and using educated guesses and value judgements to attempt it leads to a wide range of ultimate results (Buckland River Range Inventory, 1980-81). Basically, any stocking rate desired can be justifi~~ng~~ed by "selecting" the appropriate facts. Because of this general lack of understanding of arctic range management, it is imperative that such ranges be managed in a conservative manner to protect the range resource.

We do know, however, that the entire Buckland Valley is being used by caribou (Buckland River Caribou Surveys 1978-1982) and the vegetation is being grazed at a moderate level throughout most of the area (Forage Utilization Inventory - Buckland River 1980-81). Many areas that offer conditions that are most suitable for grazing, such as snow free ridgetops and benches, are consistently being grazed heavily. It is conceivable that the area is being used by caribou at or near levels that allow a sustained forage yield.

On top of all this, it is doubtful at this time the NANA reindeer operation requires the use of the Buckland River Valley. They have been able to winter their herd on a relatively small portion of the 3.2 million acres within their grazing allotment. With intensified management, they could conceivably carry over a herd 2 or 3 times the size of their present herd.

NANA should be praised for their continuing efforts towards developing the reindeer industry to provide locally produced red meat and stimulate the local economy. However, even though reindeer offer an opportunity for economic development of the region, it is doubtful that reindeer will supplant the subsistence values of the Western Arctic Caribou Herd in the forseeable future. There is no reason to jeopardize traditional values provided by caribou until the reindeer industry can demonstrate its viability and economic contribution.

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NORTHWEST REINDEER ENTERPRISES, INC.

Range Management Plan

October 1978

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II. Planning Goals - Page THREE

III. Planning Constraints - Page FOUR - FIVE

IV. Herd Size and Composition Plan - Page SIX

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Attachment # 4

I. Present Operations

1. Range: The NRE grazing area consists of the former Gray, Clark and Hadley grazing areas.

2. Number of Reindeer: The herd numbers approximately 6,500 including 5,000 NANA and 1,500 Hadley. The herd will be split into two roughly equal size herds.

3. Bull/Cow Rate: The ratio is approximately 1 bull to 3 cow.

4. Prior Winter Grazing: The NANA herd utilized the area designated as Winter Management Unit #1, Clark Range last year. The Hadley herd used the area designated as Summer Range last year.

5. Prior Summer Grazing: The NANA herd has grazed on the Baldwin Peninsula in the past. The Hadley herd has grazed in the Northern portion of the Hadley Summer range.

6. Personnel: Doug Sheldon is general manager and will head-quarter in Candle. James Smith is Chief Herder of the herd which will graze on the Clark Range. He and his two herders will operate out of Candle also. Nathan Hadley is Chief Herder of the herd operating out of Buckland on the Hadley Range. He will also have two herders.

7. Equipment: Each herder will have a snow machine. Sheldon will operate his own Piper aircraft at Company expense. A Company owned Hughes 500D helicopter will be based in Kotzebue starting in November 1978.

8. Corrals: These corrals capable of handling 10,000 deer are located at Riley Wreck (Gray Range), Church Rock (Hadley Range), and Willow Bay (Clark Range).

9. Slaughter Facilities: Non presently exist. All slaughter is accomplished on the range during winter. Limited freezer facilities are available in Kotzebue, (10,000 pounds).

II. Planning Goals

1. Graze the maximum number of reindeer on the available range without over-grazing or causing other environmental damage.

2. Through continued research and sound management practices continue to improve the health and productivity of the reindeer.

3. Provide for maximum return on investment consistant with the goal of providing for the protein needs of the people of the NANA Region.

4. Develope the Reindeer Industry to provide quality careers for NANA residents by providing educational and job opportunities with the herd.

III. Planning Constraints

1. Stocking Rates. The maximum deer grazed on any Winter Management Unit (WMV) will be determined by the Bureau of Land Management after consultation with the USDA Soil Conservation Service. Changes to the initial stocking rate will be determined by BLM and SCS based on date compiled from annual range utilization checks. Inital stocking rates will be based on a five year rotation and 75% availability of winter feed.

2. Herd Size. Experience dictates that a manageable herd size is 2,500 to 3,500 head. 3,000 head will be used for planning. Grazing operations will be conducted with two grazing units of approximately 1,500 head each to minimize the loss of graze from excessive trampling.

3. Personnel. Each herd (3,000 head) will be managed by one Chief Herder and two herders, each equipped with a snow machine. At least one herder will remain with the herd at all times (weather and daylight permitting) except during the following periods:

   a. Fawning: 24 hour coverage will be provided.
   b. Move to Corrals: 24 hour coverage.
   c. July to September: Less stringent coverage may be scheduled including the use of aircraft surveilance.

4. Protection from Preditors. Herders will take all necessary steps to protect the herd from preditors.

   a. Non-human Preditors: Try chasing them away from the herd or moving the herd away before shooting the preditor. Immediately kill the preditor if it is attacking the deer or during fawning.
   b. Human Preditors: Iff a person is caught poaching, the herders should find out if the action was accidental or deliberate and should report the incident to the General Manager so he can file charges with the State Trooper's Office.

5. Slaughter of Animals. The fastest way to provide the most for sale from our herd is to develope the herd to maximum size allowed as soon as possible. This means that we must not slaughter very many deer during the early years while the herd is growing. Every effort will be made to save animals that are sick or

5. Slaughter of Animals cont. injured. During herding operations, care must be taken to insure that small animals are not trampled. The front shovels of all bulls will be removed to reduce eye damage during rutting.

6. Range and Slaughter Facilities. No facilities will be constructed on grazing land leased from the State or Federal Governments unless prior approval has been obtained from the land owner and project approval has been granted by the NANA Regional Corporation., through its Profit Planning Process.

7. Use of Aircraft. Use of aircraft owned or operated by the company in support by the herding operations will be planned and coordinated by the General Manager. A fixed wing aircraft is available on call on a year-around basis. A helicopter is available on call during the period April-October.

IV. Herd Size & Composition Plan

	JULY 1978	DEATH LOSSES	SLAUGHTER	ADDITION	JULY 1979	1.	2.	3.	1980	1.	2.	3.	1981
			22%				28%				27%		
. Adult Males	1,367	8	400		1,933	10	300		2,493	12	300		3,375
. Adult Females	2,763	F/Cow 14			3,744	19			4,595	23			5,766
. Male Fawns	974	71% 30		900 - 30	870	26		1,220	1,194	36		1,495	1,459
. Female Fawns	981	30		900 - 30	870	26		1,220	1,194	36		1,495	1,459
	6,085				7,417				9,476			2.4% Mort.	12,059

	1981	1.	2.	3.	1982	1.	2.	3.	1983
			27%				27%		
A.	3,375	17	300		4,517	23	300		6,024
B.	5,766	29			7,196	36			8,990
C.	1,459	44		1,874	1,830	55		2,340	2,285
D.	1,459	44		1,874	1,830	55		2,340	2,285
	12,059			2.3%	15,373				19,584

	1.	2.	3.	1984	1.	2.	3.	1985	1.	2.	3.	1986
		27%				27%				20%		
A.	50	300		7,979	40	300		10,490	52			11,000
B.	45			11,250	56			14,023	70	2,637		14,553
C.	69		2,920 - 69 =	2,851	115		3,650	3,535	106		4,558	4,452
D.	69		2,920 - 69 =	2,851	115		3,650	3,535	106		4,558	[illegible]
			2.4%	24,911			3.2%	31,585	331		9,116	37,757
											2.3%	

V. Grazing Plan

YEAR	HERD (SIZE)	GRAZING RANGE/WINTER MANAGEMENT UNIT
1978	Clark #1 (3,000)	Clark/WMU-2
	Hadley #1 (3,000)	Handley/WMU-1
1979	Clark #1 (3,000)	Clark/WMU-3
	Hadley #1 (3,000)	Hadley/WMU-2
	Gray #1 (1,500)	Gray/WMU-1 or Hadley/WMU-2
1980	Clark #1 (3,200)	Clark/WMU-4
	Hadley #1 (3,200)	Hadley/WMU-3
	Gray #1 (3,000)	Gray/WMU-2 or Hadley/WMU-3
1981	Clark #1 (3,000)	Clark/WMU-5
	Clark #2 (3,000)	Clark/WMU-5
	Hadley #1 (3,000)	Hadley/WMU-4
	Gray #1 (3,000)	Gray/WMU-3 or Hadley/WMU-4
1982	Clark #1 (3,000)	Clark/WMU-1
	Clark #2 (3,000)	Clark/WMU-1
	Hadley #1 (3,200)	Hadley/WMU-5
	Hadley #2 (3,200)	Hadley/WMU-5
	Gray #1 (3,200)	Gray/WMU-4 or Hadley/WMU-5

V. Grazing Plan cont.

YEAR	HERD (SIZE)	GRAZING RANGE/WINTER MANAGEMENT UNIT
1983	Clark #1 (3,000)	Clark/WMU-2
	Clark #2 (3,000)	Clark/WMU-2
	Hadley #1 (3,000)	Hadley/WMU-1
	Hadley #2 (3,000)	Hadley/WMU-1
	Hadley #3 (3,000)	Hadley/WMU-1
	Hadley #4 (1,500)	Hadley/WMU-1
	Gray #1 (3,000)	Gray/WMU-5 or Hadley/WMU-1
1984	Clark #1 (3,000)	Clark/WMU-3
	Clark #3 (3,000)	Clark/WMU-3
	Hadley #1 (3,500)	Hadley/WMU-2
	Hadley #2 (3,500)	Hadley/WMU-2
	Hadley #3 (3,000)	Hadley/WMU-2
	Hadley #4 (3,000)	Hadley/WMU-2
	Hadley #5 (3,000)	Hadley/WMU-2
	Gray #1 (3,000)	Gray/WMU-1 or Hadley/WMU-2
1985	Clark #1 (3,000)	Clark/WMU-4
	Clark #2 (3,000)	Clark/WMU-4
	Hadley #1 (3,000)	Hadley/WMU-3
	Hadley #2 (3,000)	Hadley/WMU-3
	Hadley #3 (3,000)	Hadley/WMU-3
	Hadley #4 (3,000)	Hadley/WMU-3
	Hadley #5 (3,000)	Hadley/WMU-3

V. Grazing Plan cont.

YEAR	HERD (SIZE)	GRAZING RANGE/WINTER MANAGEMENT UNIT
1985	Hadley #6 (3,000)	Hadley/WMU-3
	Hadley #7 (3,000)	Hadley/WMU-3
	Hadley #8 (1,600)	Hadley.WMU-3
	Gray #1 (3,000)	Gray/WMU-2 or Hadley/WMU-3
1986	Clark #1 (3,000)	Clark/WMU-5
	Clark #2 (3,000)	Clark/WMU-5
	Hadley #1 (3,000)	Hadley/WMU-4
	Hadley #2 (3,000)	Hadley/WMU-4
	Hadley #3 (3,000)	Hadley/WMU-4
	Hadley #4 (3,000)	Hadley/WMU-4
	Hadley #5 (3,000)	Hadley/WMU-4
	Hadley #6 (3,000)	Hadley/WMU-4
	Hadley #7 (3,000)	Hadley/WMU-4
	Hadley #8 (3,000)	Hadley/WMU-4
	Gray #1 (3,000)	Gray/WMU-3 or Hadley/WMU-3

CARIBOU AND DOMESTIC REINDEER ON PUBLIC LANDS IN ALASKA:

INTRODUCTION TO A UNIQUE MANAGEMENT PROBLEM

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CARIBOU AND DOMESTIC REINDEER GRAZING ON PUBLIC LANDS IN ALASKA: INTRODUCTION TO A UNIQUE MANAGEMENT PROBLEM

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Abstract: In northwestern Alaska, the Bureau of Land Management (BLM) must deal with a unique grazing problem where wild and domestic populations of the same species, *Rangifer tarandus*, compete for the use of the same winter range. NANA Regional Native Corporation is interested in expanding and intensifying domestic reindeer grazing on winter range of the Western Arctic Caribou Herd. Conflicts between these two uses as well as the history and present status of both the reindeer industry and wild caribou in northwestern Alaska are discussed. Ultimate decisions concerning expansion of domestic reindeer grazing on caribou winter range will have widespread effects not only on land management concerning reindeer grazing on all public lands in the region but will also have major economic effects. Reindeer represent potential economic development, while caribou are important to maintaining the traditional subsistence lifestyles of many Natives. It is imperative that the reindeer industry be expanded cautiously and intelligently so as not to harm the Western Arctic Caribou Herd.

In northwestern Alaska, BLM is attempting to cope with a unique grazing situation in which two populations of the same species, one wild (caribou) and one domestic (reindeer), compete for use of high-quality winter range. The problem of allocating range resources to wild and domestic grazers is not new to public land managers. For conventional livestock such as cattle, sheep, or horses, the manager can use knowledge of food habits and habitat needs of both the livestock and the wild ungulates as well as the forage available to accommodate both uses. He can monitor range trend and condition to maintain both the wild and domestic grazers within range capacity. However, because of the intraspecific nature of conflicts between domestic reindeer and wild caribou, management problems extend beyond mere allocation of range resources.

The need to address this problem has arisen because of the interest of the NANA Regional Native Corporation in intensifying reindeer grazing on BLM's Hadley reindeer allotment, on the Arctic Circle, which NANA now is permitted to use. The eastern half of the Hadley allotment is temporarily withdrawn from winter grazing of reindeer because caribou use that area. NANA's planned development of its reindeer operation depends on the use of the productive tundra winter ranges in that portion of the allotment. BLM land managers must make a decision on whether to allow winter reindeer grazing or to adjust the Hadley allotment boundary so as to permanently remove that area from future reindeer use and dedicate it to management as caribou winter range.

The decision made by BLM on this matter may have far reaching effects on future land use decisions concerning reindeer grazing on all public lands in northwestern Alaska. Land status in Alaska is presently in a state of flux because of the Alaska Statehood Act of 1958 (Public Law 85-508), the Alaska Native Claims Settlement Act of 1971 (Public Law 92-203), and the Alaska National Interest Lands Conservation Act of 1980 (Public Law 96-487). Prior to the last two laws, BLM managed most the land in northwestern Alaska that was grazed by reindeer. Now on much of this land, management authority is being transferred to other federal agencies, such as the National Park Service and the U. S. Fish and Wildlife Service, and land ownership is passing to the State of Alaska, as well as Alaskan Natives at the individual and village or regional corporation levels. To further complicate the situation, it is presently planned to manage reindeer grazing on public lands within traditional allotment boundaries by cooperative agreement of all state and federal agencies concerned. Any decision by BLM on the present Hadley allotment conflict is sure to affect reindeer management on all areas used now or in the future, regardless of land management authority, and will set a precedent regarding expansion of reindeer grazing onto caribou range.

CONFLICTS BETWEEN CARIBOU AND DOMESTIC REINDEER

The problems peculiar to caribou management and reindeer husbandry on overlapping ranges have been discussed by Klein (in press). The factor unique to this situation is that reindeer often are absorbed into migrating caribou herds. This has occurred frequently in Alaska where loose herding of reindeer is common, and it happens occasionally even where reindeer are closely herded, as in the Soviet Union. In Alaskan history, reindeer herding was widely successful only when major caribou herds in northwestern Alaska had declined and withdrawn from areas used by reindeer (Stern et al. 1977). When the caribou herd recovered and resumed its traditional migrations, reindeer were lost to caribou wherever ranges overlapped (Figure 1), and the reindeer industry receded to the Seward Peninsula.

Other important conflicts discussed by Klein (in press) are similar to those in conventional livestock operations in the western United States but are accentuated by the intraspecific nature of caribou and reindeer grazing. When reindeer are loosely herded, the potential for competition for forage is increased because the dietary overlap with caribou is almost complete. If closely herded, reindeer use some

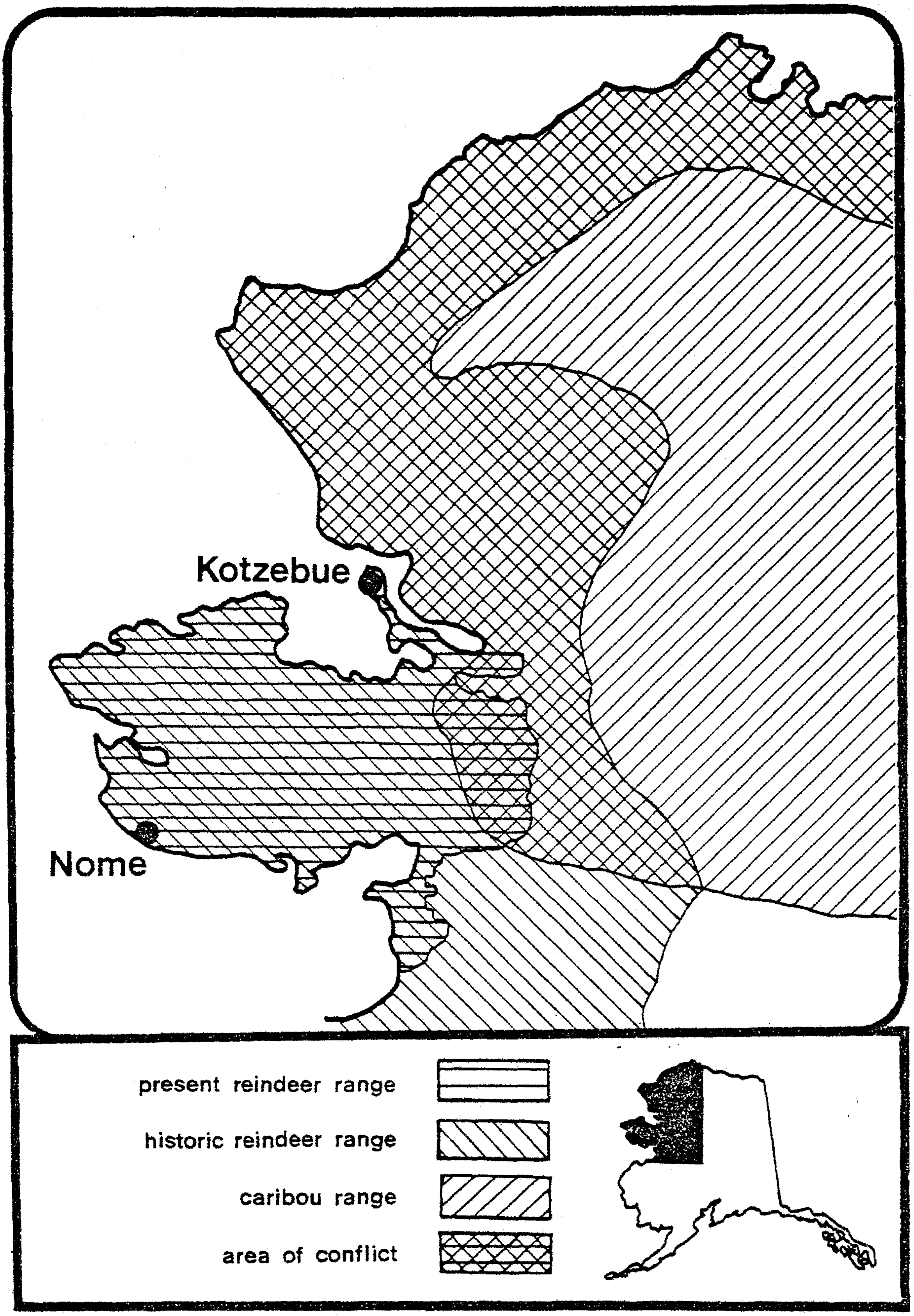

Figure 1. Present and historic distribution of caribou and reindeer in northwestern Alaska.

areas more intensely and the potential for overgrazing increases (Andreev 1975). On slow-growing lichen ranges, where most of the potential for nutrient cycling is locked up in the cold, wet, organic mat, overgrazed areas recover slowly (Palmer and Rouse 1945). Because of limited range research, especially in recent years, on Alaskan tundra ranges and the limited or questionable applicability of research done elsewhere, any decision to increase reindeer use of these ranges should be made cautiously and conservatively.

Disease transmission is also important because of the intraspecific nature of caribou/reindeer grazing. If diseases such as brucellosis are to be controlled within the domestic reindeer herds, contact with caribou must be minimized.

Another major concern of reindeer owners is the losses from wolves (*Canis lupus*) that follow migrating caribou into reindeer ranges. Wolves not only prey on reindeer but can also scatter the herds.

The combination of all these factors makes coexistence of reindeer and caribou on overlapping ranges a complex problem for public land managers. Interest in expanding an existing reindeer herd on the BLM's Hadley grazing allotment into winter range that is important to the Western Arctic Caribou Herd (WACH), has focused statewide attention on these problems and BLM's ultimate solution. The histories of the WACH and the reindeer industry in this area illustrate the importance of any decision on these conflicting land uses.

HISTORY OF THE WESTERN ARCTIC CARIBOU HERD

Through its history the WACH has had major changes in numbers, movement patterns, and distribution encompassing much of northwestern Alaska (Skoog 1968). When white explorers first visited the Seward Peninsula, in the late 1700s, caribou were seasonally abundant in the area (Van Stone 1968). Apparently, the caribou population decreased in the area in the late 1800s. By 1880, few caribou were left on the Seward Peninsula, and by 1890 the herd had contracted into its "center of habitation" in the central Brooks Range (Skoog 1968). This change probably was part of a natural fluctuation in population size.

Caribou continued to be virtually absent from most of northwestern Alaska until the mid-1930s, when caribou concentrations were located along the Chukchi Sea coast, north of the Seward Peninsula (Rood 1942). From 1950 onward, large portions of the WACH, often most of the herd, wintered south of the Brooks Range (Hemming 1971). Large concentrations of caribou have wintered in the tundra ranges of the Selawik Hills, Selawik Flats, and the Buckland River Valley (Figure 2). Since 1950, the WACH has used this area more consistently than any other portion of its winter range (Skoog 1968, Davis and Valkenburg 1978, Unpublished data from Alaska Department of Fish and Game 1979, 1980).

The WACH declined drastically between 1970 and 1976, when it dropped from 240,000 to only 70,000 animals (Davis and Valkenburg 1978). The decline was caused largely by excessive harvest (Davis and Valkenburg 1978) although natural predation, disease, and possibly, range conditions also contributed. It created a "caribou crisis" (Stern et al. 1977) in northwestern Alaska since a subsistence mainstay for the widely scattered human population of the region was suddenly in short supply. At the end of the 19th century, nomadic ancestors of local residents had coped with a similar situation by emigrating from the area, but that option was not feasible for people living in villages in modern Alaska. Fortunately, Alaska Department of Fish and Game (ADFG) placed restrictions upon hunter take and initiated a campaign to minimize waste of wildlife resources. The herd had several years of

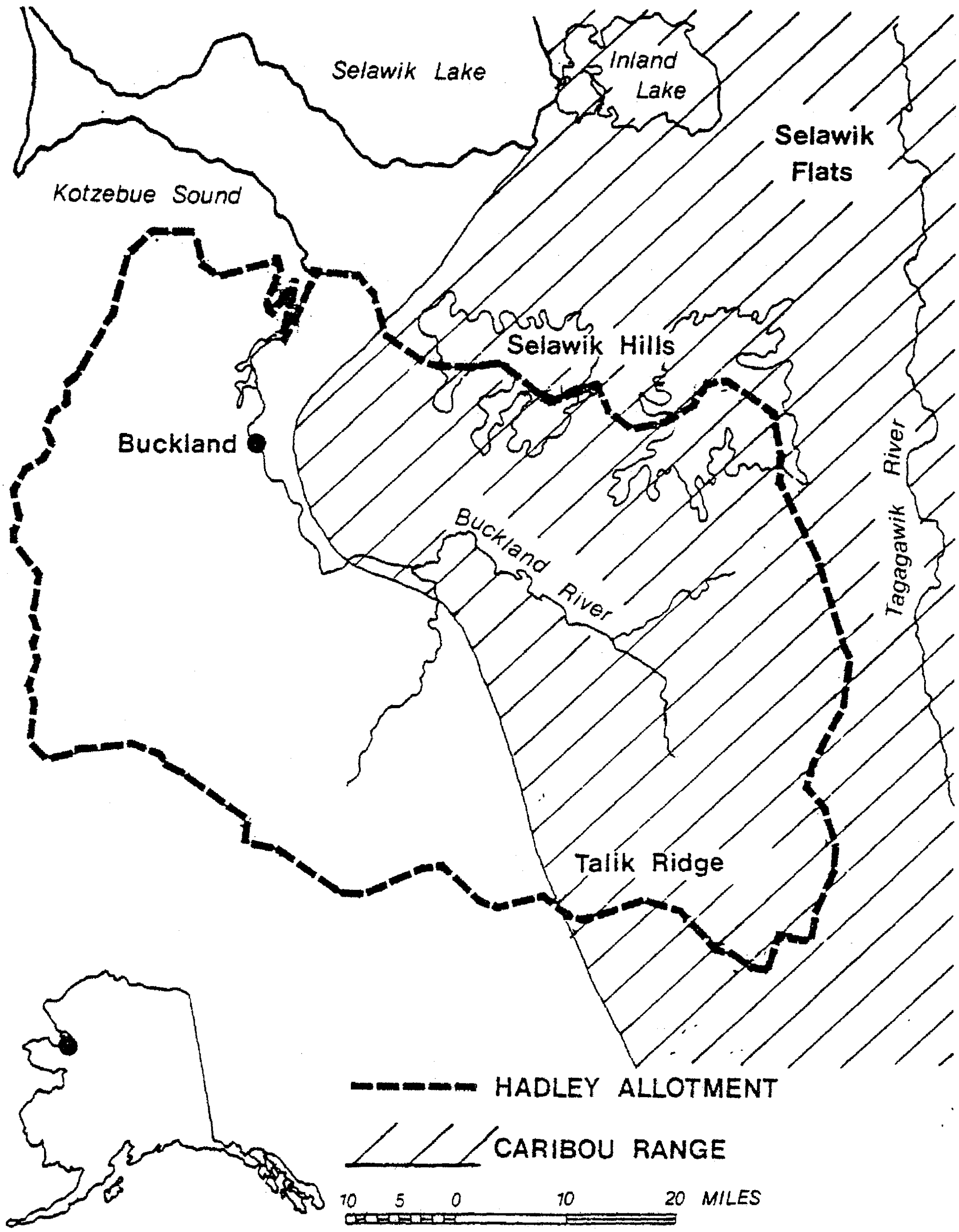

Figure 2. Location of Hadley reindeer grazing allotment and caribou winter range in the Buckland River area of northwestern Alaska.

good reproduction that turned it toward recovery. Today, the best estimates of herd size are about 140,000 caribou (Patrick Valkenburg, ADFG, personal communication). The history of this herd shows, however, that any perturbation of the caribou population's well-being significantly affects the lifestyles of Alaskans in the 100,000 square miles (250,000 sq km) of northwestern Alaska that it ranges over.

HISTORY OF DOMESTIC REINDEER GRAZING

Historical development of the reindeer industry in Alaska has been summarized by Stern et al. (1977). The reindeer industry has gone through three major phases of development. These are introduction and growth from 1891 to 1914, non-Native ownership and exploitation to 1937, and Native ownership and attempts to develop a self-sustaining Native enterprise since 1937.

Domestic reindeer from Siberia were introduced to the Seward Peninsula in 1891, when caribou were absent. Rev. Sheldon Jackson, General Agent for Education in Alaska, began the import of reindeer to supply a stable food source and promote industrial education for local Natives (Ray 1965). Reindeer continued to be imported until 1902 when the Russian czar forbade further export of reindeer from Siberia. By this time, more than 5000 reindeer were in Alaska, from both importation and natural increase.

Despite its intended purpose, the reindeer industry benefited the Eskimos little during its early years. Most of the animals were given to Lapp herders, who had been brought to Alaska to help teach herding methods to local inhabitants, as payment for their services. Religious missions owned other herds. An investigation in 1906 by the Department of the Interior into the reindeer industry determined that it had not fulfilled its purpose, and Jackson was forced to resign. Department policy was changed to encourage placing more reindeer into Eskimo ownership (Ray 1975). By this time, the gold mining boom on the Seward Peninsula, which had provided most of the market for reindeer meat, had subsided and the easily accessible coastal ranges were showing effects of overgrazing (Lantis 1950).

After the collapse of local markets, white businessmen acquired ownership of most herds. By 1920, they expanded the reindeer industry into much of northwestern Alaska (Figure 1) and reindeer numbered about 180,000 in Alaska. From 1920 through 1929 the industry exported large amounts of reindeer meat to the continental United States. This market folded with the arrival of the Great Depression and when local demand also fell, large-scale reindeer operations collapsed.

Although the operations failed, the reindeer herds in Alaska grew to over 600,000 animals by 1934. It was apparent that these numbers were excessive. Range deterioration was widespread and many reindeer were lost to disease, predators, and winter starvation (Olson 1969).

In 1937, Congress passed the Reindeer Grazing Act (Public Law 75-413) in an attempt to restructure and save the industry as well as to save white owners from bankruptcy. The Act restricted ownership of reindeer in Alaska to Alaskan Natives and provided for the purchase by the Federal Government of all non-Native equity in the industry. During the first years that the Act was in effect, reindeer numbers declined, as the after-effects of the irruption seen in the 1920s and 1930s continued to influence the herds. At this time, many herders abandoned their herds and reindeer wandered away to join caribou herds or establish feral herds.

From the 1940s to the mid-1970s the reindeer industry consisted of small, family-owned operations primarily on the Seward Peninsula (Figure 1). Until recently, reindeer herding has been conducted partially for subsistence and partially for cash income. Free-use grazing permits issued by BLM on huge allotments, averaging almost one million acres (400,000 ha), and low stocking rates allow the herders great latitude in moving and grazing their animals. In most cases, reindeer are allowed to graze freely but are rounded up to be moved from summer range to winter range and back again. Animals are essentially wild and are harvested in the field, primarily in the fall. Meat and hides are used by the owner, used to pay herders or labor during slaughtering operations, or are sold in local villages.

The free-use permits issued by BLM for reindeer grazing are quite different from conventional grazing permits in the western United States. First, only Natives are allowed to own reindeer or apply for reindeer grazing permits in Alaska (U.S. Government 1979a). No grazing fees are assessed and no base property is required as in the West for conventional livestock grazing permits (U. S. Government 1979b). Natives need only own reindeer or be able to obtain reindeer in order to apply.

The creation of Native corporations under the Alaska Native Claims Settlement Act brought a new influence to the reindeer industry. For the first time, Alaskan Natives had access to corporate resources that could be used to finance reindeer herding on public land. One entity in particular, the NANA Regional Native Corporation of Kotzebue, Alaska, has elected to invest in the reindeer business. NANA is leading a return of regional and statewide interest in reindeer as a northern-adapted, domesticated animal that can provide employment, income, and red meat for rural Alaskans. Marketable products are red meat for local, regional, and national markets, and velvet antlers for medicinal uses in potentially lucrative markets of the Orient. Hides are used locally and may find a wider market in the future.

The Oriental market for velvet antlers has the potential to bring large profits to reindeer owners. Prices soared from $1 per pound ($2.20 per kg) in 1969 to $40 per pound ($88 per kg) in 1979 (Arobio 1981). The market has since stagnated due to economic instability in South Korea, the major market, and increased supply from other sources such as red deer (Cervus elaphus) antler from Australia and New Zealand. This market may again be important in the future.

New interest in the industry has caused some changes in herding practices and goals, which in turn intensify potential conflicts with caribou. NANA now is permitted to graze reindeer on four BLM allotments, totaling 4.2 million acres (1.7 million ha), including the Hadley allotment. The Corporation wants to expand and intensify reindeer grazing on these lands. NANA's activities are unusual for the reindeer industry, in the amounts of money invested and in the vigor with which it is pursuing new goals for the industry.

DEVELOPMENT OF THE HADLEY ALLOTMENT CONFLICT

When caribou were absent from the region, the Buckland River Valley supported reindeer herding, including a large export-oriented operation of the Alaska Livestock and Packing Company in the 1930s (Stern et al. 1977). In 1953, after the industry failed and subsequently was reorganized, Paul Hadley, of Buckland, Alaska, began herding reindeer in the area. In 1962, BLM began issuing grazing permits, and granted Mr. Hadley a permit to herd 2,000 reindeer on the 2.2 million acres (890,000 ha) of range in the grazing allotment (Figure 2). To maintain his herd, Mr. Hadley and his family often had to restrict their reindeer to the western portion of the area or move their animals away from concentrations of caribou that ranged east of the village of Buckland. While this was not impossible, it could only be done because the number of reindeer kept on the area was small. During this time, reindeer on ranges north of the Seward Peninsula were lost to migrating caribou and several herders were put out of business.

In 1976, NANA acquired reindeer and grazing permits for areas adjacent to the Hadley allotment on the north and west. Interested in a more intensive and organized grazing program, NANA began to assess the reindeer grazing potential of tundra ranges on its allotments and adjacent ones. Accordingly, NANA contracted in 1976 with the Soil Conservation Service (SCS) to conduct range inventories and estimate the numbers of reindeer each allotment could support.

Using computer-aided analysis of satellite imagery, the SCS range scientists mapped 4.5 million acres (1.8 million ha) of tundra ranges in the summer of 1976 and produced a map of cover types in 1977. Associated with this map were estimates of potential reindeer stocking rates for the various allotments covered by the survey. These figures were based on extent of potential winter range, arbitrarily defined as areas covered with more than 15 percent lichen, an important winter forage of caribou or reindeer. The extent of these potential winter ranges was determined with little regard to snow conditions on the area which greatly affect forage availability for reindeer or caribou (Thing 1977, Skogland 1978, LaPerriere and Lent 1977, Pruitt 1959). Available forage by vegetation type on these areas was determined from 70 ten-plot transects on the 4.5 million acres (1.8 million ha) where data on annual production of vascular plants and nondecayed standing crop of lichen were collected. Potential stocking rates were determined using this information, with a theoretical 5-year rotation requiring close herding of reindeer and assumptions that optimal use of lichens would be made (Andreev 1954). On the 2.2 million acre (890,000 ha) Hadley allotment, only 1.6 million acres (640,000 ha) were included on the classified satellite image used for cover mapping. In order to determine potential stocking rates on this allotment, habitat and forage composition data from the inventoried area were extrapolated across the 600,000 acre (250,000 ha) unmapped area.

From this broad inventory, SCS range scientists estimated that with careful grazing management, 33,285 reindeer could be supported on the Hadley allotment. No allowance was made for forage use by caribou on the area.

NANA has since taken over management of the Hadley reindeer operation and in 1981 received formal assignment of the Hadley grazing allotment. The Corporation proposes to expand its reindeer herd, based on use of the lichen-rich winter ranges in the Buckland River Valley and questionable stocking rates arrived at by SCS.

In 1979, NANA was given a permit by BLM to use the 800,000 acres (320,000 ha) in the Upper Koyuk River Basin, in addition to the 2.4 million acres (970,000 ha) that was already permitted to them, to allow for growth of their reindeer herds while BLM biologists assess the impacts that reindeer grazing would have on the one million acres (400,000 ha) of the Hadley allotment presently withdrawn from winter reindeer grazing. NANA owns 8,000 reindeer and is permitted by BLM to graze 13,000 animals on the 3.2 million acres (1.3 million ha) included in the grazing allotments it is allowed to use.

Meanwhile ADFG and BLM biologists have reported that large concentrations of caribou continue to winter in the eastern section of the Hadley allotment. In late February 1980, up to 15,000 caribou were located there and similar numbers were observed early in the winter of 1980-81. As many as 30,000 animals, approximately one quarter of the WACH, have been reported in this area in recent years (Patrick Valkenburg, ADFG, personal communication).

The apparently high quality winter range of the eastern half of the Hadley allotment has forced BLM to weigh alternatives about future use of this area. The area is crucial both to NANA's planned development of the commercial reindeer industry and as winter range for the WACH. The values of each use to the region and the potential economic effects of expanding reindeer grazing into caribou winter range must be assessed before necessary decisions can be made.

SOCIOECONOMIC VALUES

In making decisions concerning reindeer grazing on caribou range, public land managers must consider not only the obvious ecological conflicts but also the socioeconomic values and related impacts of both caribou and reindeer. Ultimate decisions may have wide ranging effects on the lifestyles of residents in all of northwestern Alaska.

Reindeer are privately owned and can serve as a source of income to the herder. Development of the velvet antler market, although unstable now, may bring large profits in the future. Because the herd in question here belongs to NANA, the regional Native corporation, profits from the reindeer operation would be distributed as dividend payments and services to Native residents in the Corporation's region. Reindeer might also be a stable source of red meat that could be sold to local village residents and the residents of Nome and Kotzebue. This has been a strong incentive for the expansion of the reindeer industry in northwestern Alaska. If the close herding necessary for careful rotational grazing and the projected commercial industry expansion is adopted, local herders would be employed and their salaries would bring money to the local economy. Development of meat-handling facilities and potential export markets for both meat and other by-products, such as velvet antlers and hides, could bring further economic benefits to the area.

On the other hand, caribou continue to be an important resource to Alaskan inhabitants. During its unrestricted migrations, the WACH comes in contact with 10,000 to 15,000 people of northwestern Alaska (Herbert Brownell, BLM, personal communication), many of whom depend on caribou to maintain their subsistence lifestyles. Caribou provide a seasonally but locally available supply of meat that costs little to obtain. Sport hunting of caribou by both Alaska residents and non-residents brings tens of thousands of dollars to the Alaskan economy in the forms of license fees, guiding and outfitting fees, air charter, and other hunting related costs. Although the WACH does not now support much sport hunting, it may become more important in the future. From a nonconsumptive standpoint, the WACH is a substantial and highly visible component in the ecosystem and adds significantly to the wilderness values of public lands in northwestern Alaska. It has been formally designated in the Alaska National Interest Lands Conservation Act as a resource of "national and international significance."

CONCLUSIONS

Clearly, the needs of both the domestic reindeer industry and the Western Arctic Caribou Herd are important in the future management of public lands in northwestern Alaska. Decisions favoring either reindeer or caribou will have wide-ranging and potentially deleterious effects on the other. It is imperative that decisions be made to minimize the potential overlap of the two uses and thus minimize the conflicts.

Impacts of any decision go beyond the environmental considerations normally associated with conventional grazing conflicts. The commercial reindeer industry offers an opportunity for economic development of the region, but caribou are essential for maintaining the traditional subsistence lifestyles of many Alaskans. If reindeer and caribou are to both provide their respective economic benefits, we feel that interactions of the reindeer industry with wild caribou should be minimized. Before expanding onto caribou range, the reindeer industry managers should stock ranges already dedicated to reindeer grazing, and not used by caribou, to their potential. With this approach, close herding techniques and reasonable stocking rates for reindeer on arctic tundra ranges can be developed. Both land managers and reindeer owners should explore the potential and realistic future of commercial markets for reindeer meat and by-products and gain understanding of the industry's economic effects on northwestern Alaska. Study of the economic effects may show that the actual benefits of the reindeer industry do not compensate for its impacts on the Western Arctic Caribou Herd.

It is imperative that public land managers be fully aware of the significance of their decisions. Unconventional land use problems will require equally unconventional approaches and solutions. Fortunately, in Alaska and particularly in the case of domestic reindeer grazing, it is possible to assess the effects and allow reasonable growth of the industry rather than try to ease the impacts of previous and ongoing resource use, as has occurred on public grazing lands in the American West. We hope that public land managers in Alaska will take advantage of this opportunity.

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BUCKLAND RIVER RANGE INVENTORY, 1980-81

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During the late 1970's, NANA Regional Native Corporation started an aggressive effort to establish a profitable reindeer herding operation on the northeastern Seward Peninsula (Adams and Robus 1981). Upon receiving assignment of the Hadley Reindeer Allotment, NANA voiced their interest in using the Buckland River Valley as winter range for the majority of their reindeer herd. Since this area was used in winter by a large segment of the Western Arctic Caribou Herd, BLM managers realized the potential for conflict and limited the use by reindeer of the area in question until the situation could be studied. The studies that were conducted consisted primarily of a forage inventory and winter caribou surveys (see attached report).

DESCRIPTION OF STUDY AREA

The area investigated is located approximately 125 km (75 mi) southeast of Kotzebue, Alaska (Fig. 1). The northern boundary of the area is approximately 40 km (25 mi) south of the Arctic Circle. The area is bounded on the west by State selected lands, on the north by State selected lands and the Selawik National Wildlife Refuge, on the east by the Tagagawik River, and on the south by the Continental Divide (Fig. 2). The area encompasses approximately 650,000 ha (1.6 million ac).

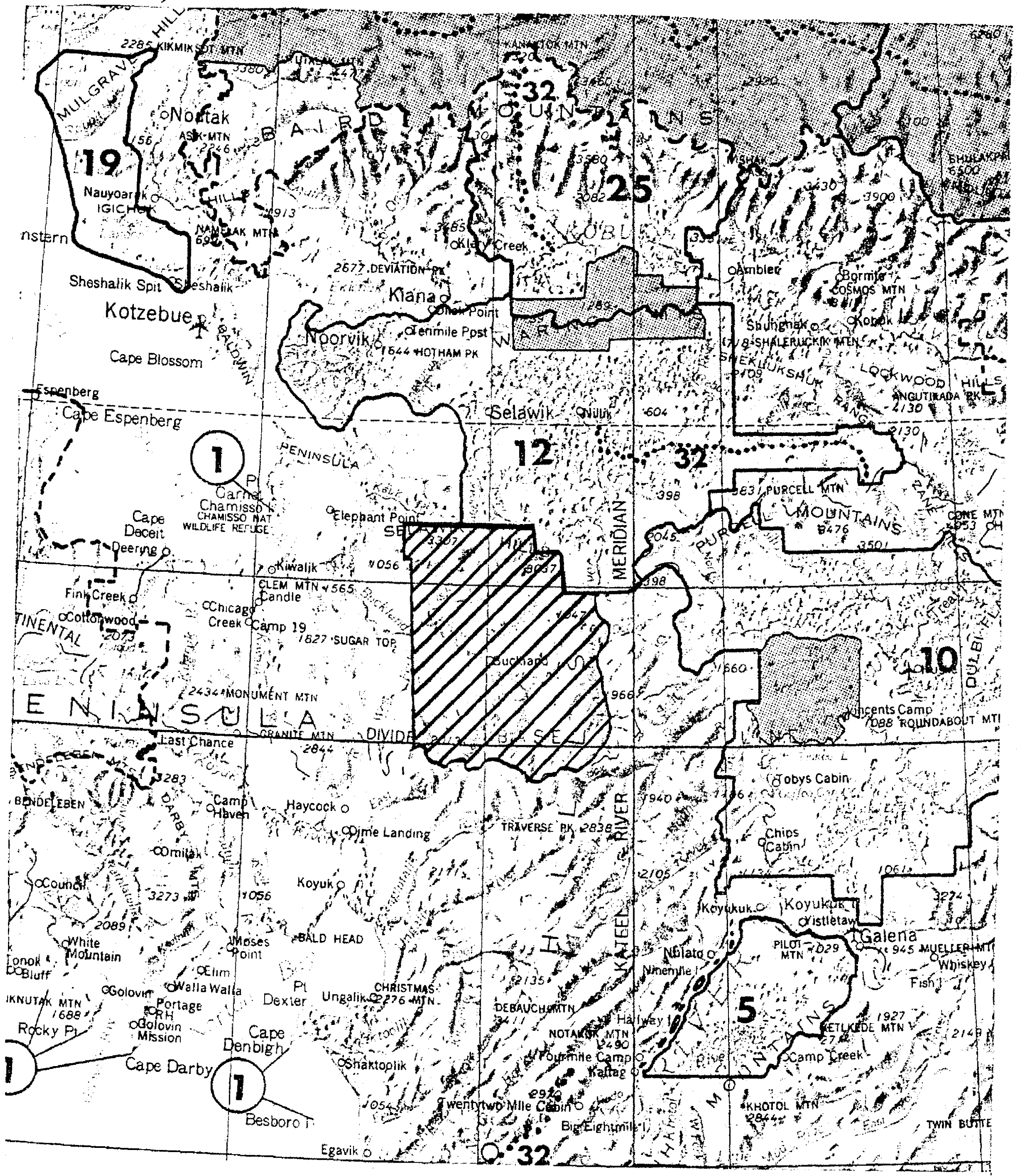

Figure 1. Location of the Buckland River Study Area.

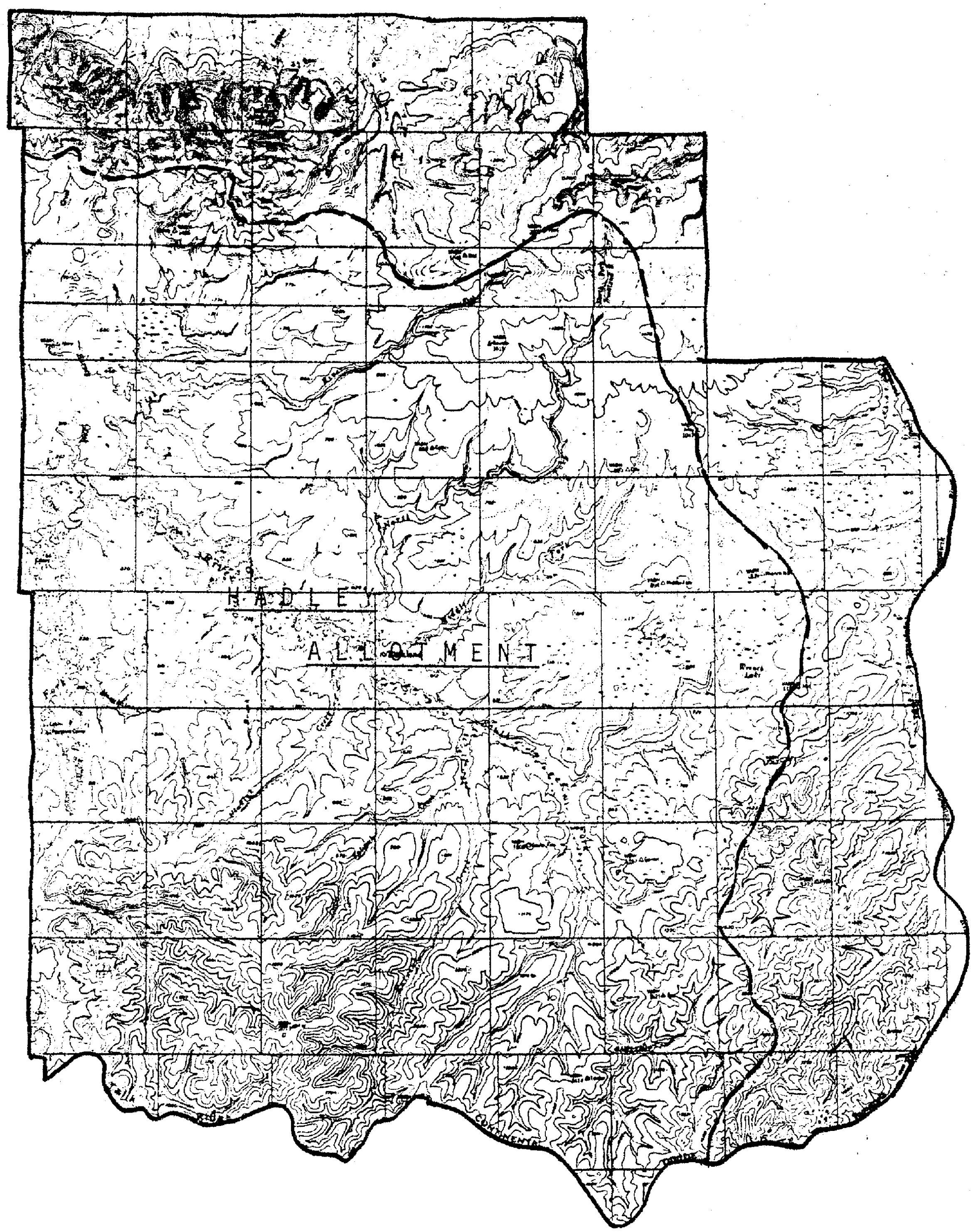

Figure 2. Geopgraphic features of the Buckland River Study Area. Dashed line represents the northern and eastern boundary of the Hadley Reindeer Allotment.

Major geographic features of the area include the Selawik Hills on the northern edge of the study area, the Buckland River Valley, and Talik Ridge and the Nulato Hills on the southern edge. Elevation ranges from 1,008 m (3,307 ft) at VABM View in the Selawik Hills to approximately 15 m (50 ft) where the Buckland River exits the area.

The study area can be divided into several general physiographic regions. The Selawik Hills are large, steeply disected mountains that are volcanic in origin. Land cover varies from barren rocky slopes and alpine tundra vegetation on the upper slopes to upland tundra at the lower elevations. The area between the Selawik Hills and the Buckland River is a broad tussock tundra plain that is deeply disected by several major drainages. South of the Buckland River, the vegetation grades from tussock tundra at the lower elevations, through black spruce forests to upland tundra on the ridges. Some alpine tundra communities are present on the higher ridges.

METHODS

Field work was conducted from 24 June to 21 August 1980 and 6 July to 8 August 1981. A total of 80 days were spent in the field during the two summers.

LANDSAT Imagery

Prior to the 1980 field season, an initial classified LANDSAT image (1980 image) was developed with the assistance of Tom George (Geophysical Institute, University of Alaska). Spectral data were clustered into 27 spectral classes that were assigned to 11 resource categories. After the 1980 field season, the 1980 image was refined (1981 image) by dividing the study area into seven physiographic units (Fig. 3) and reassigning the original 27 spectral classes to 13 resource categories within each physiographic unit. In the process of classifying the two LANDSAT images, preliminary definitions of resource classes (colors) were determined subject to field verification (Table 1). Percentages of the study area included in each resource class on each image is summarized in Table 2. Similar information for that portion of the study area included in the Hadley allotment is also in Table 2.

Verification of both LANDSAT images was conducted by comparing the vegetation type at each point where a production transect and/or a utilization transect was observed with the LANDSAT image color for both years. This analysis gives an indication of the accuracy of the images as vegetation type maps and will be discussed later.

Vegetation Production Sampling

In 1980 and 1981, 98 and 65 production transects were observed, respectively. Standing crop of lichen and annual production of major vascular species were determined on each of these transects.

In 1980, transect locations were determined each morning for transects run that day. Since we were attempting to analyze the accuracy of the LANDSAT image at the same time, transects were scattered throughout the area, but there may have been some bias toward areas that presented problems on the 1980 image. For the sake of future analysis, I will assume that the transects were located randomly.

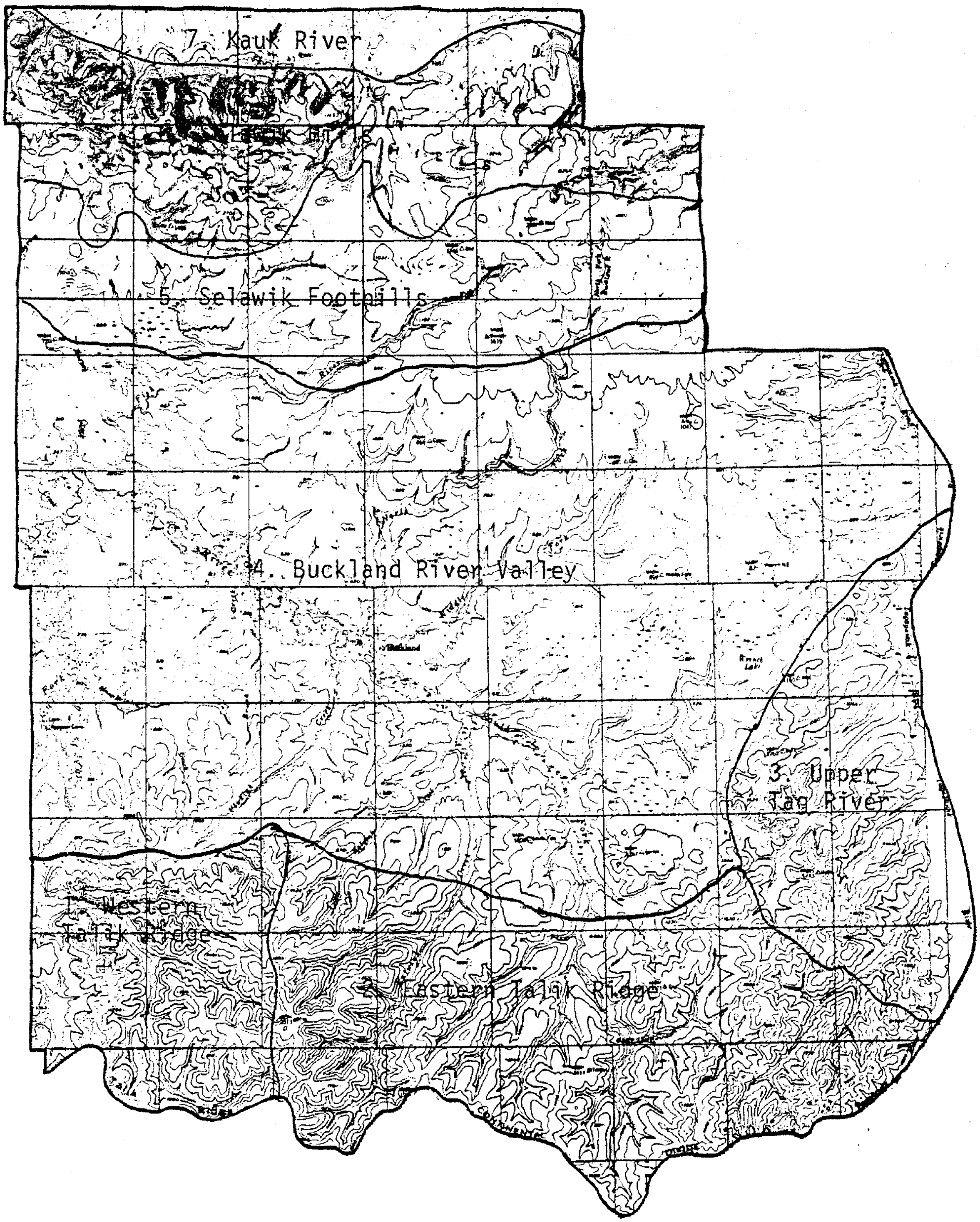

Figure 3. Physiographic regions of the Buckland River Study Area used in developing the 1981 LANDSAT image.

TABLE 1. Preliminary definitions of resource classes (colors) for 1980 and 1981 LANDSAT images of the Buckland River Study area, ALaska.

LANDSAT COLOR	1980 LANDCOVER	1981 LANDCOVER
1 Black	Recent Burns, Shadows	Recent Burns, Shadows
2 Dark Blue	Water	Water
3 Light Blue	Water	Water
4 Dark Grey	Boulder Fields	Boulder Fields
5 Grey		Alpine Tundra
6 Brown	Burns, Forest	Burns, Forest
7 Peach	Lichen Tussock Tundra	Lichen Tussock Tundra
8 Tan		Dense Shrub Upland Tundra
9 Sand	Alpine Tundra	Alpine Tundra
10 Orange	Brush	Brush
11 Red	Brush	Brush
12 Green	Tussock Tundra	Tussock Tundra
13 Olive		Upland Tundra
14 White	Clouds	Clouds

TABLE 2. Percentages of the study area and of the Hadley allotment within the study area included in each resource class on the initial (1980) and refined (1981) LANDSAT images.

	STUDY AREA		HADLEY ALLOTMENT	
LANDSAT COLOR	1980 LANDSAT IMAGE (%)	1981 LANDSAT IMAGE (%)	1980 LANDSAT IMAGE (%)	1981 LANDSAT IMAGE (%)
1 Black	5.5	3.2	3.3	0.1
2 Dark Blue	0.1	0.2	0.1	0.2
3 Light Blue	0.1		0.1	
4 Dark Grey	1.1	1.3	0.3	0.5
5 Grey		0.6		0.6
6 Brown	13.5	15.0	13.8	16.8
7 Peach	20.1	16.0	23.3	19.9
8 Tan		3.0		3.6
9 Sand	8.2	4.0	9.3	3.5
10 Orange	5.4	10.2	5.9	6.8
11 Red	9.0	4.0	6.9	2.9
12 Green	36.7	32.6	36.9	34.5
13 Olive		9.9		10.5
14 White	0.2	0.2	0.1	0.1

In 1981, the 65 transects were allocated among resource classes according to the resource class proportions of the 1981 image, variation in lichen standing crop within those resource classes from the 1980 data, and the number of transects in each resource class in 1980. Transects were allocated to minimize the sample variation as explained by Mendenhall et. al. (1971). Locations of transects within each resource class were determined by putting the transect in the largest block of that color, that was not sampled in 1980, in a randomly selected township. Fifty ha (160 ac) was the minimum size considered for sampled blocks.

For each transect, the LANDSAT color for both 1980 and 1981 images, as well as the vegetation type was recorded. A standard list of vegetation types was used (Table 3).

Each transect consisted of 5-0.2 sq. m round plots placed 10 m apart in a circular pattern. Within each plot, annual production for each vascular plant species, and the nondecadent standing crop of all lichens was estimated.

For major vascular plant species, those that were estimated to exceed a total of 5 gms green weight for all five plots, annual production was collected from the plot that was either the median for that species or contained the majority of that species on the transect. Lichen standing crop was collected in a similar manner. Lichen thalli that were discolored or deteriorated were not included in the sample, leaving only that portion of the lichen that appeared vigorous.

VEGETATION TYPE CODES

1.	Tussock Tundra	100
	Lichen Tussock Tundra	110
	Dwarf-Shrub Tussock Tundra	120
	Sedge/grass Tussock Tundra	130
	Open-Shrub Tussock Tundra	140
2.	Upland Tundra	200
	Lichen Upland Tundra	210
	Sedge/grass Upland Tundra	220
	Open Shrub Upland Tundra	230
	Dense Shrub Upland Tundra	240
	Dwarf Shrub Upland Tundra	250
3.	Alpine Tundra	300
	Boulderfield	310
	Cushion Fellfield Alpine Tundra	320
	Ericaceous Shrub	321
	Dryas	322
	Lichen Alpine Tundra	330
	Lichen Boulderfield	331
	Lichen /forb Alpine Tundra	332
	Sedge/grass Alpine Tundra	340
4.	Wetlands	400
	Alluvial Sedge Marsh	410
5.	Shrubland	500
	Brushy Drainages	510
	Alluvial Brush	520
	Brushfields	530
	Alder	531
	Aspen/Birch	532
6.	Forest	600
	Spruce Forest	610
	Lichen Spruce Forest	611
	Shrub Spruce Forest	612
	Mixed Alluvial Forest	620
7.	Grassland	700
8.	Drained Lake	800

Table 3. Vegetation types used for Buckland River Range Inventory.

Collected samples were air dried at approximately 25°C for one month and then weighed. Air dried weights were divided by field estimated wet weights and the quotient was used to correct the field estimated wet weights to an estimated dry weight of annual production for each major vascular species and total lichen standing crop.

Winter food habits of caribou on the study area were determined by fecal analysis (see report attached). From that analysis, major forage taxa were determined. Taxa that accounted for greater than 1% of the caribou winter diets were lichen, *Carex*, *Eriophorum*, *Ledum*, *Vaccinium*, and *Salix*. Compilations and statistical analysis of range inventory data were limited to these six forage taxa and total vascular production.

Vegetation data was compiled on DSC computer files as indicated by coding form descriptions (Appendix 1), and analyzed using available statistical routines on the DSC computer such as SPSS, STATPACK, and STRAT.

Inventory data was summarized by vegetation type, 1980 LANDSAT color, and 1981 LANDSAT color. Descriptive statistics such as means, standard deviations, coefficients of variation, and 95% confidence limits, were determined for each strata within the three classifications. Similar statistics were determined for stratified means of each major forage taxa within each strata of the two LANDSAT classifications, since proportions of the Hadley allotment and the entire study area in each strata could be determined. Proportions of the study area in each vegetation type were not determined, so such analysis could not be conducted for the vegetation type stratification.

RESULTS AND DISCUSSION

LANDSAT Image Verification

Distribution of locations observed, by vegetation type and LANDSAT color, are summarized in Tables 4 and 5 for the 1980 and 1981 LANDSAT stratifications, respectively. This information can be looked at in a couple of ways to attempt to assess the relative accuracy of the two LANDSAT images. For the purposes of this analysis, we have limited it to vegetation types that had 10 or more observations.

First, comparison of the percent of observations within each vegetation type that occurred in the color most often associated with that type gives some indication of the accuracy of the images. The averages, for the vegetation types that were observed more than 10 times, were 49% and 44% for the 1980 and 1981 LANDSAT images, respectively, indicating that the 1980 image was slightly more accurate.

On the other hand, the ability of the image to separate out the major types gives the opposite indication. On the 1980 image, the primary colors for the seven types that were observed more than 10 times were distributed within only three colors. On the 1981 image, the primary colors for those same seven types were distributed within five colors.

Comparing the accuracy of two LANDSAT images objectively is a difficult task as indicated by the above analysis. At the very least, the data in Tables 4 and 5 gives some indication of the probability of a vegetation type occurring

TABLE 4. Distribution of observed locations by vegetation type and 1980 LANDSAT color.

1980 LANDSAT Color [1]

Vegetation Type [2]	1	4	6	7	9	10	11	12	Totals
110			1	38	15	1		16	71
120			1			5	8	12	26
130	7		1	6	3	7	2	31	57
140	1					4	3	1	9
200				1				1	2
210		1	1	5	19			5	31
220	1			5	5	1	2	2	16
230				2		1		1	4
240								3	3
250			2		3			2	7
300								1	1
310	1	6							7
320		1	2	1	9			2	15
330		3		7	5			4	19
340			1					5	6
410								3	3
510						2			2
520								1	1
530							1	1	2
610			7					2	9
700								1	1
800			1						1
Totals	10	11	17	65	59	21	16	94	293

[1] See Table 1.

[2] See Table 3.

TABLE 5. Distribution of observed locations by vegetation type and 1981 LANDSAT color.

1981 LANDSAT Color [1]

Vegetation Type [2]	1	4	5	6	7	8	9	10	11	12	13	Totals
110					40	1		1	1	10	18	71
120				1	1	1	1	7	2	13		26
130	6			3	7			6	2	29	4	57
140							1	2	5	1		9
200					1						1	2
210		1	2		3	2	10			6	8	31
220	1	1		1		1	4		1	2	5	16
230				1						1	2	4
240						3						3
250			1		1	1				4		7
300										1		1
310	2	5										7
320		1	7	1			2			4		15
330	1	2				1	3	1		3	8	19
340				2			1	2		1		6
410										3		3
510						1				1		2
520										1		1
530								1		1		2
610				6		2				1		9
700										1		1
800				1								1
Totals	10	10	10	16	53	13	22	20	11	79	49	293

[1] See Table 1.

[2] See Table 3.

at a given point of a specific color. For example, on the 1980 image, observations of the color green (12) were 33% within sedge/grass tussock tundra, 17% within lichen tussock tundra, 13% within dwarf-shrub tussock tundra, and the remaining 37% of the observations were scattered among 16 other vegetation types.

A different tack that can be taken to compare the two images is to compare the value of each image in explaining the variation within the data we are interested in. Comparing the R^2 values (Table 6), or the portion of the variability in the data that is explained by a given stratification, gives some indication of the relative accuracy of the images. The stratification provided by the 1980 image explained more of the variability in lichen standing crop than that of the 1981 image, but it was not as good for most vascular forage taxa.

This discussion is important in considering the value of a given LANDSAT image as a vegetation map. However, the stratified mean available forage by major forage taxa were not significantly different between the 1980 and 1981 images, as explained in the following section (Table 7). Therefore, for the purpose of estimating available forage, the added work and expense in developing the 1981 image was not necessary.

Vegetation Production

Descriptive statistics for major forage taxa as stratified by vegetation type, 1980 LANDSAT color, and 1981 LANDSAT color are available in Appendices 2, 3, and 4, respectively. Stratified mean lichen standing crop and annual production of all vascular plants and major vascular forage taxa, based on the

TABLE 6. R^2 (in percent) for major forage taxa by each stratification.

	Vegetation Type	1980 LANDSAT Color	1981 LANDSAT Color
Lichen Standing Crop	59	37	28
Vascular Production	38	35	28
Carex	38	10	13
Eriophorum	33	8	10
Ledum	44	27	26
Salix	63	7	26
Vaccinium	21	10	14

TABLE 7. Stratified mean lichen standing crop and annual production of major vascular forage taxa (g/m^2 $\pm$ 2 S.E.) for the Hadley allotment within the study area and the entire study area as stratified by the 1980 and 1981 LANDSAT images (n = 163 transects).

	HADLEY		STUDY AREA	
	1980	1981	1980	1981
Lichen Standing Crop	167 $\pm$ 23	168 $\pm$ 24	156 $\pm$ 22	161 $\pm$ 22
Vascular Production	64 $\pm$ 4	63 $\pm$ 5	64 $\pm$ 4	64 $\pm$ 5
Carex	10 $\pm$ 2	9 $\pm$ 2	10 $\pm$ 2	9 $\pm$ 2
Eriophorum	10 $\pm$ 2	11 $\pm$ 3	11 $\pm$ 3	11 $\pm$ 3
Ledum	10 $\pm$ 2	10 $\pm$ 2	10 $\pm$ 2	10 $\pm$ 2
Salix	4 $\pm$ 2	4 $\pm$ 2	4 $\pm$ 2	4 $\pm$ 2
Vaccinium	11 $\pm$ 2	12 $\pm$ 2	11 $\pm$ 2	11 $\pm$ 2

stratifications provided by the 1980 and 1981 LANDSAT images, for the study area and that portion of the Hadley allotment within the study area, are summarized in Table 7.

Determination of Stocking Rates

Development of a maximum allowable number of reindeer/caribou that could be maintained on a sustained basis during the winter on the portion of the Hadley allotment included in the study area, is a task that is fraught with pitfalls, data gaps, and unanswerable questions. For the sake of illustrating the problems in determining stocking rates, I will go through the simplest of examples using the data from this inventory and other necessary parameters from the literature or from educated guesses. Table 8 illustrates the described calculations and the potential range of animal numbers depending on which end of the spectrum of values for required calculations is used. For management purposes, particularly in this case when so much of the needed information is based on assumptions or educated guesses, only the most conservative estimate is of any value. To simplify calculations and increase understanding, English units of measurement will be used.

For this simple example, the necessary information can be broken into three categories, including available forage/unit area, available area, and animal needs. Results from each of these categories can then be used to estimate a stocking rate.

TABLE 8. Determination of conservative and optimized stocking rate for BLM administered portion of Hadley reindeer allotment.

PARAMETER	CONSERVATIVE (realistic)	OPTIMIZED (unrealistic)
1. Available forage/unit area		
- Lichen standing crop 1490 ± 210 lbs/acre (± 95% CI)	1280 lbs/acre	1700 lbs/acre
- Allowable forage consumed - 5 year rotation	20%	45%
- Usable forage	256 lbs/acre	765 lbs/acre
2. Available area		
- Hadley allotment (west of Buckland River)	1.1 million acres	1.1 million acres
- 15% forested	-165,000 acres	-165,000 acres
- Total usable range	935,000 acres	935,000 acres
- Unavailable due to snow cover	33%	10%
- Actual useable range	626,000 acres	842,000 acres
- 5 year rotation	125,000 acres	168,000 acres
3. Animal needs		
- Lichen consumed/day	12 lbs.	12 lbs
- 210 day grazing season (1 October - 1 May)		
- Lichen consumed/season	2,500 lbs	2,500 lbs
4. Total useable forage (#1 x #2)	3.2×10^7 lbs	1.3×10^8 lbs
5. Estimated stocking rate (#4 ÷ #3)	13,000 reindeer	52,000 reindeer

Available Forage/Unit Area - Since lichen constitutes 63% of the diet of caribou on the study area and is the forage category that is most likely to be overgrazed, we will use lichen standing crop as the basis for determining stocking rates. From this range inventory, we determined the lichen standing crop to average approximately 1490$\pm$ 210 lbs./acre ($\pm$ 95% C.L.) for the Hadley allotment within the study area. According to Andreev (1954), 45% of the lichen standing crop can potentially be removed every five years on managed ranges in Siberia, with optimal herd control and even grazing pressure over the entire pasture and forages resources will be maintained. In reality an amount much less than this can be safely used. First, some portion of that 45% will be trampled and destroyed, but will not contribute to the used animal forage. Second, intensively managed lichen ranges are quite different from decadent climax lichen tundra like that which occurs in the Buckland River Valley. The amount of functioning tissue per lichen thalli is much less in decadent stands than on managed ranges (Andreev 1954). This may greatly limit the allowable grazing pressure. Third, Andreev's estimate of 45% is based on removal of the top 1/3 of the lichen mat. This requires that the lichen are solidly frozen into some substrate which is not the case in the Buckland Valley. Caribou remove all living lichen tissue within craters. We have no idea what affect this has on recovery time.

In addition to the above concerns, we cannot safely assume that reindeer herds will be managed to distribute grazing pressure in an optimal manner. Reindeer naturally graze more intensely than free-ranging caribou (Andreev 1975, Klein 1980). Therefore, they would have to be constantly moving during the winter to minimize localized overgrazing. In reality, the animals are held for long periods in the same location. Areas near Buckland, or that are easily accessible, would be grazed more heavily than less accessible areas. To minimize the area that would be overgrazed, some average level of removal much less than the 45% optimal level must be used.

Forage preferences of reindeer also must be considered. All lichen species are not equally preferred. In order to manage for a sustained yield of the more palatable species, a lower removal rate is necessary.

Taking all these factors into consideration, an allowable portion of the lichen standing crop that can be removed would have to be much less than 45%. That portion that may actually be consumed by reindeer and allow for sustained yields of the important forage species may realistically be around 15-20% of the lichen standing crop. I will use 20% in the example (Table 8).

Available Area - The portion of the Hadley allotment under BLM jurisdiction is approximately 1.1 million acres. Of that, nearly 20% is forested and not used significantly by caribou (Davis et al. 1982) or cannot feasibly be used by reindeer. I subtracted 15% from the total acreage to allow for some use of the forest edge which seems reasonable.

Some portion of the area will be unavailable to foraging reindeer because of deep or crusted snow. Any estimate of this is purely subjective and the actual portion of the area would vary widely between years and even within one winter. It seems reasonable that at a minimum 10% of the area would be unavailable. In order to be safe, a conservative estimate would have to consider the worst possible situation that is likely to occur during the five year grazing rotation. For the sake of this example, I used 33% as a reasonable estimate. Of the remaining acres, only 20% of the area could be used in a given year under a five-year rotational grazing strategy. That area would then be left fallow for the next four years to allow for forage recovery.

Animal Needs - Estimated forage consumption per animal is based on the daily lichen intake rate determined by Holleman et al. (1979) for free-ranging caribou and a 210-day grazing season from 1 October to 1 May, which is the approximate period that caribou use the area.

Using the information presented, an estimate of the allowable stocking rate can be determined as explained in Table 8.

As Table 8 illustrates, the estimated stocking rate can vary from a conservative but realistic estimate of 13,000 reindeer to an optimized and totally unrealistic estimate of 52,000 reindeer. Again, I must stress that this is a grossly oversimplified example based on many untested assumptions. Until many of those assumptions can be assessed and missing data acquired, I would hope that any conscientious manager would use the most conservative estimate.

If that is the case, then it is obvious that from a forage standpoint, no reindeer can be allowed east of the Buckland River as long as caribou winter in the area in the numbers that have been observed in the last few years. Minimum estimates of wintering caribou on the area have ranged from 8,000 to 20,000 animals with actual numbers probably being much higher (see attached report).

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Appendices

1. Explanation of coding forms and associated codes.

2. Descriptive statistics of major forage taxa broken down by vegetation type.

3. Descriptive statistics of major forage taxa broken down by 1980 LANDSAT classification.

4. Descriptive statistics of major forage taxa broken down by 1981 LANDSAT classification.

Appendix 1-A

EXPLANATION OF CODING FORMS
BUCKLAND RIVER-SELAWIK HILLS RANGE INVENTORY

1. Entries based on data from SCS Form 417.

2. All entries are right-justified.

TRANSECT SUMMARY

Util. or Prod. (1-2): Production Transect - leave blank
Utilization Transect - 1 in column 2

Transect Number (3-5):

Vegetation Type (6-9): 3 digit code from attached Vegetation Type Codes.

1980 Color (10-13): Color for that point on 1980 LANDSAT classification (see LANDSAT Color Codes).

1981 Color (14-17): Color for that point on 1981 LANDSAT classification (see LANDSAT Color Codes).

Physiographic Unit (18-20): See appropriate code.

Political Unit (21-23): See appropriate code.

Lichen - % frequency (24-27): % of plots that lichen occurred in on this transect.

- % cover (28-31): mean percentage for all 5 plots to the nearest whole percentage point.

Moss - % frequency (32-35)	same as for lichen
- % cover (36-39)	" " " "
Residue - % frequency (40-43)	" " " "
- % cover (44-47)	" " " "
Vascular Plants - % frequency (48-51)	" " " "
- % cover (52-55)	" " " "
Bare Ground - % frequency (56-59)	" " " "
- % cover (60-63)	" " " "
Rock - % frequency (64-67)	" " " "
- % cover (68-71)	" " " "

Site Util. Index (72-75): Number of points of utilization on 100-point 3-step transect.

Burned? (76): 1 burned, blank if not.

Appendix 1-B

VEGETATION INVENTORY DATA

Transect Number (1-3):

Vegetation Type (4-7): 3 digit code from attached Vegetation Type Codes.

1980 Color (8-11): Color for that point on 1980 LANDSAT classification (see attached LANDSAT codes).

1981 Color (12-15): Color for that point on 1981 LANDSAT classification (see attached LANDSAT codes).

Physiographic Unit (16-19): See appropriate code.

Political Unit (20-23): See appropriate code.

Species (24-30): 4 letter species code as per attached sheet.
For total lichen, LICHEN is entered.

Brush Transect (31): 1 if brush transect, leave blank if not.

Vascular Annual Production (32): If species is not lichen, enter 1.
If species is lichen, leave blank.

Total Lichen (33-34): If this lichen standing crop, enter 1.
If this is not lichen standing crop, leave blank.

Lichen Species (35-36): If this is a lichen species, enter 1.
If this is not a lichen species, leave blank.

Vascular Annual Production (fill in only if 1 is in column 32)
- Weight estimate (37-42): g/m^2 to the nearest gram for vascular species.
- % frequency (43-48): % of plots on transect that species occurred in.

Lichen Standing Crop (fill in only if 1 is in column 34)
- Weight estimate (49-54): g/m^2 of all nondecadent lichen to the nearest g.
- % frequency (55-60): % of plots that lichen occurred in.

Lichen Species (fill in only if 1 is in column 36)
- % frequency (61-66): % of plots that this lichen species occurred in.
- % of total (67-72): mean portion of all lichens for this species in all 5 plots.

Burned? (73): If site is burned - 1
If site is unburned - leave blank.

Appendix 1-C

LANDSAT COLOR CODES

Black	1
Dark Blue	2
Light Blue	3
Dark Grey	4
Grey	5
Brown	6
Peach	7
Tan	8
Sand	9
Orange	10
Red	11
Dark Green	12
Olive	13
White	14

PHYSIOGRAPHIC UNITS

Western Talik Ridge	1
Eastern Talik Ridge	2
Upper Tag River	3
Buckland River Valley	4
Selawik Foothills	5
Selawik Hills	6
Kauk River	7

POLITICAL UNIT

Hadley Allotment	1
West of Tag River	2
East of Tag River	3

Appendix 1-D

VEGETATION TYPE CODES

1. Tussock Tundra	100
Lichen Tussock Tundra	110
Dwarf-Shrub Tussock Tundra	120
Sedge/grass Tussock Tundra	130
Open-Shrub Tussock Tundra	140
2. Upland Tundra	200
Lichen Upland Tundra	210
Sedge/grass Upland Tundra	220
Open Shrub Upland Tundra	230
Dense Shrub Upland Tundra	240
Dwarf Shrub Upland Tundra	250
3. Alpine Tundra	300
Boulderfield	310
Cushion Fellfield Alpine Tundra	320
Ericaceous Shrub	321
Dryas	322
Lichen Alpine Tundra	330
Lichen Boulderfield	331
Lichen /forb Alpine Tundra	332
Sedge/grass Alpine Tundra	340
4. Wetlands	400
Alluvial Sedge Marsh	410
5. Shrubland	500
Brushy Drainages	510
Alluvial Brush	520
Brushfields	530
Alder	531
Aspen/Birch	532
6. Forest	600
Spruce Forest	610
Lichen Spruce Forest	611
Shrub Spruce Forest	612
Mixed Alluvial Forest	620
7. Grassland	700
8. Drained Lake	800

Appendix 1-E

Vegetation Type Descriptions

100 - Tussock Tundra - areas of reindeer lichens, sedges, and dwarf shrubs where *Eriophorum vaginatum* is the dominant sedge. This type occurs primarily at the lower elevations and dominates most of the Buckland River Valley.

110 - Lichen Tussock Tundra - tussock tundra dominated by reindeer lichens such as *Cetraria cucullata*, *Cladonia rangiferina*, *Cladonia mitis* and *Cladonia alpestris*.

120 - Dwarf Shrub Tussock Tundra - tussock tundra dominated by dwarf shrubs such as *Ledum palustre*, *Vaccinium uliginosum*, *Vaccinium vitas-idaea*, and *Betula nana*.

130 - Sedge/grass Tussock Tundra - tussock tundra dominated by *Eriophorum vaginatum*.

140 - Open Shrub Tussock Tundra - tussock tundra with an overstory of scattered tall shrubs, primarily *Salix* or *Alnus crispa*.

200 - Upland Tundra - upland slopes characterized by solifluction lobes and frost boils. *Carex* is the dominant sedge. This type occurs primarily in Selawik Hills and Talik Ridge.

210 - Lichen Upland Tundra - upland tundra dominated by reindeer lichens. Most of the lichen occurs on frost boiled areas.

220 - Sedge/grass Upland Tundra - upland tundra dominated by *Carex*, primarily *C. bigelowii*.

230 - Open Shrub Upland Tundra - upland tundra with an overstory of scattered tall shrubs, primarily *Alnus crispa*, and *Salix*.

240 - Dense Shrub Upland Tundra - upland tundra with a dense overstory of *Salix*. This type occurs at the edge between spruce forest and upland tundra ridges on Talik Ridge.

250 - Dwarf Shrub Upland Tundra - upland tundra domimated by dwarf shrubs.

300 - Alpine Tundra - tundra of high ridges and dry sites primarily in the Selawik Hills. This type occurs in a few locations on Talik Ridge.

310 - Boulderfield.

320 - Cushion Fellfield Alpine Tundra - areas characterized by intermixed boulderfields, frostpockets, and cushion tundra.

321 - Ericaceous Shrub - dominated by *Arctostaphylos*, *Loiseleuria*, and/or *Ledum*.

322 - *Dryas* - dominated by *D. octopetala* or *D. integrifolia*.

330 - Lichen Alpine Tundra - alpine tundra dominated by reindeer lichens or *Stereocaulon*.

331 - Lichen Boulderfield.

332 - Lichen/forb Alpine Tundra - dominated by lichens and forbs such as *Lupinus*, *Cerastium*, *Eritrichium*, *Geum*, *Minuartia*, and *Oxytropis*.

340 - Sedge/grass Alpine Tundra - alpine tundra dominated by sedges and grass such as *Poa*, *Hierchloe*, and *Arctogrostis*. This type occurred on only a few ridges in the Tagagawik River drainage that appeared to have been burned recently.

400 - Wetlands

410 - Alluvial Sedge Marsh - wetlands within major drainage channels. Some areas are polygonized. *Carex aquatilis* is the dominant sedge.

500 - Shrublands

510 - Brushy Drainages - small drainages dominated by a closed canopy of tall shrubs, primarily *Salix*.

520 - Alluvial Brush - brush fields on benches within the major river channels. *Salix* is the dominant shrub.

530 - Brushfields - dense hillside brush.

531 - Alder Brushfields.

532 - Aspen/Birch Brushfields.

600 - Forest

610 - Spruce Forest

611 - Lichen Spruce Forest - spruce forests where the dominant understory vegetation is reindeer lichen. These areas tended to be small patches that were drier than the surrounding forest floor.

612 - Shrub Spruce Forest - spruce forests with an understory of tall shrubs. Composed primarily of *Salix*.

620 - Mixed Alluvial Forest - mixed spruce and deciduous forest primarily along major river drainages. This type occurred mainly on the Tagagawik River.

700 - Grassland - areas of tall grass, primarly *Calamogrostis*, *Arctogrostis*, and *Festuca*, within the 1977 burn on the Kauk and Mangoak River.

800 - Drained Lake - should have been included under the wetland type.

Appendix 1-F

BUCKLAND RIVER RANGE INVENTORY
PLANT SPECIES CODES

GRASSES AND GRASSLIKE PLANTS

NAME	CODE
Agrostis species	AGROS2
Arctagrostis latifolia	ARLA2
Calamagrostis species	CALAM
Calamagrostis canadensis	CACA4
Calamagrostis inexpansa	CAIN
Carex species	CAREX
Carex aquatilis	CAAQ
Carex bigelowii	CAB15
Carex saxatilis	CASA10
Equisetum species	EQUIS
Eriophorum angustifolium	ERAN6
Eriophorum vaginatum	ERVA4
Festuca species	FESTU
Hierochloe species	HIERO
Kobresia species	KOBRE
Luzula species	LUZUL
Poa species	POA++
Unknown grass	UNGR

FORBS

NAME	CODE
Aconitum species	ACON1
Andromeda polifolia	ANPO
Anemone species	ANEMO
Anemone narcissiflora	ANNA
Antennaria species	ANTEN
Arnica species	ARNIC
Arnica mollis	ARMO
Artemisia species	ARTEM
Artemisia arctica	ARAR3
Boykinia richardsonii	BOYKI
Caltha species	CALTH
Campanula species	CAMPA
Castilleja species	CASTI
Cerastium species	CERAS
Claytonia species	CLAYT
Delphinium species	DELPH
Diapensia species	DIAPE
Dodecatheon frigidum	DOFR

FORBS Continued

NAME	CODE
Epilobium angustifolium	EPAN2
Eritrichium species	ERITR
Galium species	GALIU
Gentiana species	GENT1
Geum species	GEUM
Hedysarum species	HEDYS
Hesperis species	HESPE2
Iris species	IRIS
Lupinus species	LUPIN
Melandrium species	MELAN
Mertensia species	MERTE
Minuartia species	ARENA
Oxycoccus microcarpus	OXMI
Oxytropis species	OXYTR
Papaver lapponicum	PALA9
Pedicularis species	PEDIC
Pentstemon species	PENST
Petasites frigidus	PEFR5
Polemonium species	POLEM
Polygonum species	POLYG
Polygonum bistorta	BIPL
Polygonum viviparum	BIVI
Potentilla species	POTEN
Pyrola species	PYROL
Rubus chameamorus	RUCH
Rumex arcticus	RUAR6
Sanguisorba species	SANGU2
Saussurea angustifolia	SAAN
Saxifraga species	SAXIF
Saxifraga hieracifolia	SAHI2
Saxifraga hirculus	SAHI1
Sedum species	SEDUM
Senecio congestus	SECO
Solidago species	SOLID
Solidago multiradiata	SOMU
Stellaria species	STELL
Thalictrum species	THALI2
Tofieldia species	TOFIE
Valeriana species	VALER
Unknown forb	UNFO

SHRUBS

NAME	CODE
Alnus crispa	ALCR6
Arctostaphylos alpina	ARAL2
Arctostaphylos rubra	ARRU
Betula species	BETUL
Betula glandulosa	BEGL
Betula nana	BENA
Betula papyrifera	BEPA
Cassiope tetragona	CATE11
Chamaedaphne calyculata	CHAMA5
Dryas integrifolia	DRIN4
Dryas octopetala	DROC
Empetrum nigrum	EMNI
Ledum palustre decumbens	LEPA2
Loiseleuria procumbens	LOISE
Populus tremuloides	POTR
Potentilla fruticosa	POFR1
Rosa species	ROSA
Salix species	SALIX
Salix arbusculoides	SAAR3
Salix arctica	SAAR4
Salix glauca	SAGL
Salix phlebophylla	SAPH
Salix pulchra	SAPU
Salix reticulata	SARE2
Salix rotundifolia	SARO2
Spiraea beauverdiana	SPBE
Vaccinium uliginosum	VAUL
Vaccinium vitis-idaea	VAVI

LICHENS

NAME	CODE
Alectoria species	ALECT
Alectoria nigricans	ALNI2
Alectoria ochroleuca	ALOC3
Asahinea species	ASAHI
Cetraria cucullata	CECU3
Cetraria islandica	CEIS
Cetraria nivalis	CENI4
Cetraria pinastri	CEPI
Cetraria richardsonii	CERI
Cladonia species	CLADO

LICHENS Continued

Cladonia alpestris	CLAL
Cladonia amaurocraea	CLAM
Cladonia capitata	CLCA
Cladonia cenotea	CLCE
Cladonia chlorophea	CLCH
Cladonia coccifera	CLCO2
Cladonia cornuta	CLCO1
Cladonia crispata	CLCR
Cladonia cyanipes	CLCY
Cladonia gracilis	CLGR3
Cladonia mitis/arbuscula	CLMI2AR
Cladonia pixidata	CLPY
Cladonia pleurota	CLPL
Cladonia rangiferina	CLRA
Cladonia tilesia	CLTI
Cladonia turgida	CLTU
Cladonia uncialis	CLUN
Cornicularia species	CORNI
Cornicularia divergens	CODI
Dactylina species	DACTY4
Hypogymnia species	HYPOG
Icmadophila ericitorum	ICMO
Leptogium species	LEPTO
Lobaria linita	LOLI
Nephroma arcticum	NEAR
Parmelia species	PARME
Parmelia omphalodes	PAOM
Peltigera species	PELTI
Peltigera aphthosa	PEAP
Peltigera canina	PECA
Solorina crocea	SOCR
Sphaerophorus species	SPHAE
Stereocaulon species	STERE
Thamnolia species	THAMN2
Umbellicaria species	UMBEL

Appendix 2-A

Breakdown of lichen standing crop by vegetation type (n = number of transects in type).

Vegetation Type [1]	n	Mean (g/m^2)	2 S.E. [2]	S.E./$\bar{x}$ [3]
110	31	319	50	0.08
120	14	26	6	0.11
130	38	66	24	0.19
140	7	50	48	0.48
210	13	320	212	0.33
220	10	120	72	0.30
230	4	170	148	0.44
240	2	11	21	0.95
250	4	33	40	0.60
310	2	387	121	0.16
320	4	49	43	0.44
330	15	522	168	0.16
340	2	34	9	0.13
410	3	0	-	-
510	1	0	-	-
520	1	6	-	-
530	2	8	15	0.94
610	8	126	59	0.23
700	1	20	-	-
800	1	0	-	-

$R^2 = 58.5\%$

[1] see Vegetation type codes (Table 3).

[2] approx. 95% confidence limits.

[3] coefficient of variation.

Appendix 2-B

Breakdown of total vascular production by vegetation type (n = number of transects in type).

Vegetation Type [1]	n	Mean (g/m^2)	2 S.E. [2]	S.E./$\bar{x}$ [3]
110	31	48	5.5	0.06
120	14	85	18.9	0.11
130	38	75	10.2	0.07
140	7	89	19.3	0.11
210	13	56	10.0	0.09
220	10	62	15.2	0.12
230	4	66	42.8	0.33
240	2	82	29.0	0.18
250	4	76	16.3	0.11
310	2	1	1.0	1.00
320	4	46	32.9	0.36
330	15	31	12.7	0.20
340	2	32	2.0	0.03
410	3	61	26.9	0.22
510	1	112	-	-
520	1	72	-	-
530	2	120	80.0	0.33
610	8	64	19.3	0.15
700	1	102	-	-
800	1	57	-	-
R^2 = 38%				

[1] see Vegetation type codes (Table 3).

[2] approx. 95% confidence limits.

[3] coefficient of variation.

Appendix 2-C

Breakdown of <u>Carex</u> annual production by vegetation type (n = number of transects in type).

Vegetation Type [1]	n	Mean (g/m^2)	2 S.E. [2]	S.E./$\bar{x}$ [3]
110	31	3	1.4	0.23
120	14	13	8.4	0.32
130	38	10	3.7	0.18
140	7	11	6.7	0.30
210	13	14	4.2	0.15
220	10	17	5.5	0.16
230	4	16	11.0	0.34
240	2	3	5.0	0.83
250	4	5	6.7	0.67
310	2	0	-	-
320	4	1	1.0	1.00
330	15	3	1.5	0.24
340	2	4	7.0	0.87
410	3	28	6.4	0.11
510	1	14	-	-
520	1	7	-	-
530	2	21	41.0	0.98
610	8	5	3.3	0.35
700	1	33	-	-
800	1	50	-	-

$R^2 = 38.1\%$

[1] see Vegetation type codes (Table 3).

[2] approx. 95% confidence limits.

[3] coefficient of variation.

Appendix 2-D

Breakdown of <u>Eriophorum</u> annual production by vegetation type (n = number of transects in type).

Vegetation Type [1]	n	Mean (g/m^2)	2 S.E. [2]	S.E./$\bar{x}$ [3]
110	31	13	3.9	0.15
120	14	20	10.3	0.26
130	38	21	6.4	0.02
140	7	10	10.4	0.50
210	13	4	5.1	0.64
220	10	2	2.1	0.67
230	4	0	-	-
240	2	0	-	-
250	4	0	-	-
310	2	0	-	-
320	4	0	-	-
330	15	0	-	-
340	2	0	-	-
410	3	0	-	-
510	1	0	-	-
520	1	0	-	-
530	2	0	-	-
610	8	0	-	-
700	1	4	-	-
800	1	0	-	-

$R^2 = 32.9\%$

[1] see Vegetation type codes (Table 3).

[2] approx. 95% confidence limits.

[3] coefficient of variation.

Appendix 2-E

Breakdown of Ledum annual production by vegetation type (n = number of transects in type).

Vegetation Type[1]	n	Mean (g/m^2)	2 S.E.[2]	S.E./$\bar{x}$[3]
110	31	9	2.3	0.12
120	14	28	9.3	0.17
130	38	15	3.9	0.13
140	7	16	7.7	0.23
210	13	6	4.5	0.38
220	10	5	5.2	0.56
230	4	9	9.2	0.50
240	2	3	6.0	1.00
250	4	15	4.4	0.15
310	2	0	-	-
320	4	0	-	-
330	15	0	-	-
340	2	0	-	-
410	3	0	-	-
510	1	0	-	-
520	1	0	-	-
530	2	1	2.0	1.00
610	8	1	1.8	1.00
700	1	20	-	-
800	1	0	-	-

$R^2 = 44.3\%$

[1] see Vegetation type codes (Table 3).

[2] approx. 95% confidence limits.

[3] coefficient of variation.

Appendix 2-F

Breakdown of Salix annual production by vegetation type (n = number of transects in type).

Vegetation Type [1]	n	Mean (g/m^2)	2 S.E. [2]	S.E./$\bar{x}$ [3]
110	31	0	-	-
120	14	0	-	-
130	38	1	0.7	0.39
140	7	3	3.3	0.65
210	13	2	2.4	0.58
220	10	7	4.3	0.30
230	4	7	8.1	0.62
240	2	38	70.0	0.92
250	4	1	1.9	0.76
310	2	0	-	-
320	4	1	2.5	1.00
330	15	2	1.8	0.41
340	2	0	-	-
410	3	5	5.8	0.62
510	1	63	-	-
520	1	12	-	-
530	2	5	7.0	0.78
610	8	21	11.3	0.27
700	1	3	-	-
800	1	0	-	-

R^2 = 62.6%

[1] see Vegetation type codes (Table 3).

[2] approx. 95% confidence limits.

[3] coefficient of variation.

Appendix 2-G

Breakdown of Vaccinium annual production by vegetation type (n = number of transects in type).

Vegetation Type [1]	n	Mean (g/m^2)	2 S.E. [2]	S.E./$\bar{x}$ [3]
110	31	12	2.2	0.09
120	14	14	5.0	0.18
130	38	15	3.7	0.12
140	7	20	9.1	0.23
210	13	14	6.2	0.22
220	10	6	6.6	0.55
230	4	15	13.8	0.46
240	2	4	8.0	1.00
250	4	12	2.9	0.12
310	2	0	-	-
320	4	0	-	-
330	15	3	5.3	0.78
340	2	0	-	-
410	3	15	24.5	0.83
510	1	3	-	-
520	1	8	-	-
530	2	6	4.0	0.33
610	8	10	10.7	0.57
700	1	4	-	-
800	1	0	-	-

R^2 = 21%

[1] see Vegetation type codes (Table 3).

[2] approx. 95% confidence limits.

[3] coefficient of variation.

APPENDIX 3-A

Breakdown of lichen standing crop by 1980 LANDSAT Color (n = number of transects in stratum).

1980 Color	n	Mean (g/m^2)	2 S.E. [1]	S.E./$\bar{x}$ [2]
1 Black	7	26	77	1.48
4 Dark Grey	6	255	98	0.19
6 Brown	14	84	42	0.25
7 Peach	32	313	71	0.11
9 Sand	28	362	107	0.15
10 Orange	17	47	42	0.45
11 Red	13	33	25	0.38
12 Green	46	113	41	0.18
STRATIFIED MEAN				
HADLEY	163	167	23	0.07
STUDY AREA	163	156	22	0.07
R^2 = 36.7%				

[1] approx. 95% confidence limits.

[2] coefficient of variation.

APPENDIX 3-B

Breakdown of total vascular annual production by 1980 LANDSAT Color (n = number of transects in stratum).

1980 Color	n	Mean (g/m^2)	2 S.E. [1]	S.E./$\bar{x}$ [2]
1 Black	7	59	22.1	0.19
4 Dark Grey	6	5	6.3	0.67
6 Brown	14	66	17.1	0.13
7 Peach	32	43	6.2	0.07
9 Sand	28	59	7.4	0.06
10 Orange	17	89	14.8	0.08
11 Red	13	89	15.0	0.08
12 Green	46	69	9.2	0.07
STRATIFIED MEAN				
HADLEY	163	64	4.4	0.03
STUDY AREA	163	64	4.4	0.03
R^2 = 34.9%				

[1] approx. 95% confidence limits.

[2] coefficient of variation.

APPENDIX 3-C

Breakdown of *Carex* annual production by 1980 LANDSAT Color (n = number of transects in stratum).

1980 Color	n	Mean (g/m^2)	2 S.E. [1]	S.E./$\bar{x}$ [2]
1 Black	7	16	13.3	0.43
4 Dark Grey	6	1	2.7	1.00
6 Brown	14	7	7.0	0.49
7 Peach	32	6	2.3	0.21
9 Sand	28	8	3.0	0.20
10 Orange	17	13	6.8	0.27
11 Red	13	11	5.2	0.24
12 Green	46	12	3.5	0.14
STRATIFIED MEAN				
HADLEY	163	10	1.7	0.09
STUDY AREA	163	10	1.8	0.09
R^2 = 9.4%				

[1] approx. 95% confidence limits.

[2] coefficient of variation.

APPENDIX 3-D

Breakdown of *Eriophorum* annual production by 1980 LANDSAT Color (n = number of transects in stratum).

1980 Color	n	Mean (g/m^2)	2 S.E. [1]	S.E./$\bar{x}$ [2]
1 Black	7	20	15.5	0.39
4 Dark Grey	6	0	-	-
6 Brown	14	6	8.9	0.71
7 Peach	32	8	3.2	0.20
9 Sand	28	6	0.7	0.07
10 Orange	17	14	9.0	0.33
11 Red	13	17	9.0	0.26
12 Green	46	12	5.2	0.22
STRATIFIED MEAN				
HADLEY	163	10	2.4	0.12
STUDY AREA	163	11	2.5	0.12
R^2 = 8.4%				

[1] approx. 95% confidence limits.

[2] coefficient of variation.

APPENDIX 3-E

Breakdown of *Ledum* annual production by 1980 LANDSAT Color (n = number of transects in stratum).

1980 Color	n	Mean (g/m^2)	2 S.E. [1]	S.E./$\bar{x}$ [2]
1 Black	7	7	5.6	0.41
4 Dark Grey	6	0	-	-
6 Brown	14	5	3.7	0.41
7 Peach	32	7	2.4	0.17
9 Sand	28	6	2.5	0.21
10 Orange	17	17	5.9	0.17
11 Red	13	26	11.4	0.22
12 Green	46	11	3.4	0.16
STRATIFIED MEAN				
HADLEY	163	10	1.6	0.08
STUDY AREA	163	10	1.7	0.08
R^2 = 26.5%				

[1] approx. 95% confidence limits.

[2] coefficient of variation.

APPENDIX 3-F

Breakdown of *Salix* annual production by 1980 LANDSAT Color (n = number of transects in stratum).

1980 Color	n	Mean (g/m^2)	2 S.E. [1]	S.E./$\bar{x}$ [2]
1 Black	7	0	-	-
4 Dark Grey	6	0	-	-
6 Brown	14	9	8.0	0.43
7 Peach	32	2	1.5	0.37
9 Sand	28	2	1.5	0.41
10 Orange	17	6	7.4	0.65
11 Red	13	2	2.6	0.69
12 Green	46	5	3.5	0.37
STRATIFIED MEAN				
HADLEY	163	4	1.7	0.20
STUDY AREA	163	4	1.7	0.21
$R^2 = 6.5\%$				

[1] approx. 95% confidence limits.

[2] coefficient of variation.

APPENDIX 3-G

Breakdown of *Vaccinium* annual production by 1980 LANDSAT Color (n = number of transects in stratum).

1980 Color	n	Mean (g/m^2)	2 S.E. [1]	S.E./$\bar{x}$ [2]
1 Black	7	7	6.4	0.46
4 Dark Grey	6	0	-	-
6 Brown	14	11	8.3	0.38
7 Peach	32	9	2.6	0.15
9 Sand	28	13	4.1	0.16
10 Orange	17	17	5.4	0.16
11 Red	13	13	6.6	0.26
12 Green	46	12	3.2	0.14
STRATIFIED MEAN				
HADLEY	163	11	1.8	0.08
STUDY AREA	163	11	1.8	0.08
R^2 = 9.8%				

[1] approx. 95% confidence limits.

[2] coefficient of variation.

APPENDIX 4-A

Breakdown of lichen standing crop by 1981 LANDSAT Color (n = number of transects in stratum).

1981 Color	n	Mean (g/m^2)	2 S.E. [1]	S.E./$\bar{x}$ [2]
1 Black	7	81	107	0.66
4 Dark Grey	4	239	149	0.31
5 Grey	2	485	105	0.11
6 Brown	12	75	53	0.35
7 Peach	17	282	108	0.19
8 Tan	6	110	124	0.56
9 Sand	14	300	146	0.24
10 Orange	18	91	69	0.38
11 Red	9	75	81	0.54
12 Green	47	106	41	0.19
13 Olive	27	339	110	0.16
STRATIFIED MEAN				
HADLEY	163	168	24	0.07
STUDY AREA	163	161	22	0.07
R^2 = 28.0%				

[1] approx. 95% confidence limits.

[2] coefficient of variation.

APPENDIX 4-B

Breakdown of total vascular production by 1981 LANDSAT Color (n = number of transects in stratum).

1981 Color	n	Mean (g/m^2)	2 S.E. [1]	S.E./$\bar{x}$ [2]
1 Black	7	43	31.3	0.36
4 Dark Grey	4	7	8.8	0.63
5 Grey	2	64	37.0	0.29
6 Brown	12	66	19.0	0.14
7 Peach	17	48	10.3	0.11
8 Tan	6	77	21.8	0.14
9 Sand	14	72	15.9	0.11
10 Orange	18	75	13.1	0.09
11 Red	9	93	22.8	0.12
12 Green	47	71	8.8	0.06
13 Olive	27	44	6.6	0.08
STRATIFIED MEAN				
HADLEY	163	63	4.8	0.04
STUDY AREA	163	64	4.6	0.04
R^2 = 27.9%				

[1] approx. 95% confidence limits.

[2] coefficient of variation.

APPENDIX 4-C

Breakdown of *Carex* annual production by 1981 LANDSAT Color (n = number of transects in stratum).

1981 Color	n	Mean (g/m^2)	2 S.E. [1]	S.E./$\bar{x}$ [2]
1 Black	7	15	13.9	0.47
4 Dark Grey	4	2	4.0	1.00
5 Grey	2	7	6.0	0.43
6 Brown	12	10	8.7	0.42
7 Peach	17	3	1.8	0.28
8 Tan	6	9	9.5	0.55
9 Sand	14	16	8.9	0.29
10 Orange	18	7	3.2	0.23
11 Red	9	10	5.3	0.27
12 Green	47	12	3.3	0.14
13 Olive	27	5	2.0	0.19
STRATIFIED MEAN				
HADLEY	163	9	1.9	0.10
STUDY AREA	163	9	1.8	0.09
R^2 = 12.7%				

[1] approx. 95% confidence limits.

[2] coefficient of variation.

APPENDIX 4-D

Breakdown of Eriophorum annual production by 1981 LANDSAT Color (n = number of transects in stratum).

1981 Color	n	Mean (g/m^2)	2 S.E. [1]	S.E./$\bar{x}$ [2]
1 Black	7	14	15.7	0.58
4 Dark Grey	4	0	-	-
5 Grey	2	0	-	-
6 Brown	12	9	11.2	0.62
7 Peach	17	14	4.9	0.18
8 Tan	6	0	0.7	1.00
9 Sand	14	3	4.5	0.73
10 Orange	18	16	8.1	0.26
11 Red	9	14	10.0	0.36
12 Green	47	12	5.3	0.22
13 Olive	27	6	3.9	0.33
STRATIFIED MEAN				
HADLEY	163	11	2.7	0.13
STUDY AREA	163	11	2.6	0.12
R^2 = 9.7%				

[1] approx. 95% confidence limits.

[2] coefficient of variation.

APPENDIX 4-E

Breakdown of Ledum annual production by 1981 LANDSAT Color (n = number of transects in stratum).

1981 Color	n	Mean (g/m^2)	2 S.E. [1]	S.E./$\bar{x}$ [2]
1 Black	7	4	5.3	0.71
4 Dark Grey	4	0	–	–
5 Grey	2	7	14.0	1.00
6 Brown	12	6	4.5	0.39
7 Peach	17	9	2.9	0.17
8 Tan	6	4	6.2	0.75
9 Sand	14	7	4.4	0.33
10 Orange	18	19	7.9	0.21
11 Red	9	25	10.7	0.22
12 Green	47	12	3.6	0.14
13 Olive	27	4	2.1	0.26
STRATIFIED MEAN				
HADLEY	163	10	1.6	0.08
STUDY AREA	163	10	1.6	0.08
R^2 = 25.6%				

[1] approx. 95% confidence limits.

[2] coefficient of variation.

APPENDIX 4-F

Breakdown of *Salix* annual production by 1981 LANDSAT Color (n = number of transects in stratum).

1981 Color	n	Mean (g/m^2)	2 S.E. [1]	S.E./$\bar{x}$ [2]
1 Black	7	0	-	-
4 Dark Grey	4	0	-	-
5 Grey	2	0	-	-
6 Brown	12	9	5.9	0.34
7 Peach	17	0	-	-
8 Tan	6	26	24.7	0.47
9 Sand	14	3	2.8	0.43
10 Orange	18	1	1.0	0.90
11 Red	9	4	3.5	0.42
12 Green	47	4	2.8	0.40
13 Olive	27	2	1.6	0.34
STRATIFIED MEAN				
HADLEY	163	4	1.6	0.19
STUDY AREA	163	4	1.4	0.18
R^2 = 26.3%				

1 approx. 95% confidence limits.

2 coefficient of variation.

APPENDIX 4-G

Breakdown of *Vaccinium* annual production by 1981 LANDSAT Color (n = number of transects in stratum).

1981 Color	n	Mean (g/m^2)	2 S.E. [1]	S.E./$\bar{x}$ [2]
1 Black	7	4	5.6	0.63
4 Dark Grey	4	0	–	–
5 Grey	2	24	15.0	0.32
6 Brown	12	10	8.8	0.46
7 Peach	17	12	3.2	0.13
8 Tan	6	14	13.4	0.47
9 Sand	14	18	7.3	0.20
10 Orange	18	13	4.5	0.17
11 Red	9	15	9.8	0.32
12 Green	47	12	3.0	0.12
13 Olive	27	6	2.6	0.21
STRATIFIED MEAN				
HADLEY	163	12	1.9	0.08
STUDY AREA	163	11	1.8	0.08
R^2 = 14.3%				

[1] approx. 95% confidence limits.

[2] coefficient of variation.

FORAGE UTILIZATION INVENTORY - BUCKLAND RIVER - 1980-81

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During the summers of 1980 and 1981, we attempted to quantify the relative severity of forage utilization by caribou in the Buckland River Valley. This was conducted in conjuction with the range inventory in the area.

METHODS

A site utilization index (SUI) was determined for each of 248 locations within the study area during the two summers. The SUI was based on a 100 point 3-step transect. Presence or absence of use within a $0.1m^2$ plot at the toe of the observers boot was recorded at each of the 100 points. Use was defined as clipped branches on shrubs, grazed potions of grasses and grass-like plants, and cratered or disturbed lichen. The SUI for that location was the number of plots in which use was observed.

In 1980, general descriptions of the vegetative type and utilization were recorded at each site. This included a description of the intensity of cratering, the disturbance to the lichen material, and the distribution of use. After the field season, the SUI and general description of use were compared in order to group SUI's into general classes of grazing intensity. The classes arrived at are:

Class 1 (SUI = 0): No utilization evident.

Class 2 (SUI = 1-10): Light utilization.

Class 3 (SUI = 11-25): Moderate utilization.

Class 4 (SUI = 26-45): Heavy utilization.

Class 5 (SUI = 46-100): Severe utilization.

RESULTS AND DISCUSSION

Results of the 248 transects are summarized in Table 1 by vegetation type and utilization class. Classes 1, 2, 3, 4, and 5 accounted for 8, 40, 38, 8, and 7% of the 248 transects, respectively.

Results for major types, those in which 10 or more transects were observed, are depicted in Figure 1. Lichen dominated types (110, 210, 330) were more heavily grazed than were types dominated by other forage classes. Upland and alpine tundra also tended to show more use then did the lower elevation tussock tundras.

Figures 2 through 6 show the distribution of transects within each utilization class over the study area. It is of interest to note that class 4 grazing intensity occurred on ridgetops in the Selawik Hills and Talik Ridge on the benches above the major drainages north of the Buckland River which tend to be relatively snow free during winter. Class 5 grazing intensity occurred only on ridgetops in the Selawik Hills and Talik Ridge. These key areas are the most likely to show the signs of overgrazing and may be worthy of closer attention.

Table 1. Summary of Utilization Transects by Site Utilization Index Class and Vegetative Type

SUI CLASS

Vegetation Types	1	2	3	4	5	T
110	2	25	32	7	1	67
120	1	17	6	0	0	24
130	6	25	13	4	1	49
140	1	3	5	0	0	9
200	0	2	0	0	0	2
210	0	9	12	1	8	30
220	1	4	5	2	3	15
230	1	1	2	0	0	4
240	1	0	1	0	0	2
250	1	0	3	1	0	5
300	0	0	0	0	1	1
320	0	1	3	1	0	5
330	0	5	7	1	3	16
340	1	2	0	2	0	5
410	3	0	0	0	0	3
510	0	0	0	1	0	1
520	1	0	0	0	0	1
610	0	3	4	1	0	8
700	0	1	0	0	0	1
Totals	19	98	93	21	17	248
% of total	8	40	38	8	7	100

See Vegetation Type Codes, Buckland River Range Inventory (Appendix 1-D)

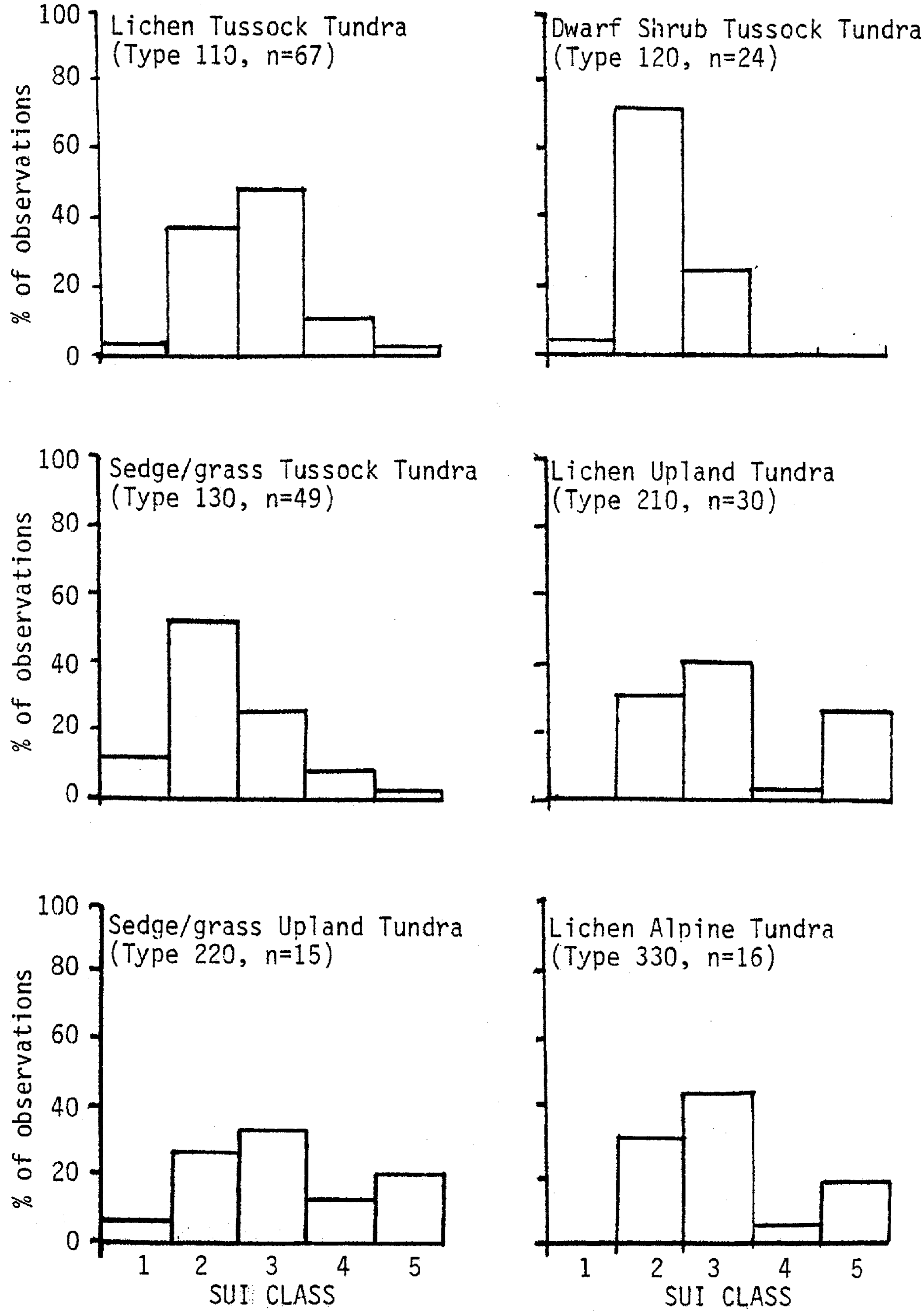

Figure 1. Distribution of Site Utilization Indices on 6 major vegetation types of the Buckland River Study Area.

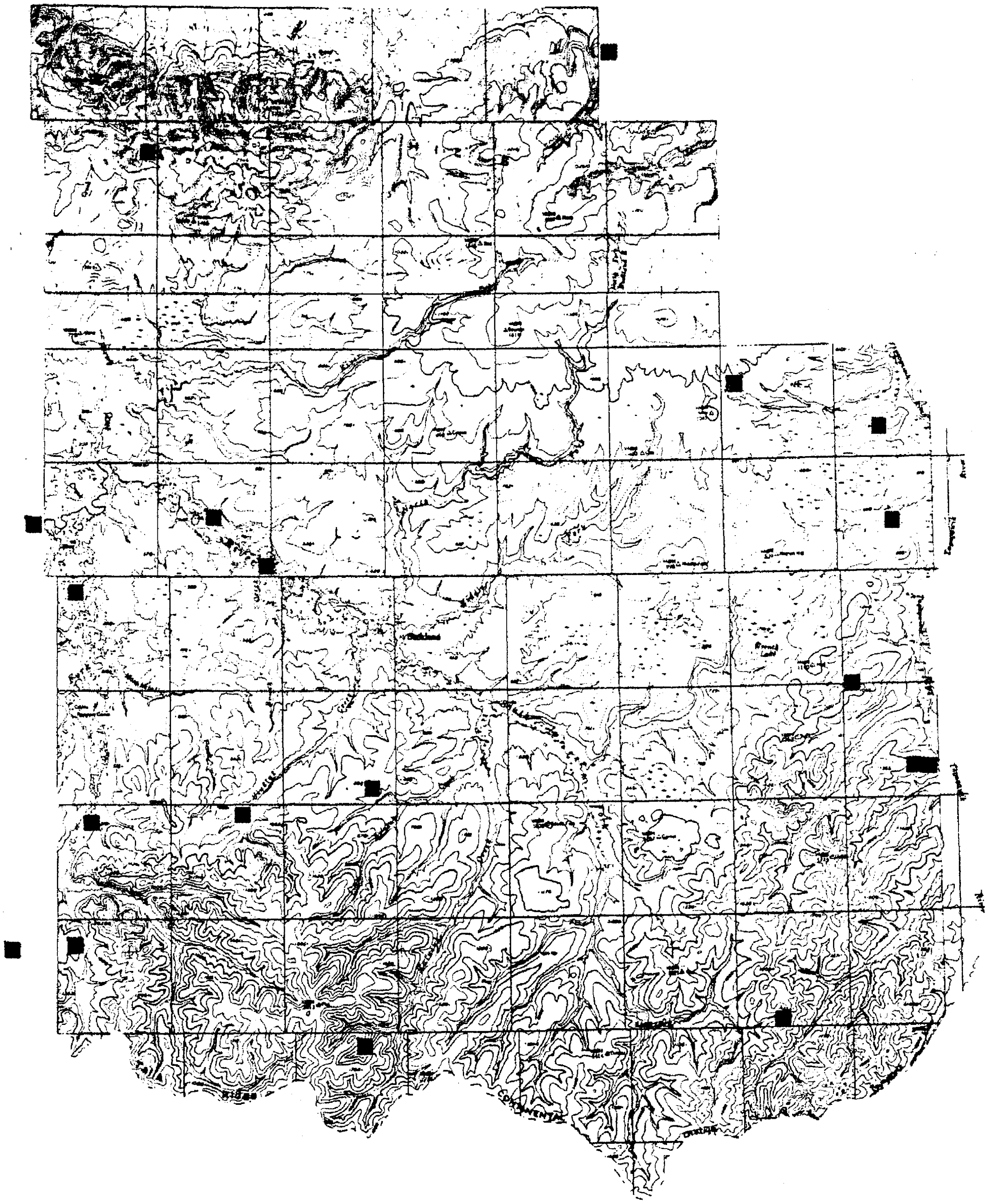

Figure 2. Sites with a Site Utilization Index of 0, Buckland River Study Area.

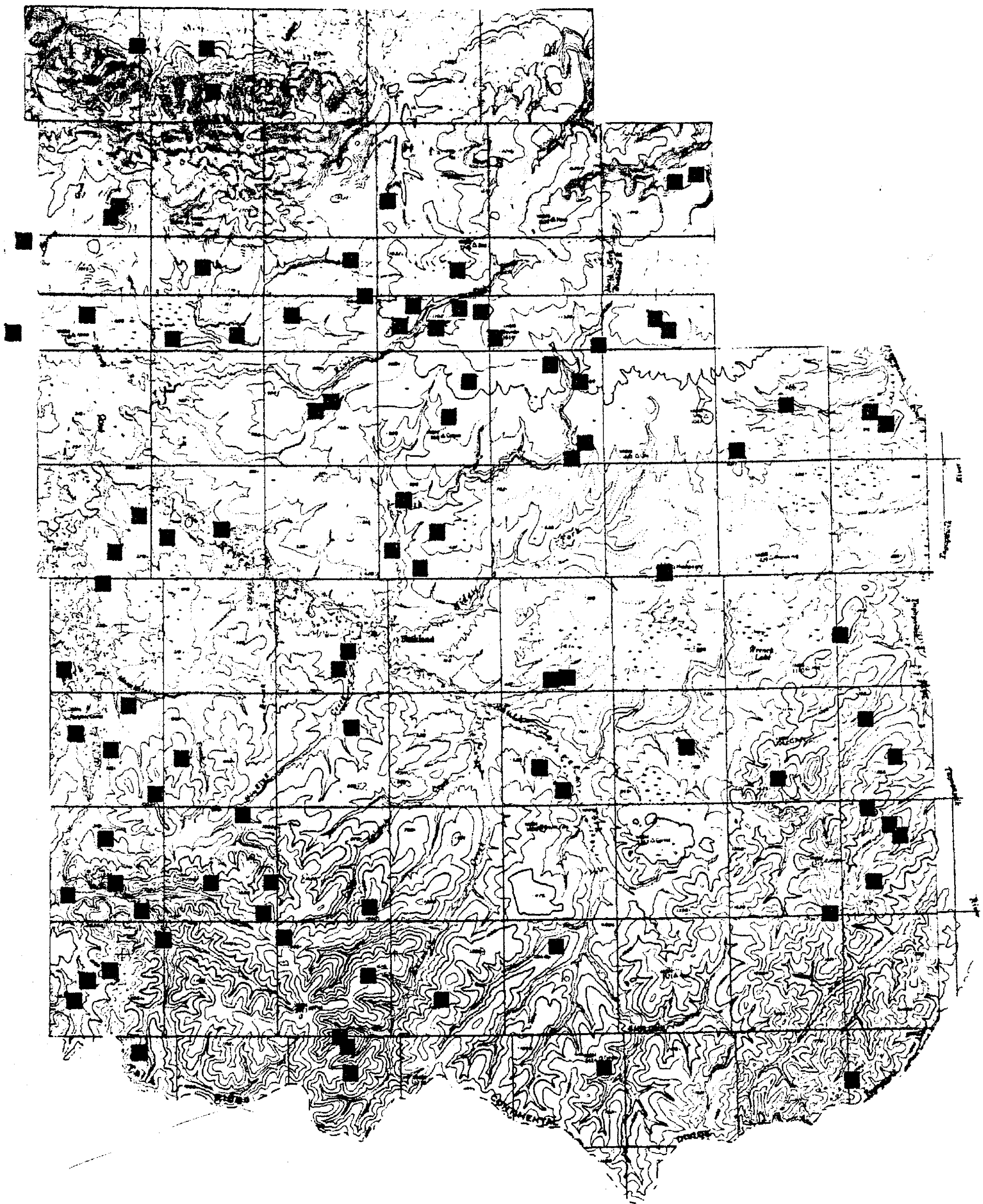

Figure 3. Sites with a Site Utilization Index of 1-10, Buckland River Study Area.

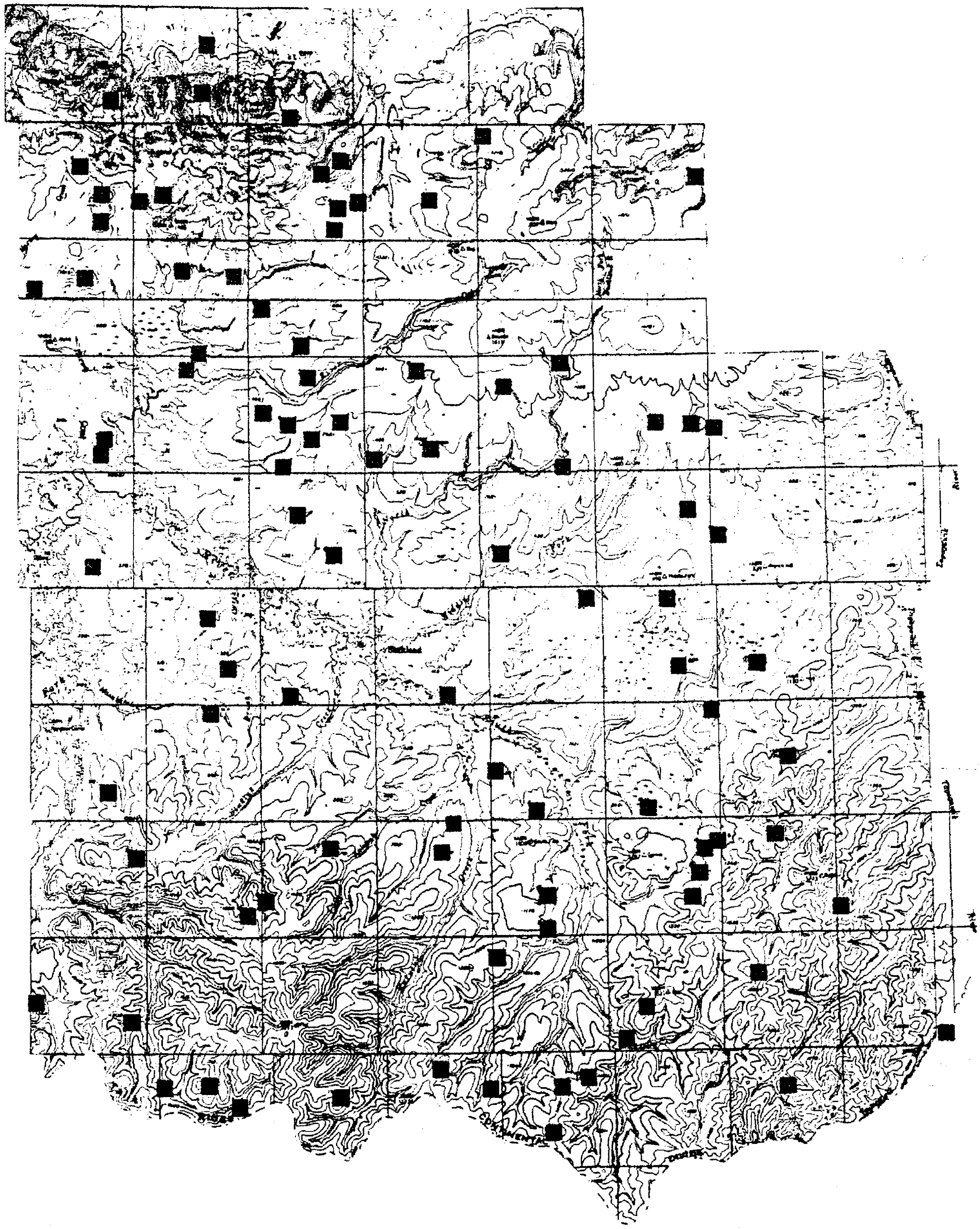

Figure 4. Sites with Site Utilization Index of 11-25, Buckland River Study Area.

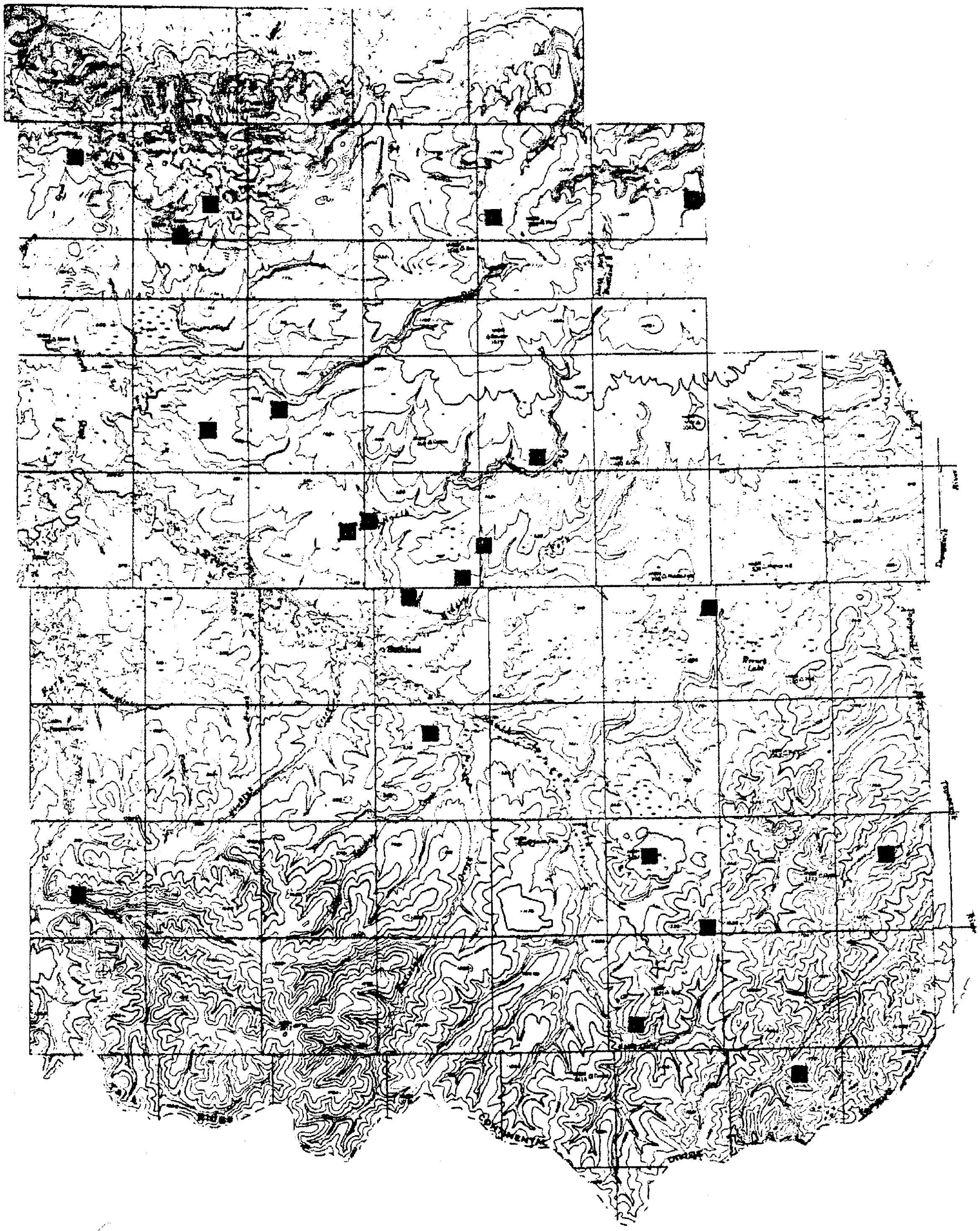

Figure 5. Sites with a Site Utilization Index of 26-45, Buckland River Study Area.

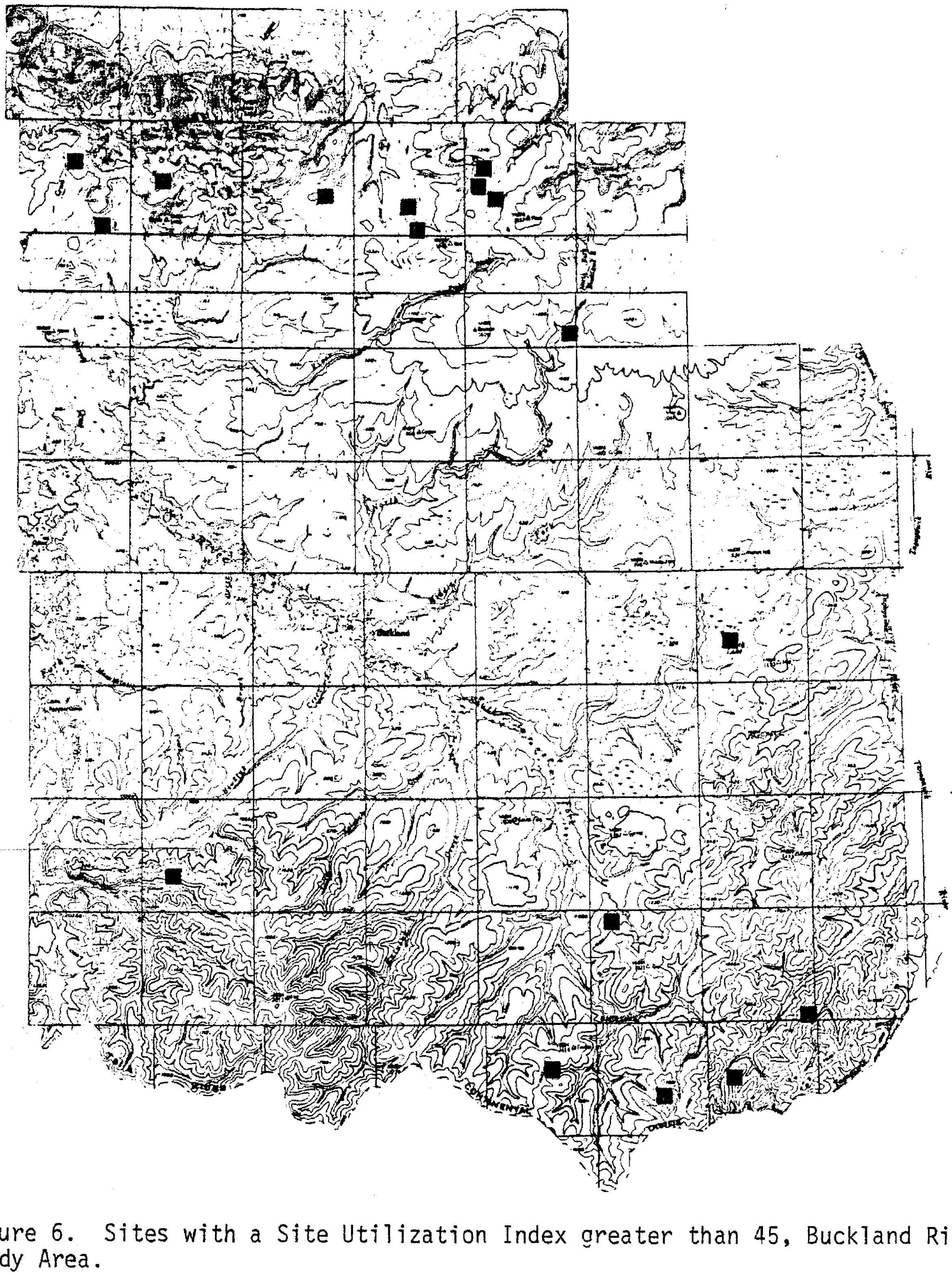

Figure 6. Sites with a Site Utilization Index greater than 45, Buckland River Study Area.

This technique appears to be well adapted to lichen dominated ranges. In these areas, cratered or disturbed lichen is apparent and easy to quantify. On grass or shrub dominated tundra use of those forage classes is not as apparent and therefore, use is more difficult to quantify. A suggested improvement would be to only count points that occurred in lichen and continue the transects until 100 points have been recorded. This would quantify grazing intensity on lichens only and, since lichens are likely the forage class that is most sensitive to overgrazing, this data would probably be more useful than that which we collected. This would also allow for meaningful comparisons between vegetation types.

CARIBOU FOOD HABITS AND FORAGE PREFERENCES - BUCKLAND RIVER VALLEY - Winter 1981

LAYNE G. ADAMS, Wildlife Biologist, Northwest Resource Area, Fairbanks District Office, Bureau of Land Management

During winter 1981, 75 caribou fecal samples were collected on 3 sites between the Buckland River and the Selawik Hills. An additional 20 winter fecal samples were collected on an alpine site within the Selawik Hills in July 1981. Twenty-five samples were also collected from wintering reindeer in the Kiwalik River Valley on 19 February 1981.

Samples were analyzed by the Composition Anaylsis Laboratory, Department of Range Science, Colorado State University using the method developed by Sparks and Malechek (1968). Twenty microscope fields per pellet group were observed to determine percent relative density of discerned fragments in the feces by genera. Several lichen genera were conglomerated because fragments cannot be differentiated and are reported as Cetraria type lichens. These genera included Cetraria, Alectoria and Dactylina.

During summer 1982, composition of forage on areas where fecal samples were collected was determined. Three canopy coverage transects as described by Daubenmire (1959) were measured. Transects consisted of 15 20 x 50 cm quadrats at 3 m intervals along a 50 m tape. On Buckland River Sites 1, 2, and 3 and the Kiwalik River Site (Figs. 1 and 2) transects were placed perpendicular to the obvious drainage pattern with one transect beginning 50 m up slope from the end of the previous transect and all running parallel to each other. This staggered pattern was used to maximize collection of information that would show the variation within the site. On Buckland Site 4, transects were placed down vegetated stringers within the boulder field to minimize the amount of rock recorded.

Preference indices (PI) were determined using the method described by Van Dyne and Heady (1965) which is calculated as follows for species i:

$$PI = \frac{\%\text{ of diet composed of species i}}{\%\text{ of total forage composed of species i}}$$

With this method, PI ranges, from 0 to infinity. Values that are less than 1 indicate that species are being used to a lesser extent than their relative availability and are not preferred. Values greater than 1 indicate a preference.

Preferences indices were determined for major forage categories (Grasses and grasslike species, Forbs, Shrubs, Lichen, Moss) and selected genera that were the most common in the diet information. These genera were *Eriophorum*, *Carex*, *Vaccinium*, *Ledum*, *Salix*, *Cetraria* type lichens, and *Cladonia*. Preference indices were computed by site as well as using the composite of diet and mean forage composition for Buckland Sites 1, 2 and 3. Diet information collected at Buckland Site 4 was not representative of species available at that site. The animals inhabiting that site had obviously fed downslope on areas of tussock tundra. Because of these factors, preference indices were not determined for the site and it was not used in calculations of overall caribou preference indices for the Buckland Valley.

Summaries of all information collected are included in the attached tables. As expected both caribou and reindeer showed preference for lichens, particularly those of the *Cladonia* genus. Reindeer showed a much stronger preference for shrubs, particularly *Vaccinium*, than caribou. Both caribou and reindeer avoided *Betula* although it was abundant. Caribou preferred *Salix*, but this may be an artifact of sampling. Willows are available in many brushy water courses close to where fecal samples were collected; therefore, abundance of this taxon was underestimated. It is difficult to determine preference for highly mobile grazers such as caribou and, therefore, the composite preference indices are probably a better representation of caribou diet selection.

Genera that accounted for more than 1% of the diet caribou included sedges (*Eriophorum*, *Carex*), shrubs (*Vaccinium*, *Ledum*, *Salix*), lichen (*Cladonia*, *Cetraria* type lichen, *Stereocaulon*), and moss (*Selaginella*).

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Sparks, D.R. and J.C. Malechek, 1968. Estimating percentage dry weight in diets using microscopic technique. J. Range Manage. 21(4): 264-265.

Van Dyne, G.M. and H.F. Heady 1965. Botanial composition of sheep and cattle diets on a mature annual range. Hilgardia 36: 465-492.

MEAN CARIBOU FOOD HABITS AND FORAGE PREFERENCES
Sites 1, 2, 3, in Buckland Valley - Winter

Taxon	Food Habits: Mean Frequency (%)	Food Habits: Mean Composition (%)	Mean Available Forage (%)	Composite Preference Index
Grasses and Grasslikes	93	14.4 ± 5.4[1]	14.9	1.0
Eriophorum	81	10.5	7.2	1.5
Carex	55	3.2	6.7	0.5
Poa	13	0.6		
Festuca	3	0.1		
Luzula	1	0.1		
Equisetum	1	0		
Forbs	13	0.7 ± 1.3[1]	6.5	0.1
Hedysarum	7	0.3		
Stellaria	5	0.5		
Shrubs	97	15.9 ± 6.1[1]	30.0	0.5
Vaccinium	87	10.2	17.2	0.6
Ledum	57	3.3	6.1	0.5
Salix	39	2.1	0.8	2.6
Dryas	5	0.2		
Lichen	100	63.0 ± 9.7[1]	27.7	2.3
Cladonia	100	37.8	16.2	2.3
Cetraria (type)	100	16.8	13.3	1.3
Stereocaulon	72	5.3		
Peltigera	15	0.6		
Thamnolia	3	0.1		
Moss	77	5.9 ± 3.6[1]	20.7	0.3
Selaginella	69	4.6		
Unknown Moss	17	0.7		
Sphagnum	16	0.7		

1 ± 2 standard errors (approximately 95% confidence limits).

CARIBOU FOOD HABITS AND FORAGE PREFERENCES
Buckland River Valley Site 1 - 27 March 1981 (n=25)

Taxon	Food Habits Frequency (%)	Food Habits Mean (%)	Available Forage (%)	Preference Index
Grasses and Grasslikes	92	15.7 ± 3.7[1]	18.1	0.9
Eriophorum	84	11.7	0.3	39.0
Carex	64	3.1	15.8	0.2
Poa	12	0.6		
Festuca	4	0.2		
Luzula	4	0.2		
Forbs	20	1.3 ± 1.3[1]	1.8	0.7
Stellaria	12	1.0		
Hedysarum	8	0.3		
Shrubs	100	18.9 ± 5.2[1]	44.5	0.4
Vaccinium	88	12.0	18.2	0.7
Ledum	56	4.0	5.4	0.7
Salix	44	2.6	2.5	1.0
Dryas	8	0.3		
Lichen	100	56.7 ± 7.5[1]	9.6	5.9
Cladonia	100	35.7	1.9	18.8
Cetraria (type)	100	15.4	7.3	2.1
Stereocaulon	68	4.8		
Peltigera	12	0.3		
Thamnolia	4	0.1		
Moss	76	7.4 ± 3.8[1]	26.0	0.3
Selaginella	68	5.6		
Unknown moss	20	1.0		
Sphagnum	16	0.8		

1 ± 2 standard errors (approximately 95% confidence limits).

CARIBOU FOOD HABITS AND FORAGE PREFERENCES
Buckland River Valley - Site 2-27 March 1981 (n=25)

Taxon	Food Habits Frequency (%)	Food Habits Mean (%)	Available Forage (%)	Preference Index
Grasses and Grasslikes	92	14.3 ± 4.1[1]	16.3	0.9
Eriophorum	80	11.9	12.9	0.9
Carex	40	1.9	2.7	0.7
Festuca	4	0.2		
Poa	4	0.2		
Equisetum	4	0.1		
Forbs	12	0.6 ± 0.7[1]	6.4	0.1
Hedysarum	8	0.3		
Stellaria	4	0.3		
Shrubs	96	14.5 ± 3.9[1]	27.8	0.5
Vaccinium	84	8.9	23.0	0.4
Salix	52	3.0		
Ledum	44	2.1	7.5	0.3
Dryas	4	0.1		
Lichen	100	66.4 ± 6.9[1]	22.7	2.9
Cladonia	100	46.5	18.4	2.5
Cetraria (type)	96	14.3	12.2	1.2
Stereocaulon	64	4.3		
Peltigera	24	1.1		
Thamnolia	4	0.2		
Moss	68	4.2 ± 1.4[1]	26.0	0.2
Selaginella	60	3.1		
Unknown mosses	24	0.8		
Sphagnum	12	0.5		

1 ± 2 standard errors (approximately 95% confidence limits).

CARIBOU FOOD HABITS AND FORAGE PREFERENCES
Buckland River Valley Site 3-27 March 1981 (n=25)

Taxon	Food Habits Frequency (%)	Food Habits Mean (%)	Available Forage (%)	Preference Index
Grasses and Grasslikes	96	13.3 ± 3.6[1]	10.4	1.3
Eriophorum	80	8.0	8.3	1.0
Carex	60	4.5	1.6	2.8
Poa	24	0.9		
Forbs	8	0.3 ± 0.4[1]	11.2	0
Hedysarum	4	0.2		
Stellaria	4	0.1		
Shrubs	96	14.4 ± 3.7[1]	17.7	0.8
Vaccinium	88	9.7	10.4	0.9
Ledum	72	3.8	5.4	0.7
Salix	20	0.7		
Dryas	4	0.2		
Lichen	100	65.9 ± 6.1[1]	50.7	1.3
Cladonia	100	38.2	28.4	1.3
Cetraria (type)	100	20.6	20.4	1.0
Stereocaulon	84	6.8		
Peltigera	8	0.3		
Moss	88	6.0 ± 1.7[1]	10.1	0.6
Selaginella	80	5.1		
Sphagnum	20	0.7		
Unknown moss	8	0.3		

1 ± 2 standard errors (approximately 95% confidence limits).

CARIBOU FOOD HABITS AND FORAGE PREFERENCES
Buckland River Valley Site 4 - Winter samples collected
7 July 1981 (n=20)

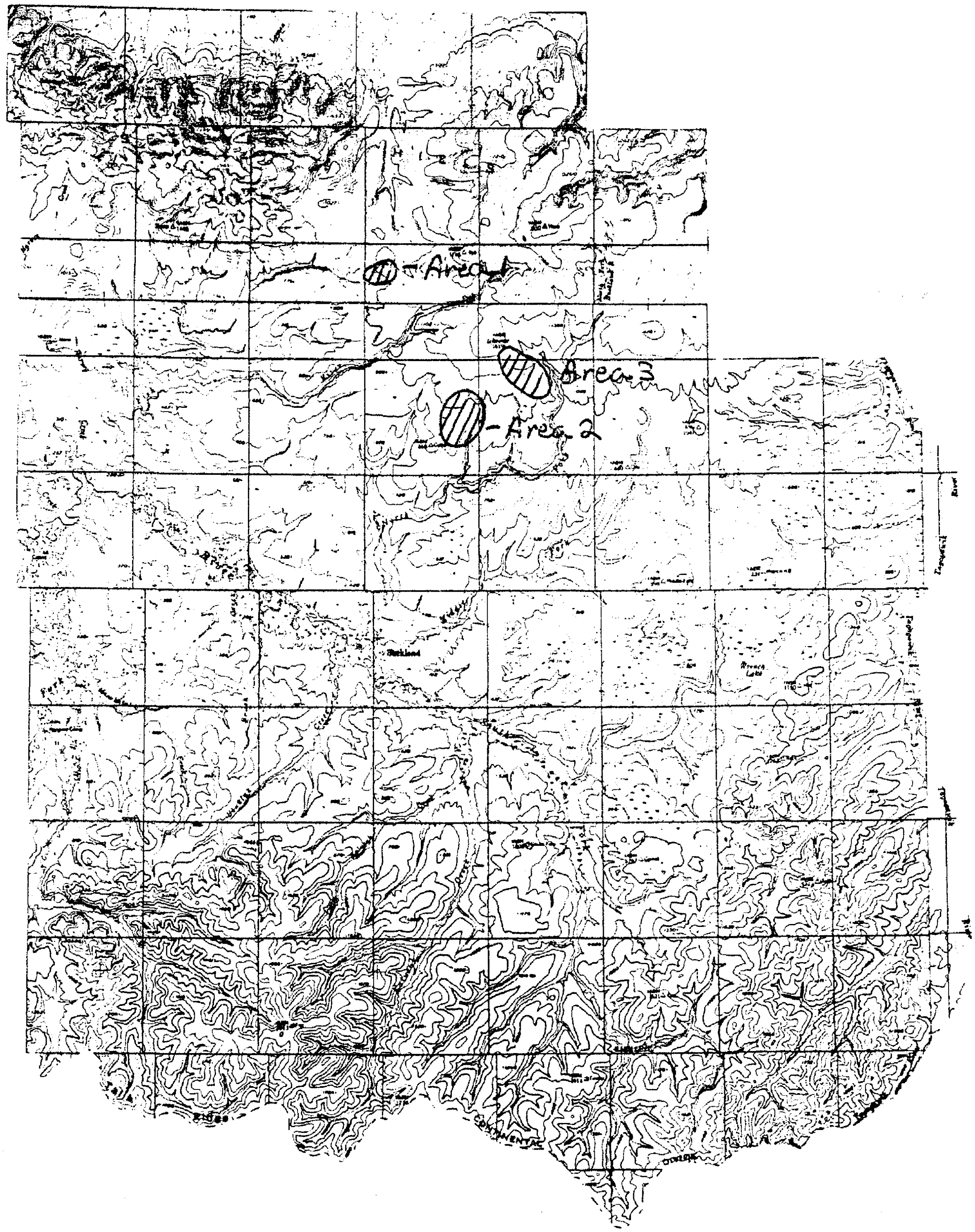
Taxon	Food Habits Frequency (%)	Food Habits Mean (%)	Available Forage (%)	Preference Index
Grasses and Grasslikes	95	19.5 ± 8.3[1]	Not Calculated (Area pellets were collected in was a dry boulder field. Diet information indicates animal had grazed in a Tussock Tundra area).	
Eriophorum	45	8.6		
Carex	70	5.8		
Poa	80	4.6		
Luzula	10	0.4		
Unknown grass	5	0.1		
Forbs				
Shrubs	100	16.1 ± 3.6[1]		
Vaccinium	80	7.6		
Salix	85	6.3		
Ledum	45	2.2		
Empetrum	5	0.1		
Lichen	100	53.7 ± 8.5[1]		
Cladonia	100	37.1		
Cetraria (type)	90	9.7		
Stereocaulon	75	5.5		
Thamnolia	10	1.2		
Peltigera	5	0.1		
Moss	95	10.7 ± 2.8[1]		
Selaginella	90	7.3		
Unknown moss	40	2.9		
Sphagnum	20	0.6		

1 ± 2 standard errors (approximately 95% confidence limits).

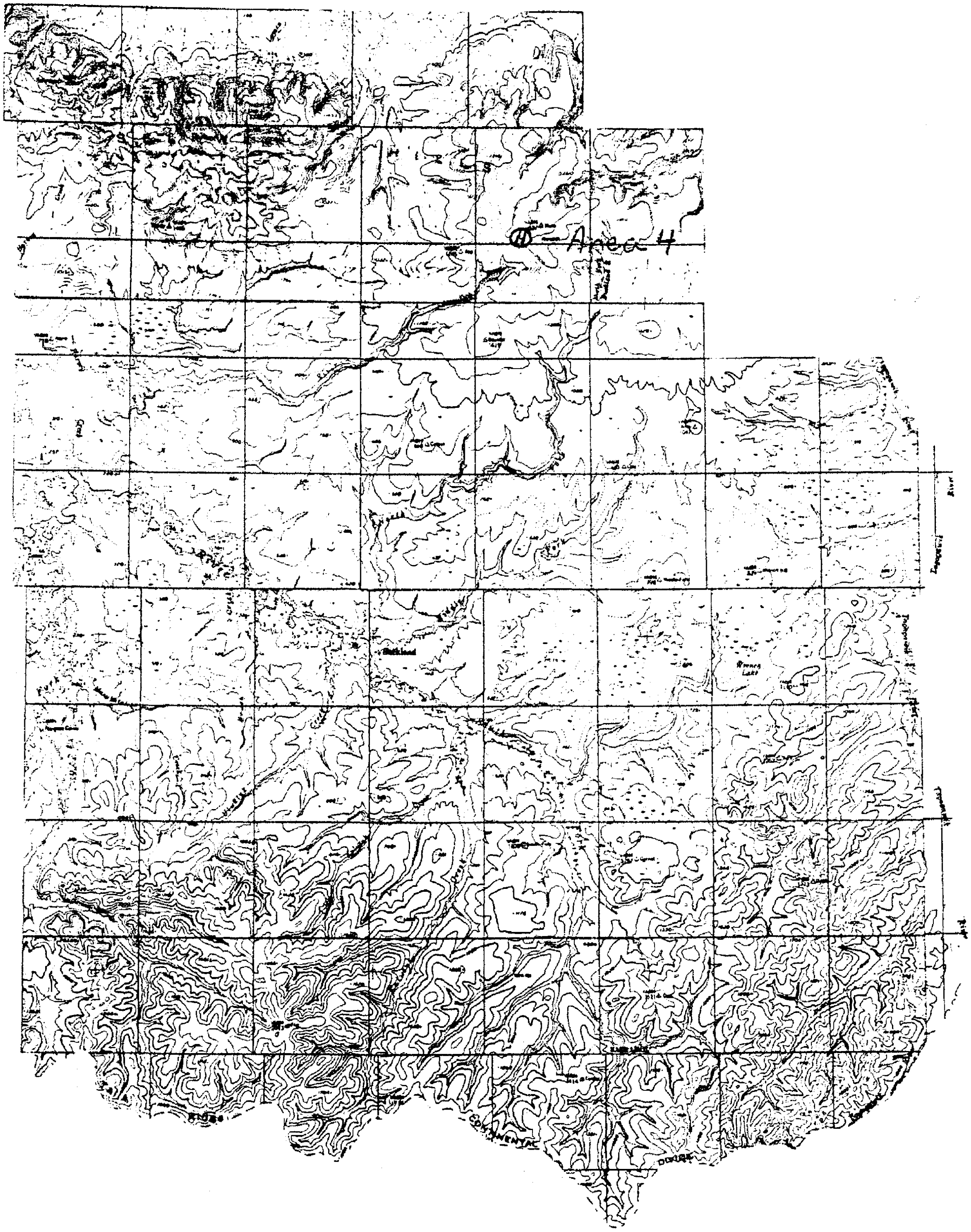
REINDEER FOOD HABITS AND FORAGE PREFERENCES
Kiwalik River - 19 February 1981 (n=24)

Taxon	Food Habits Frequency (%)	Food Habits Mean (%)	Available Forage (%)	Preference Index
Grasses and Grasslikes	67	4.5 ± 2.0[1]	12.3	0.4
Eriophorum	54	2.7	9.9	0.3
Carex	33	1.6	1.9	0.8
Unknown grass	4	0.2		
Forbs			13.8	0
Shrubs	100	45.9 ± 10.5[1]	29.0	1.6
Vaccinium	100	39.7	7.8	5.1
Ledum	83	7.2	16.5	0.4
Salix	8	0.2		
Lichen	96	42.1 ± 9.7[1]	5.0	8.4
Cladonia	92	35.4	2.3	15.4
Stereocaulon	42	2.1		
Catraria (type)	33	1.3	2.6	0.5
Peltigera	8	0.3		
Moss	100	7.3 ± 1.8[1]	40.7	0.2
Sphagnum	58	3.0		
Selaginella	67	2.8		
Unknown moss	42	1.6		

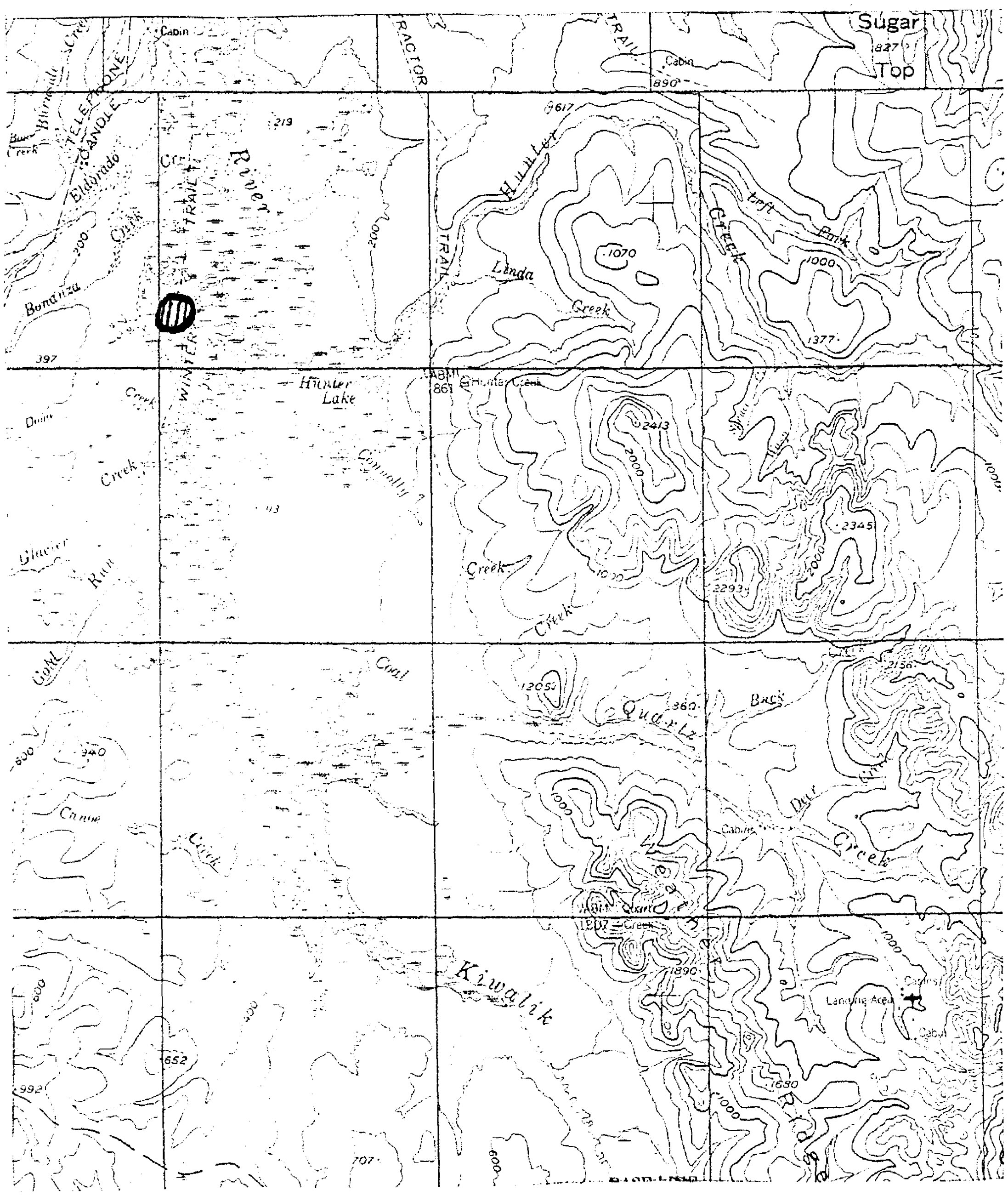
1 ± 2 standard errors (approximately 95% confidence limits).



Locations of caribou fecal collection sites 27 March 1981, Buckland River Valley, Alaska.



Location of winter caribou fecal collection, 7 July 1981. Buckland Valley, Alaska.



Location of reindeer fecal collection, 19 February 1981, Kiwalik River, Alaska.

BUCKLAND RIVER CARIBOU SURVEYS 1978-1982

LAYNE G. ADAMS, Wildlife Biologist, Northwest Resource Area, Fairbanks District Office, Bureau of Land Management

Surveys were carried out in the Buckland River Valley through the winter of 1977-78 and winters from 1979 to 1982 to document use of area by the Western Arctic Caribou Herd as part of the analysis of the reindeer/caribou conflict on the Hadley Reindeer Allotment. Survey results are summarized in Table 1 and on maps that are appended.

The Buckland River Valley was used consistently during the years surveyed. Caribou arrive in the area as early as mid-September (Unpubl. ADF&G data) and usually leave by the end of April. Minimum estimates of animals observed ranged from 5,000 to 20,000 during the 4 winters in which surveys were conducted. Actual numbers may be much higher since many surveys did not cover the entire area or were conducted during poor weather conditions. ADF&G estimates have been as high as 40,000 in 1980 (Jim Davis, ADF&G personal communication) when our surveys showed a minimum of 20,000 caribou.

All portions of the study area were used by caribou during at least one of the winters as indicated on attached maps. Locations of major concentrations of caribou changed erratically throughout the entire winter.

The Buckland River Valley and Selawik Hills have been consistently used by the Western Arctic Caribou Herd for the past 30 years (Appendix 2), even during the population crash that occured during the mid-1970's. Davis et al. (1982) stated that the Buckland River drainage was one of the three most heavily used winter ranges of the Western Arctic Herd. Maintaining this area for caribou winter use is of primary importance to the well-being of the Western Arctic Herd.

During winter 1981-82, caribou were reported as far west as Imuruk Lake on the Seward Peninsula (Carl Grauvogel, ADF&G personal communication). Because of this, two surveys were flown in the Kiwalik River drainage where NANA wintered their reindeer herd. These surveys were flown on 17 November and 4 December 1981. A minimum estimate of 1,400 caribou was determined during the November survey (Table 1, Appendix 1). ADF&G also reported 1,600 caribou west of the Kiwalik River on Mina Creek (Carl Grauvogel, ADF&G personal communication). This expansion to the west of winter ranges used by the Western Arctic Herd has created problems for the NANA reindeer operation. Estimated losses of reindeer to caribou herd ranged from 1,500 to 4,000 (Walter Sampson, NANA, personal communication).

LITERATURE CITED

Davis J. L., P. Valkenburg, and R. Boertje, 1982. Home range use, social structure, and habitat selection of the Western Arctic Caribou Herd. Final Rep. U.S. National Park Service Contract No. CX 9100-8-0032. 36 pp. and appendices.

TABLE 1.

Summary of caribou observations during surveys on the Buckland River and vicinity, Winter 1978 - 1982.

Survey Dates	Buckland River Study Area	North or West of Study Area
1977 - 1978		
4 January	4,800	
1979 - 1980		
6 December	1,100	
31 January, 1 and 2 February	10,200	1,000
16 February	5,200	700
29 February	2,600	1,000
1980 - 1981		
17 December	500	300
20 January	17,200	
4 February	19,500	
17 and 18 February	11,400	1,600
25 March	5,200	
16 and 17 April	8,900	
1981 - 1982		
29 October	1,800	800
16 November	1,600	1,300
17 November (West Fork and Kiwalik)		2,000
3 and 4 December	1,700	400
4 December (West Fork and Kiwalik)		650
11 February	400	
24 and 25 February	8,100	300
15 and 16 March	7,400	4,000
28 April	70	

APPENDIX 1

BUCKLAND RIVER CARIBOU SURVEYS-1978-1982

Legend

Area Surveyed.

Study Area Boundaries (on supplemental maps).

Caribou Groups

≤25

26-50

51-100

101-500

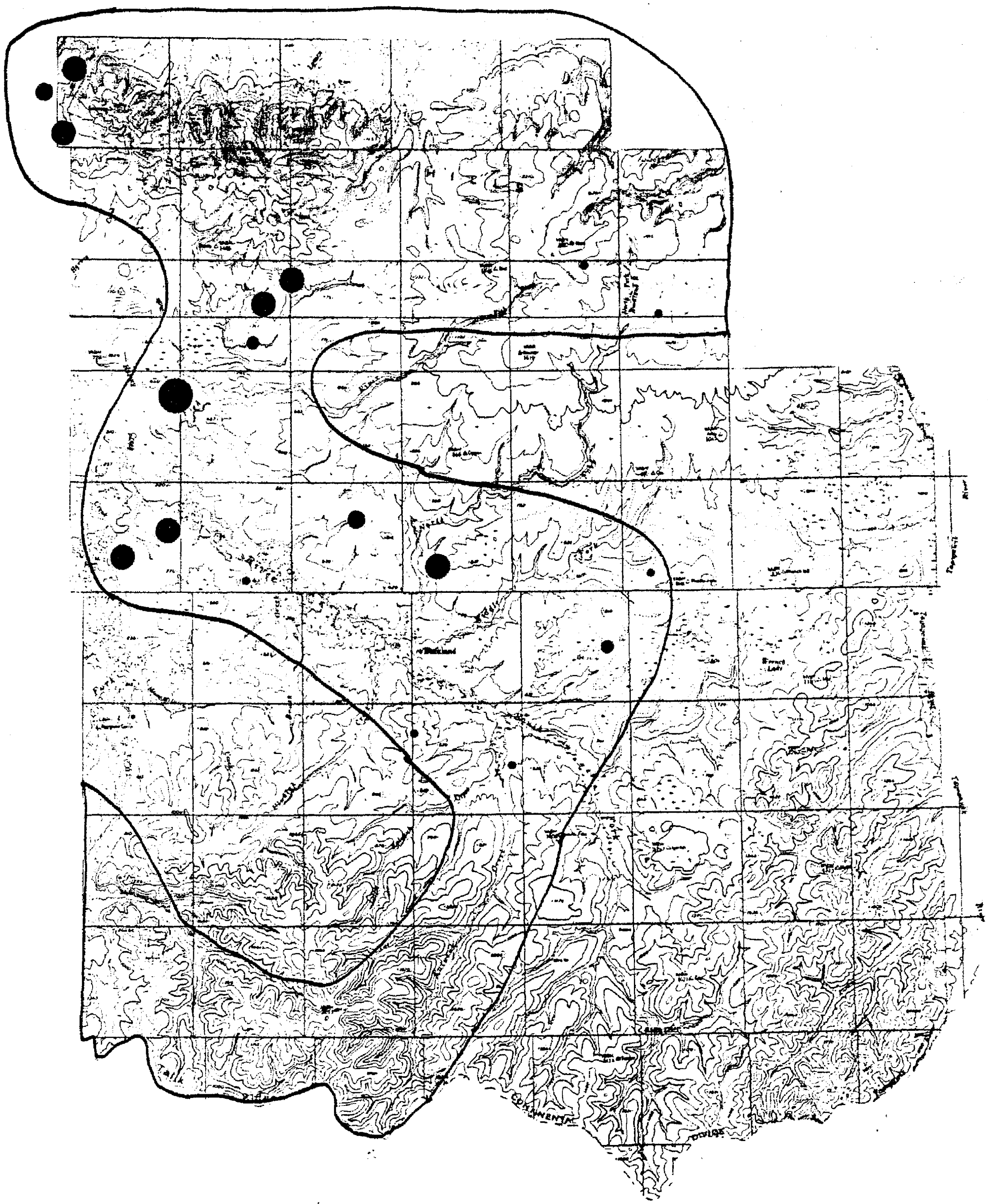
501-1000

1001-5000

5001-10000

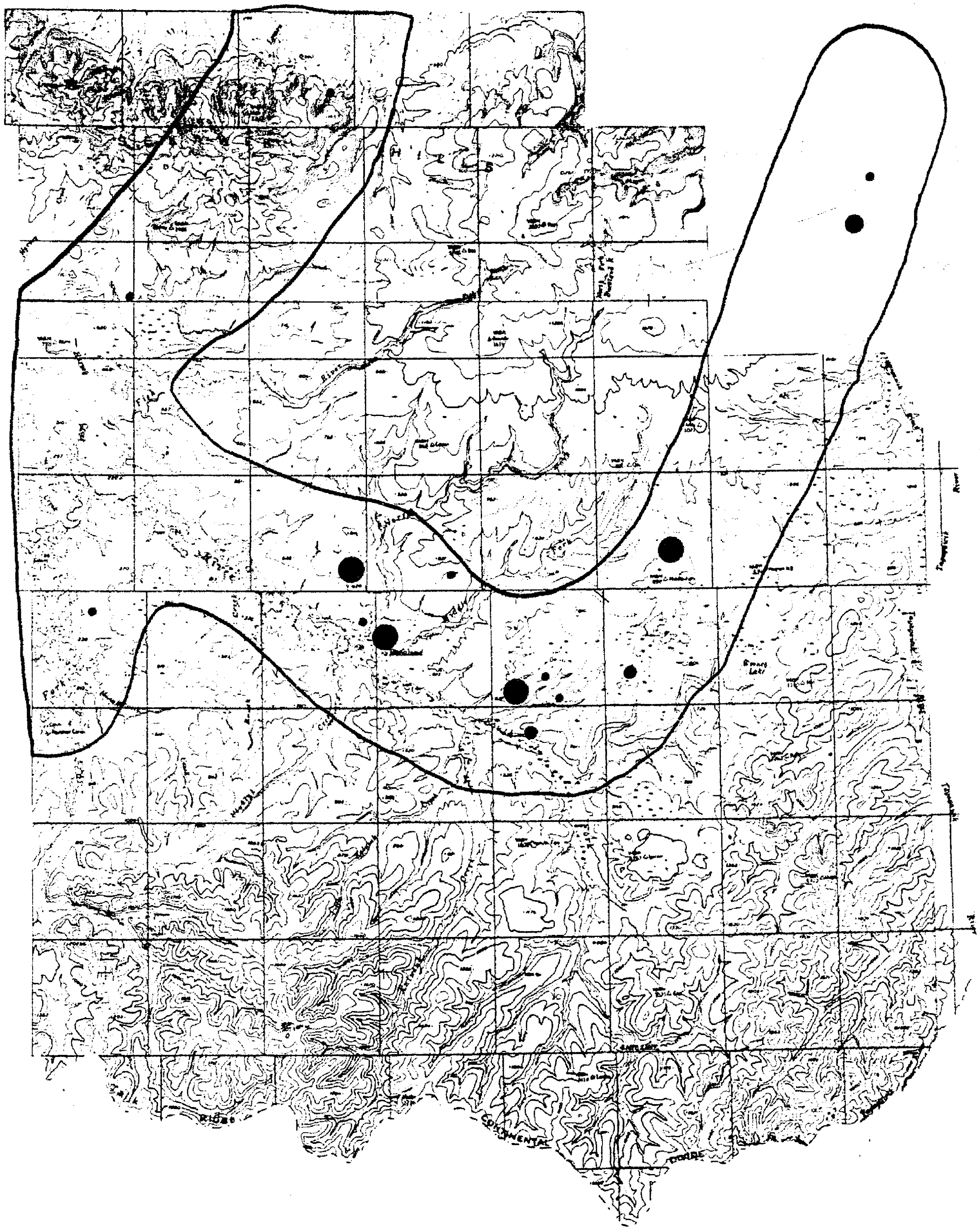
>10000

WINTER 1977-1978

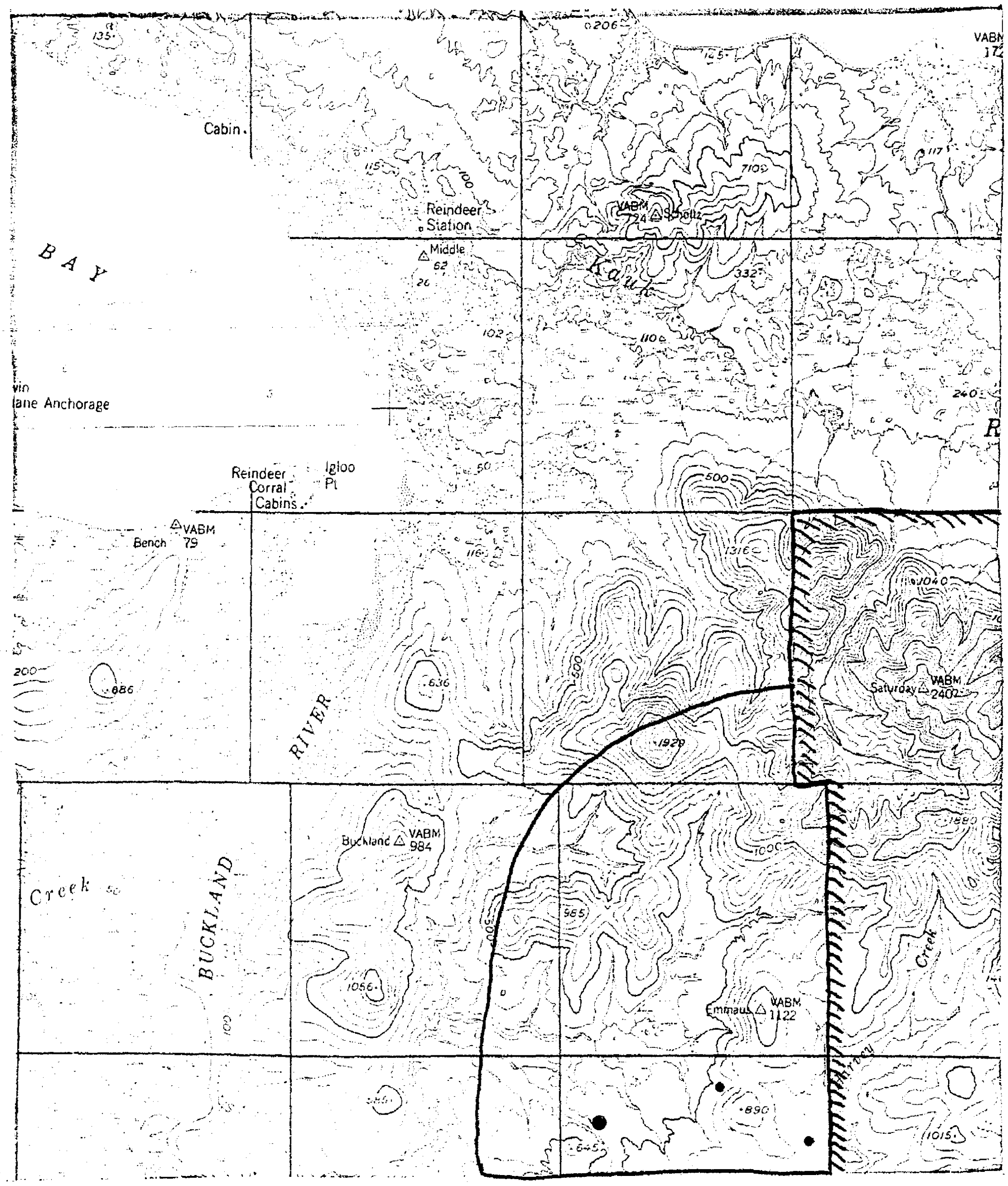


Buckland Valley Caribou Survey- 4 January 1978-4800 caribou observed.

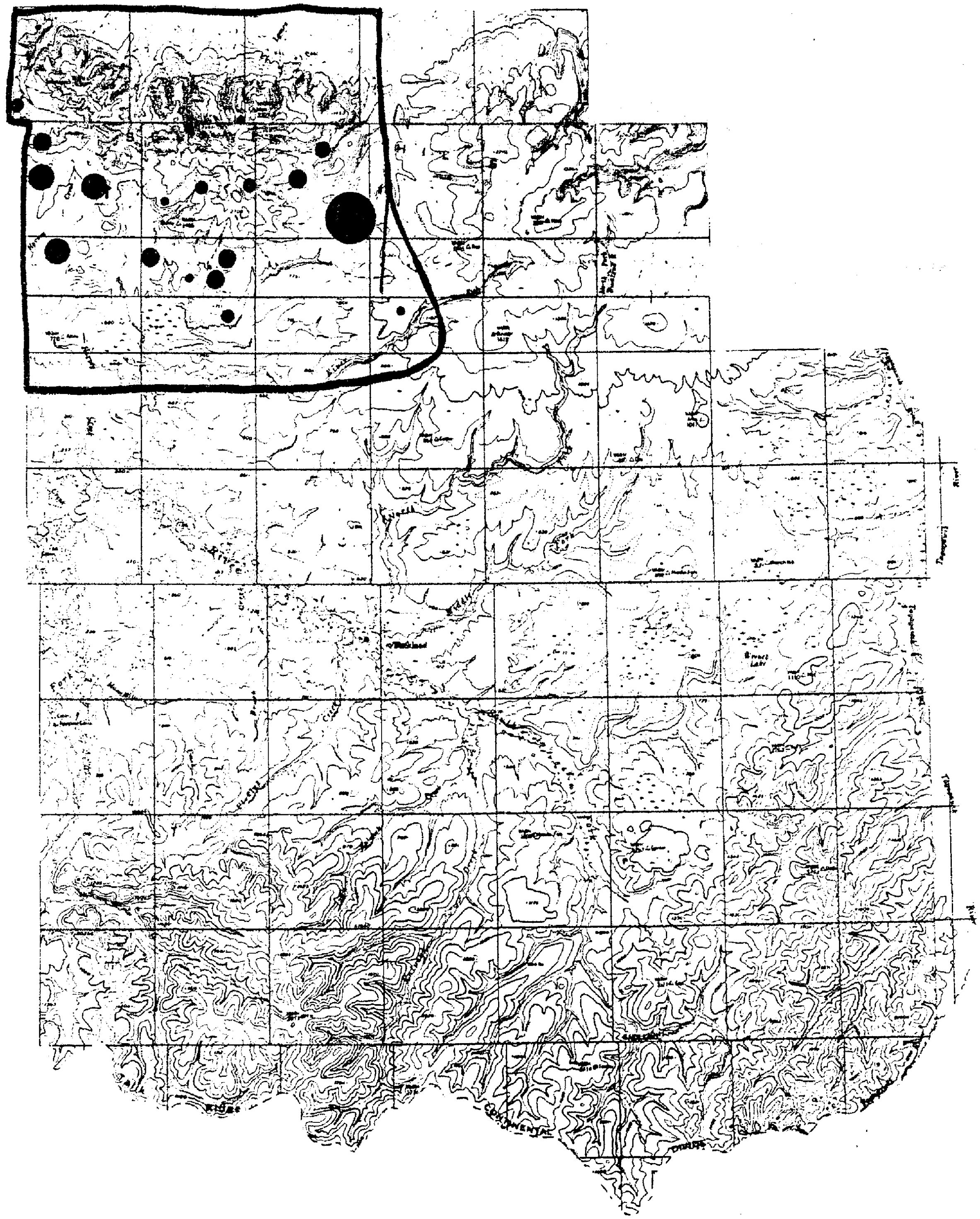
WINTER 1979-1980



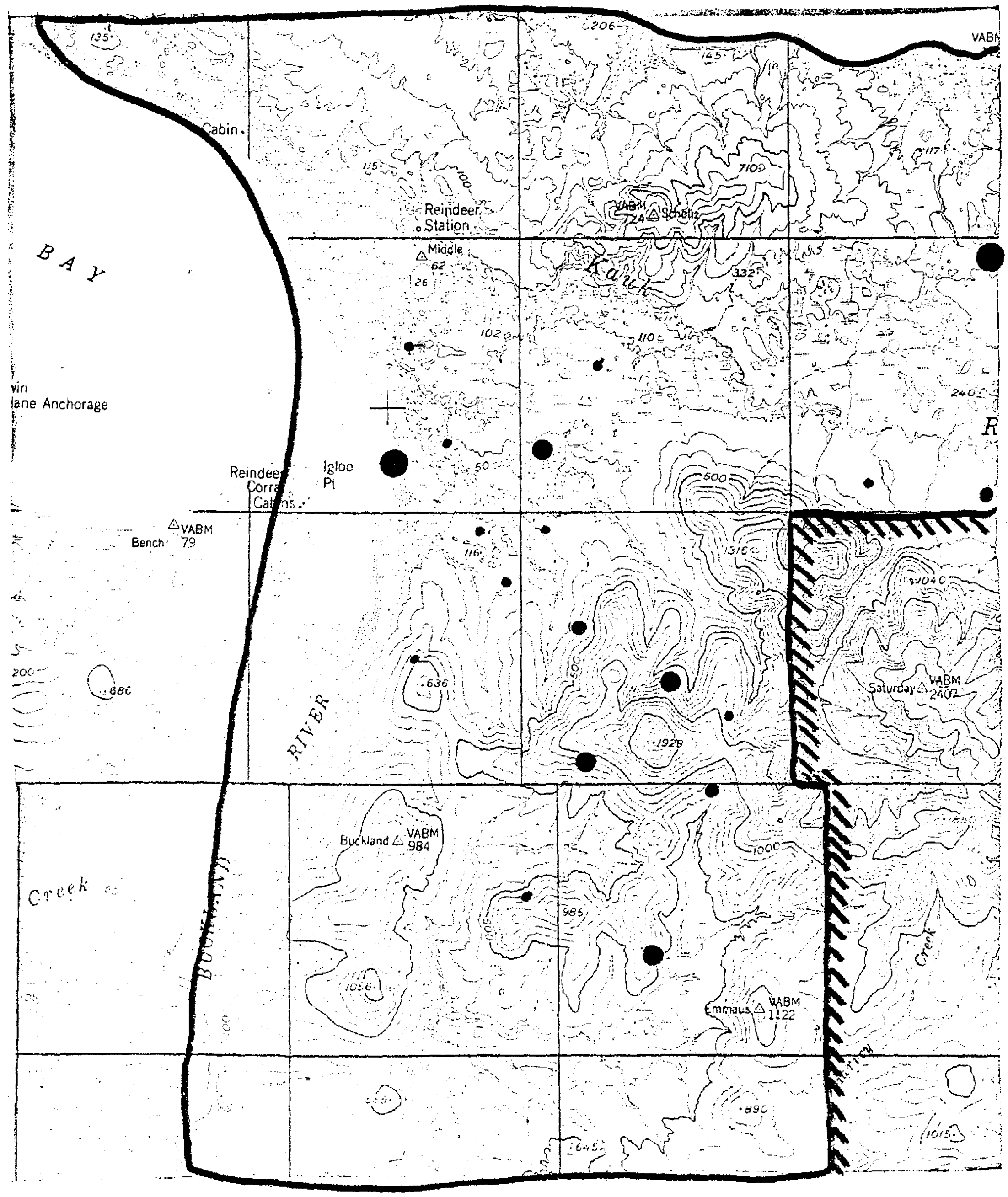
Buckland Valley Caribou Survey- 6 December 1979- 1100 caribou observed.
(40 observed west of study area-see supplemental map).



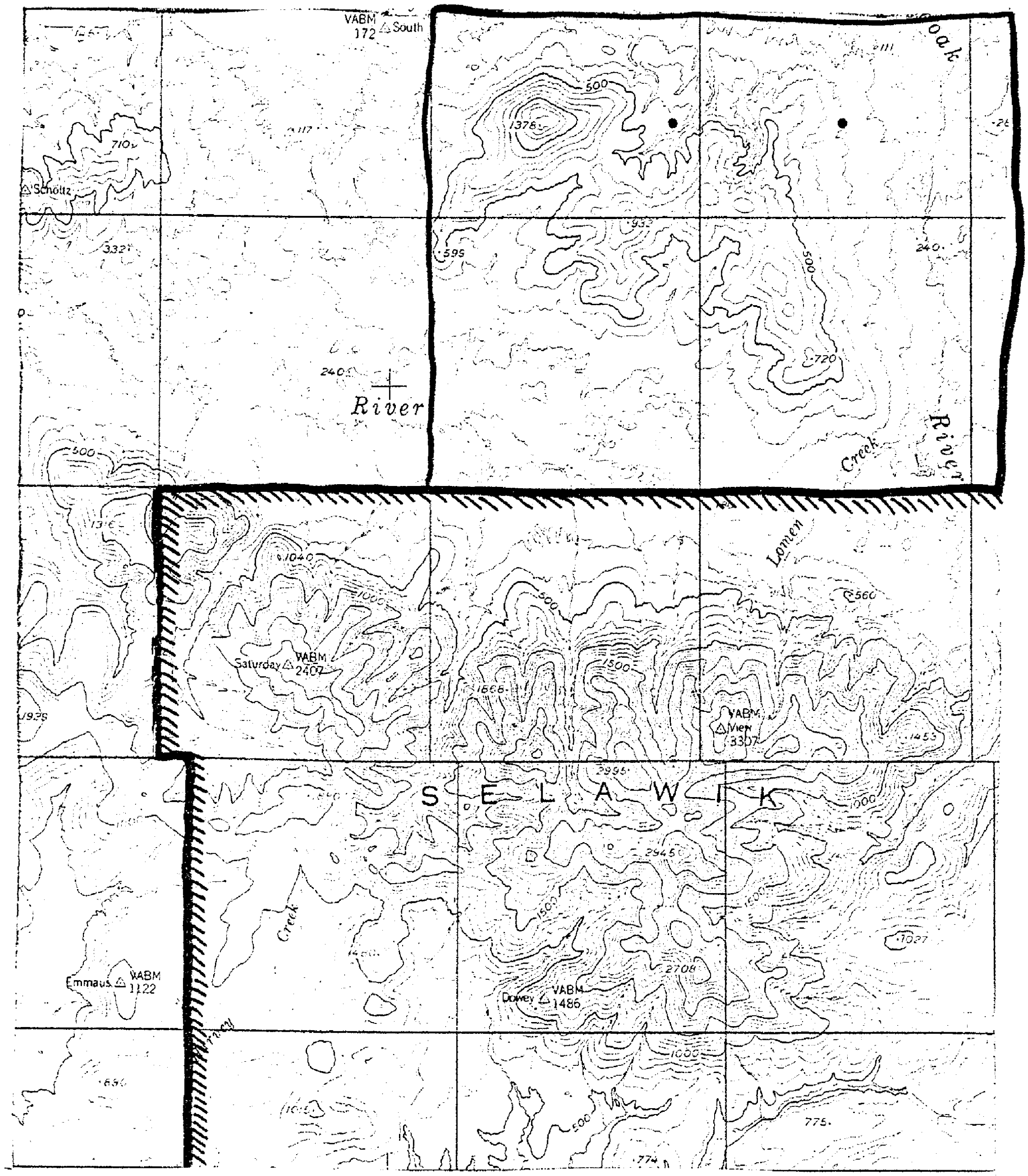
Supplemental map for 6 December 1979 Buckland Valley Caribou Survey.



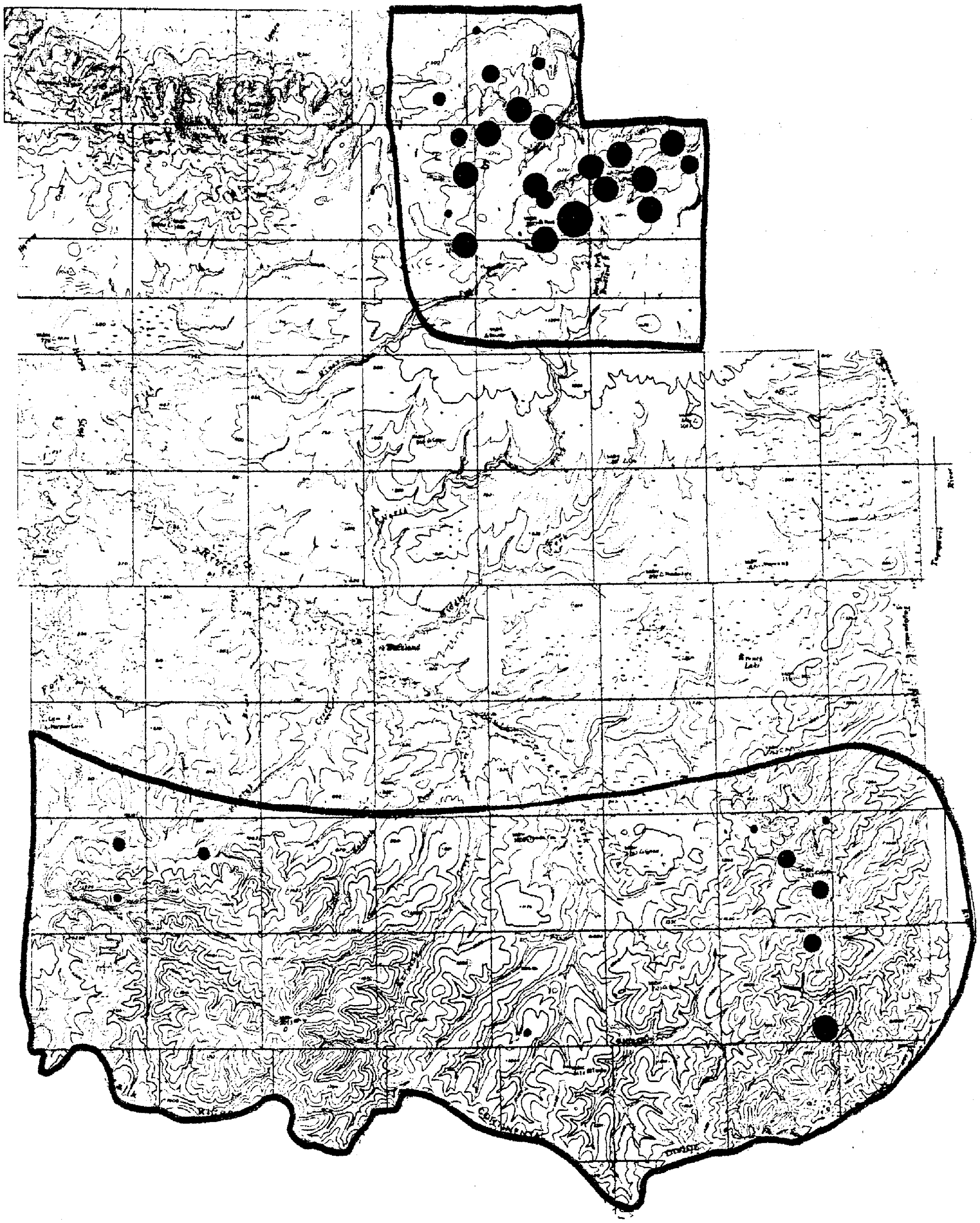
Buckland Valley Caribou Survey- 31 January 1980- 5200 caribou observed. (1000 observed north and west of study area-see supplemental map).



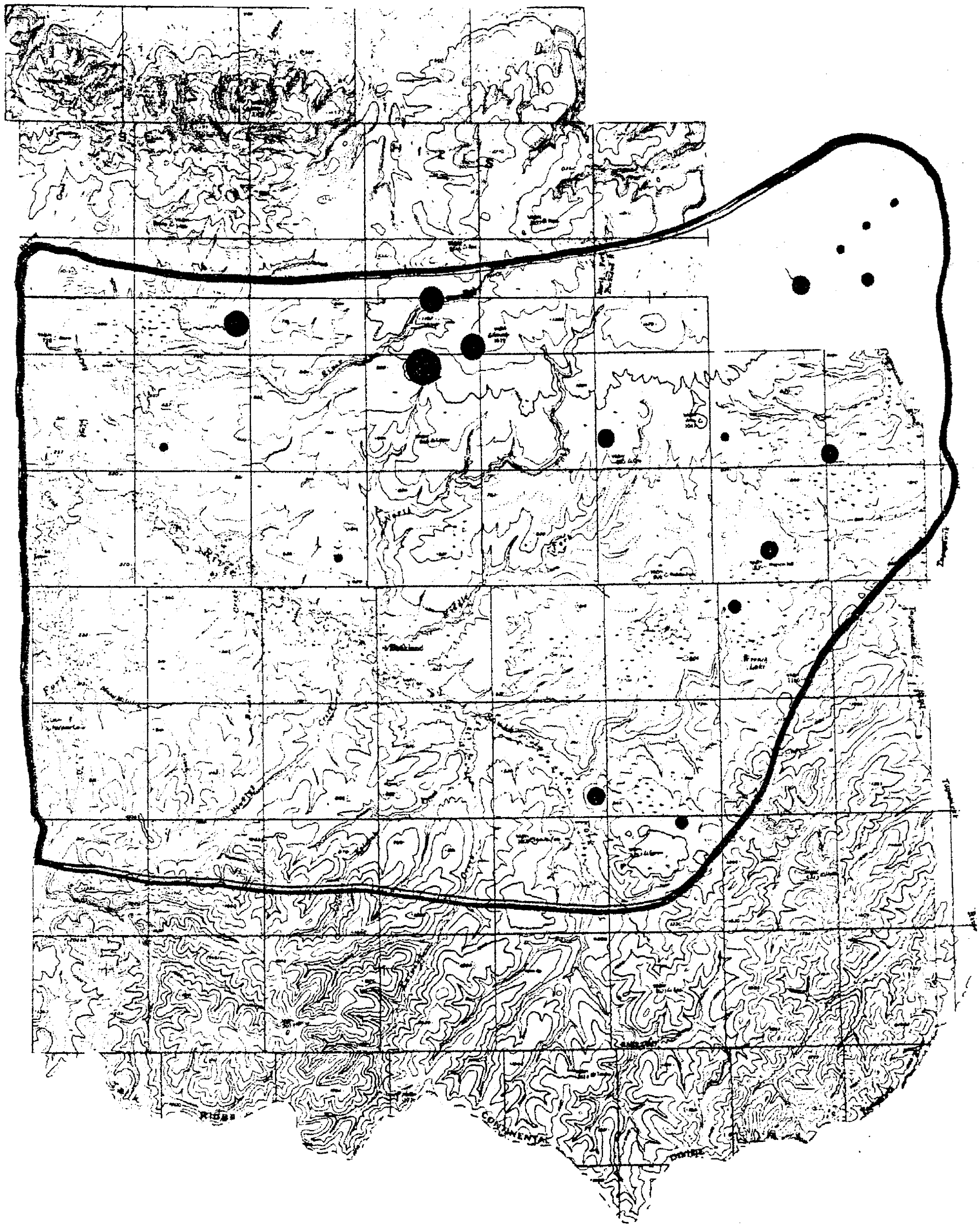
Supplemental map for 31 January 1980 Buckland Valley Caribou Survey.



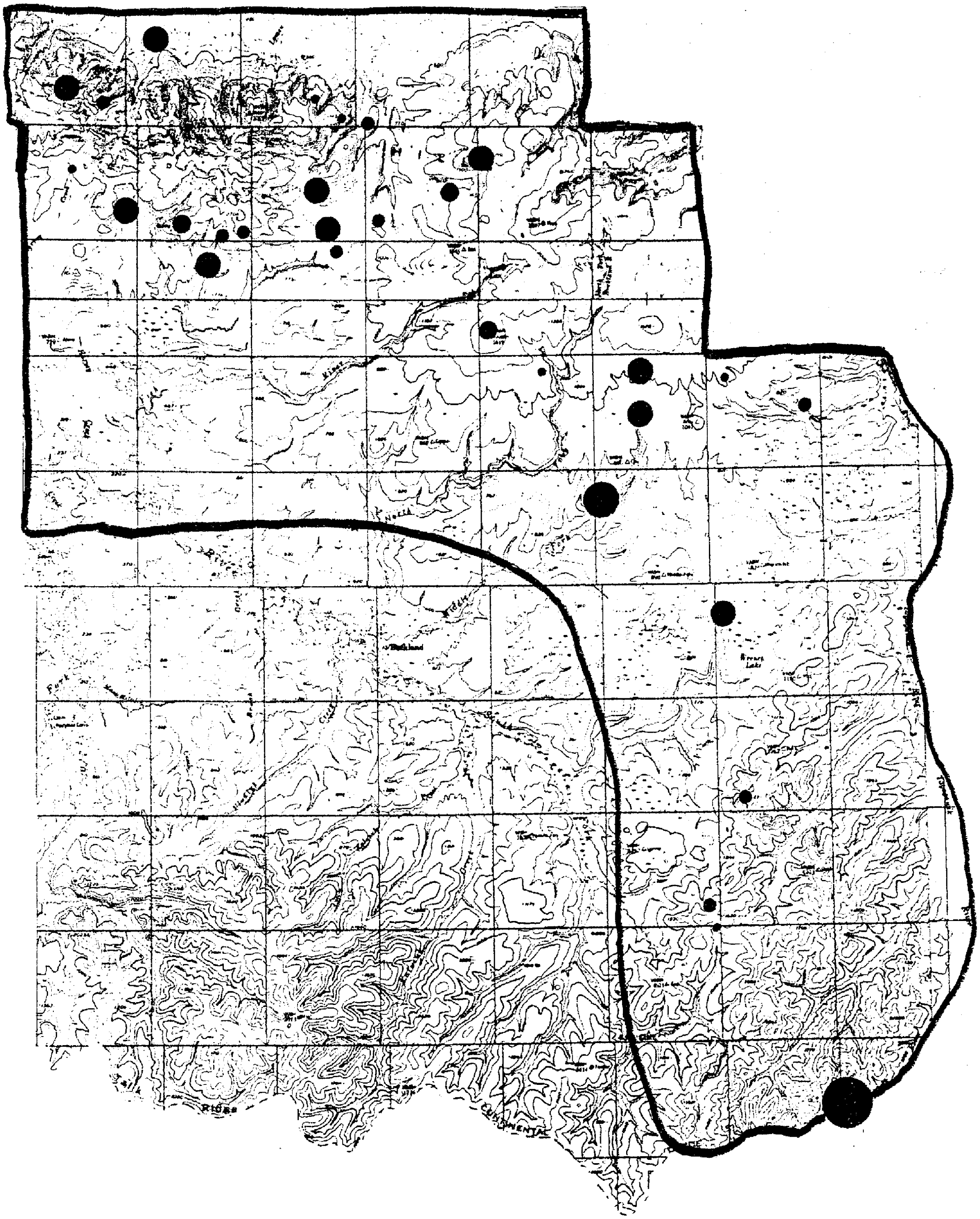
Supplemental map for 31 January 1980 Buckland Valley Caribou Survey.



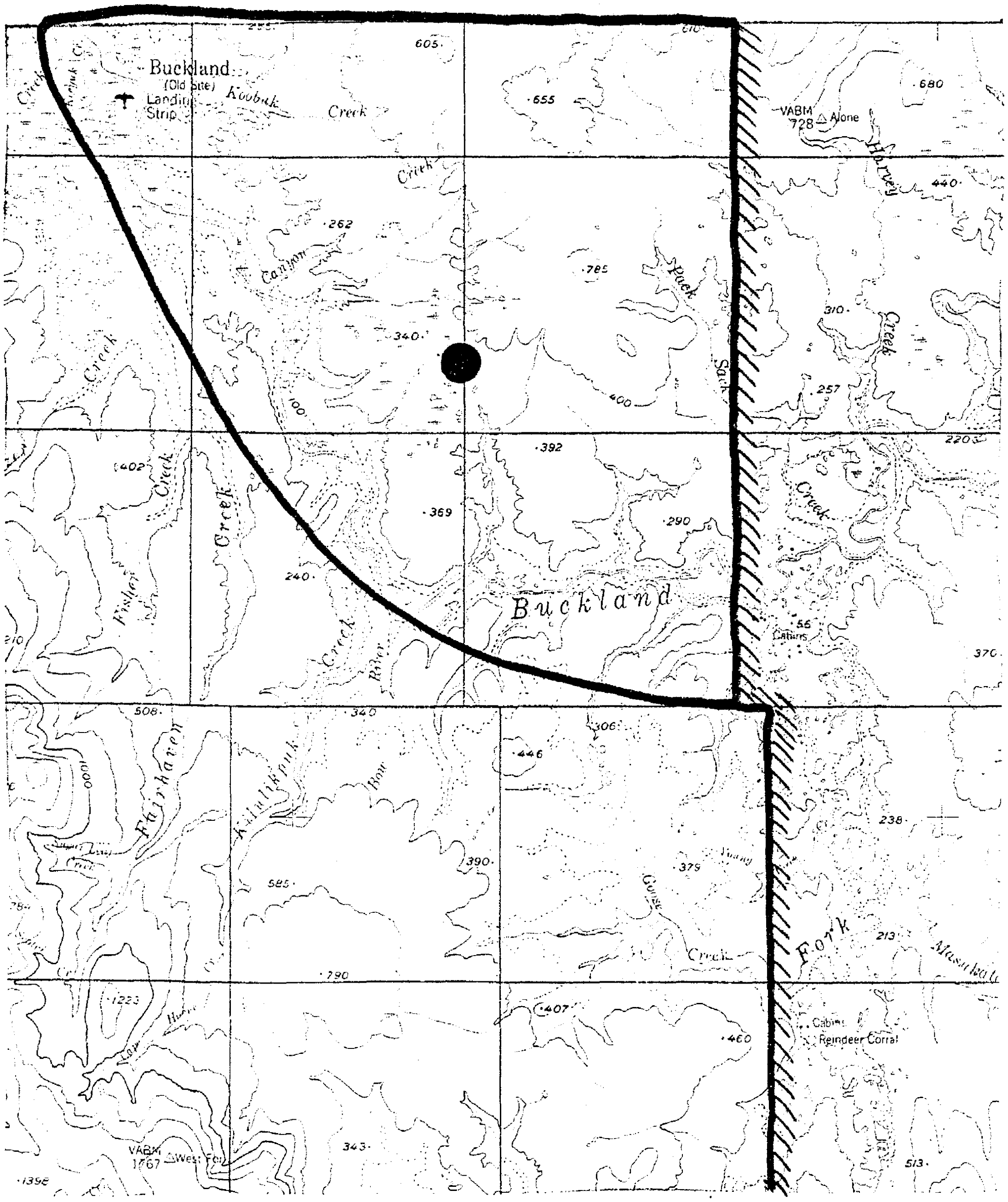
Buckland Valley Caribou Survey-1 February 1980-4000 caribou observed.



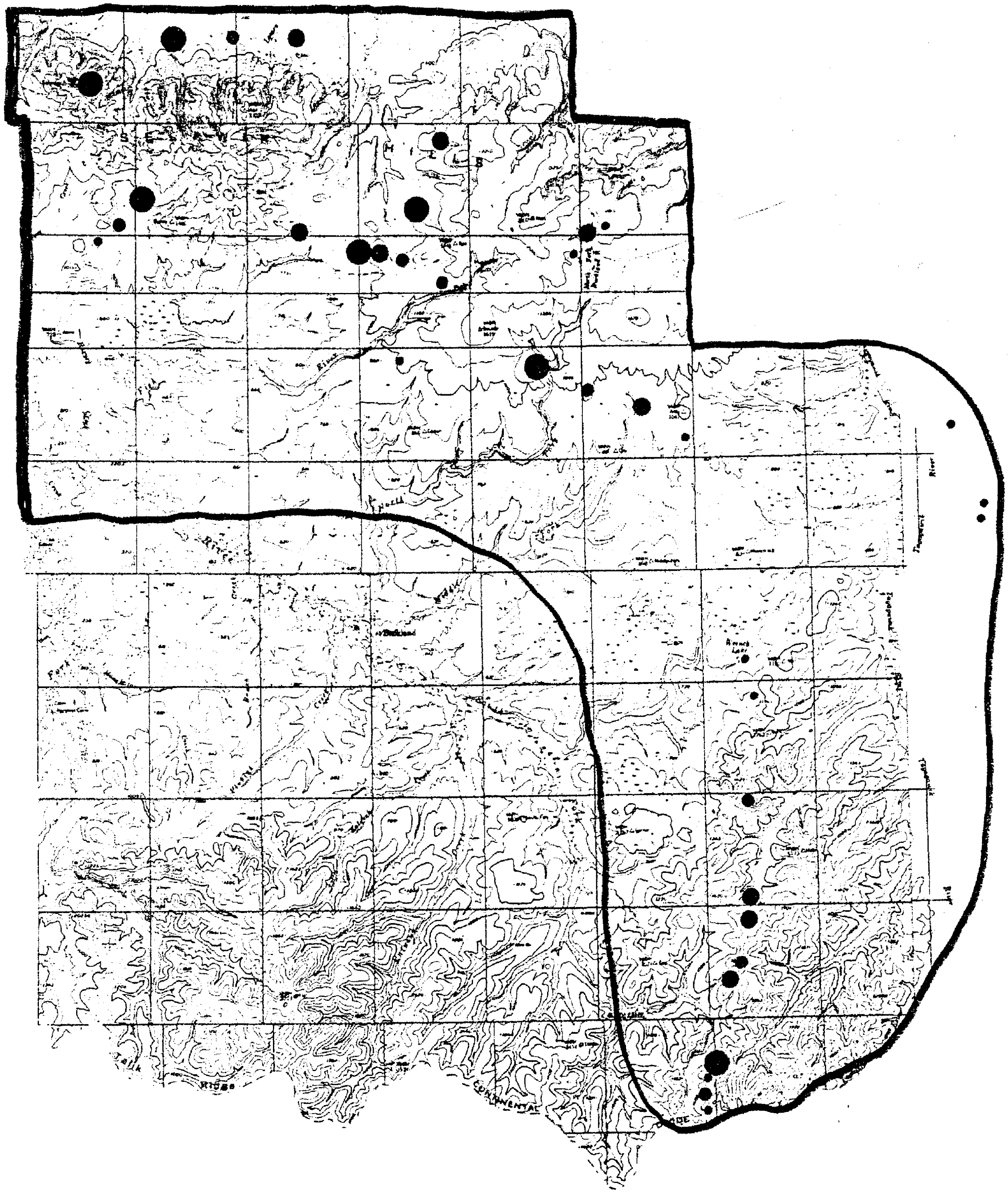
Buckland Valley Caribou Survey-2 February 1980-2000 caribou observed.



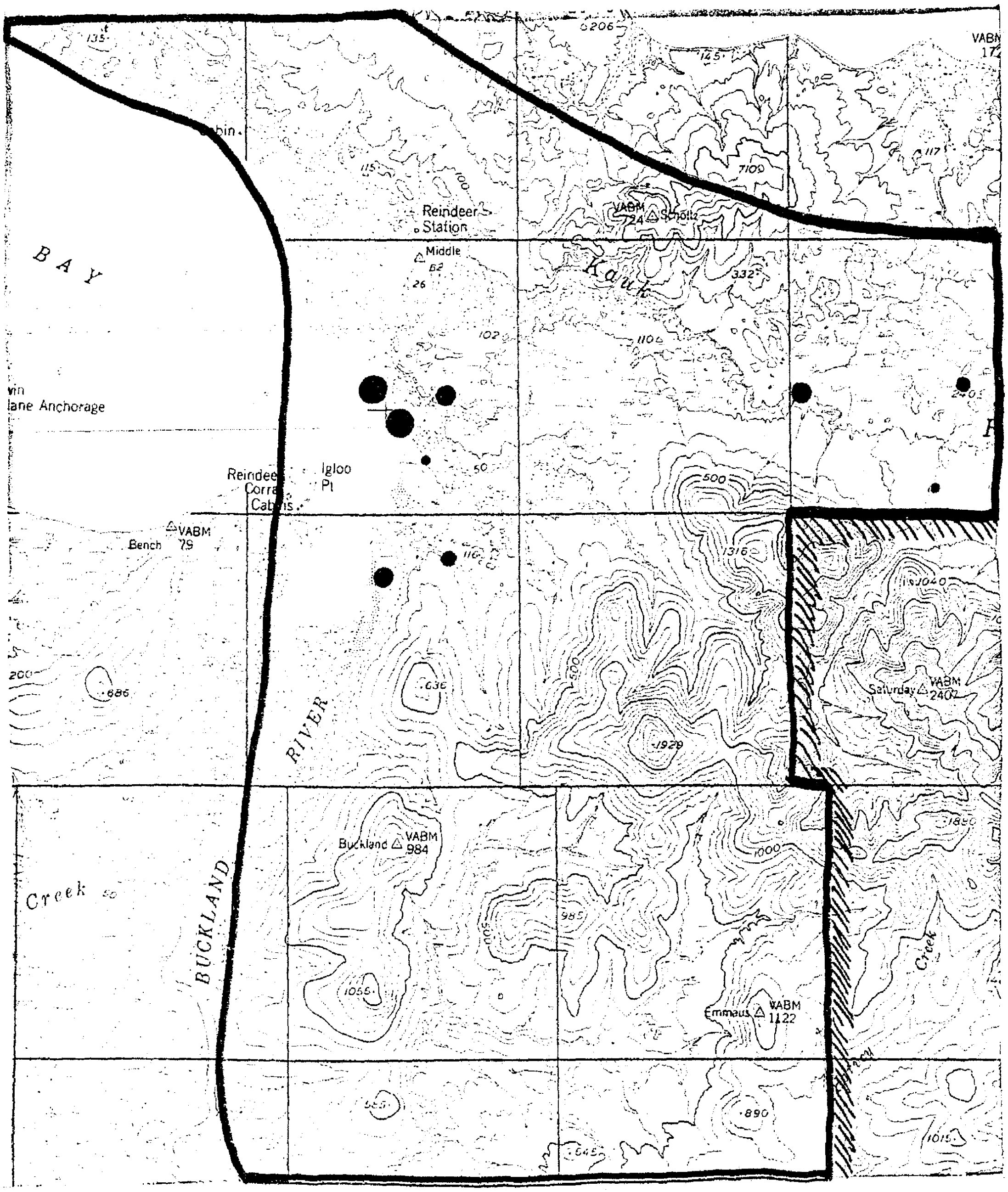
Buckland Valley Caribou Survey-16 February 1980-5900 caribou observed.
(700 observed west of study area-see supplemental map).



Supplemental map for 16 February 1980 Buckland Valley Caribou Survey.

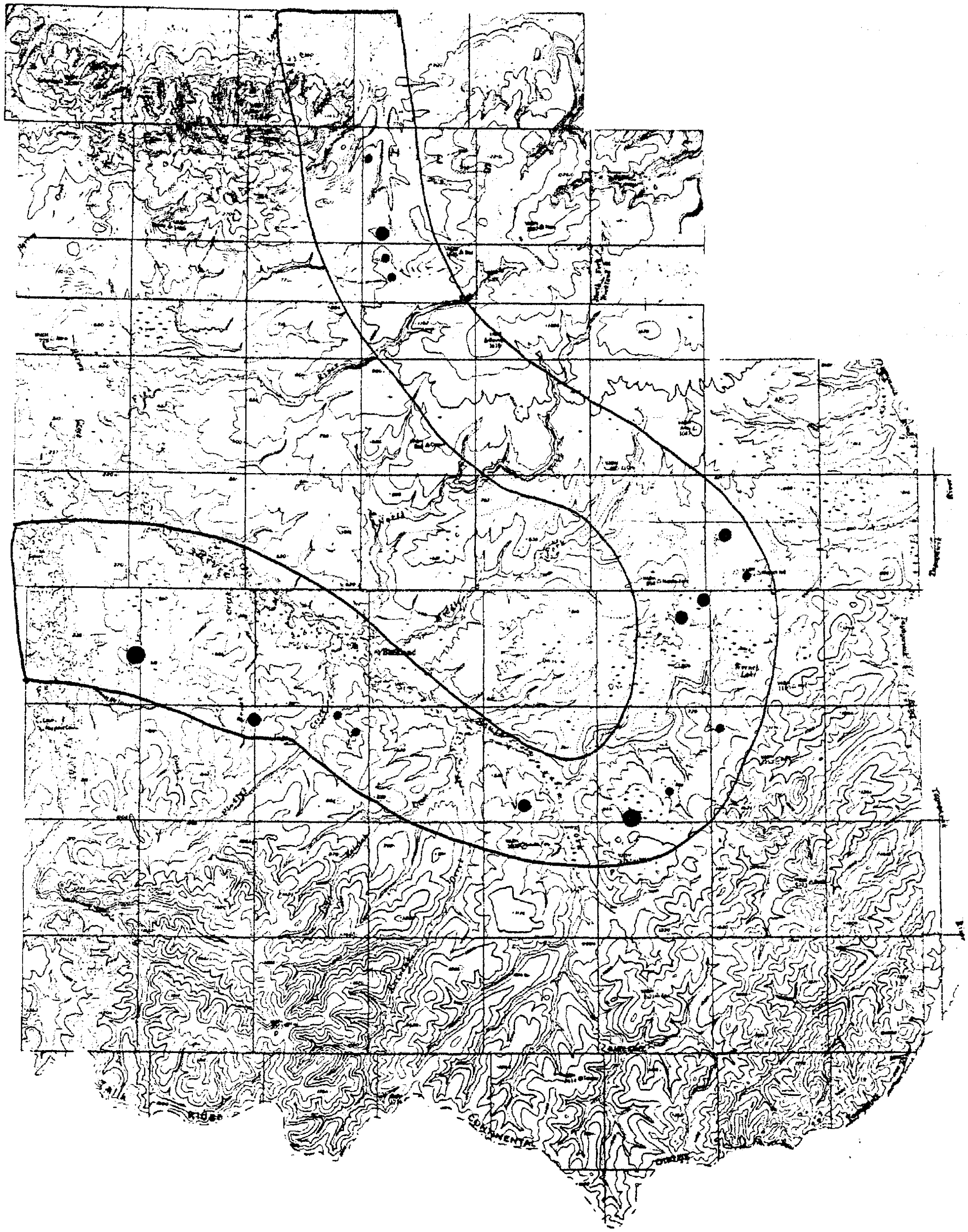


Buckland Valley Caribou Survey-29 February 1980-3600 caribou observed.
(1000 observed north and west of study area-see supplemental map).

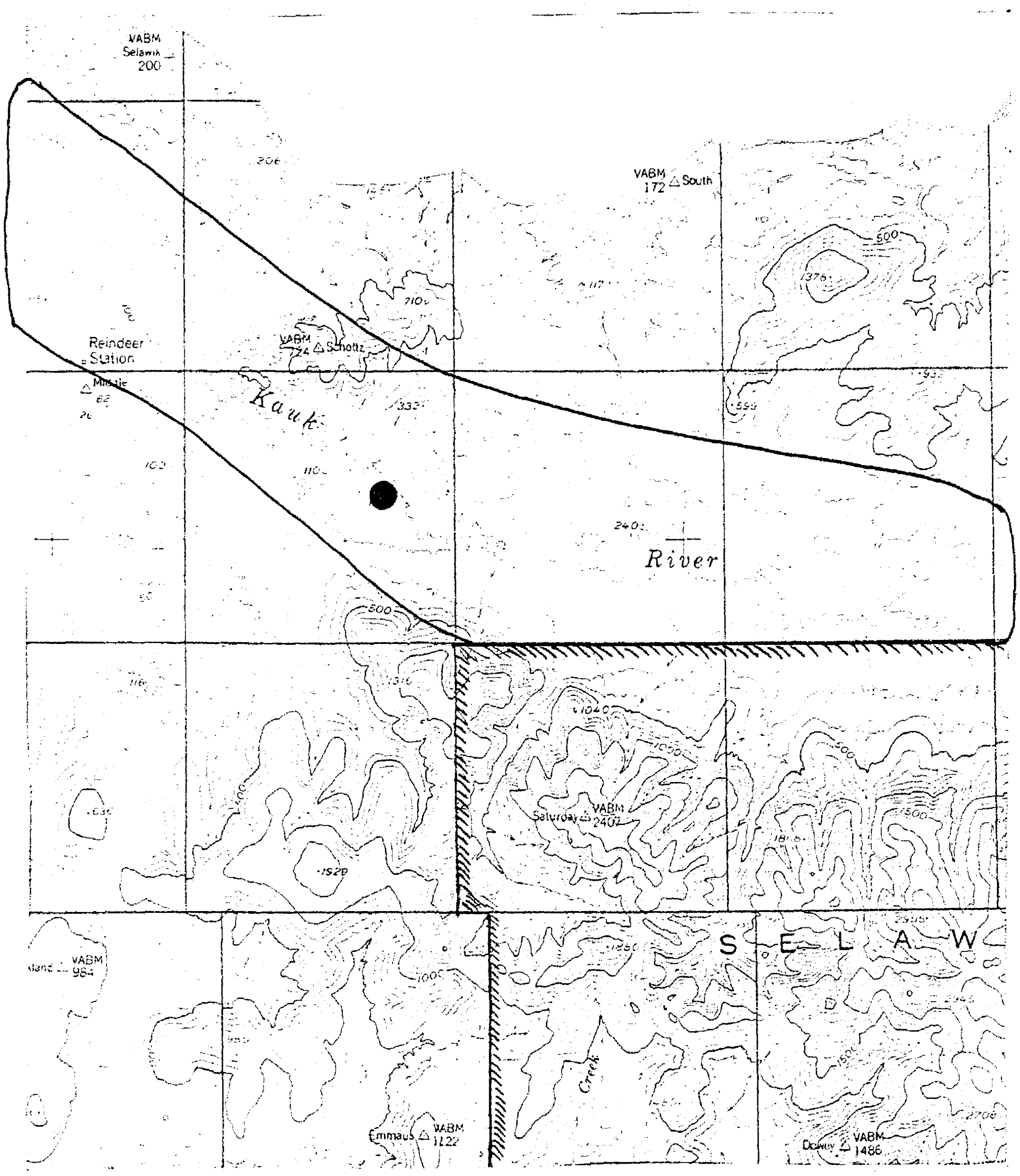


Supplemental map for 29 February 1980 Buckland Valley Caribou Survey.

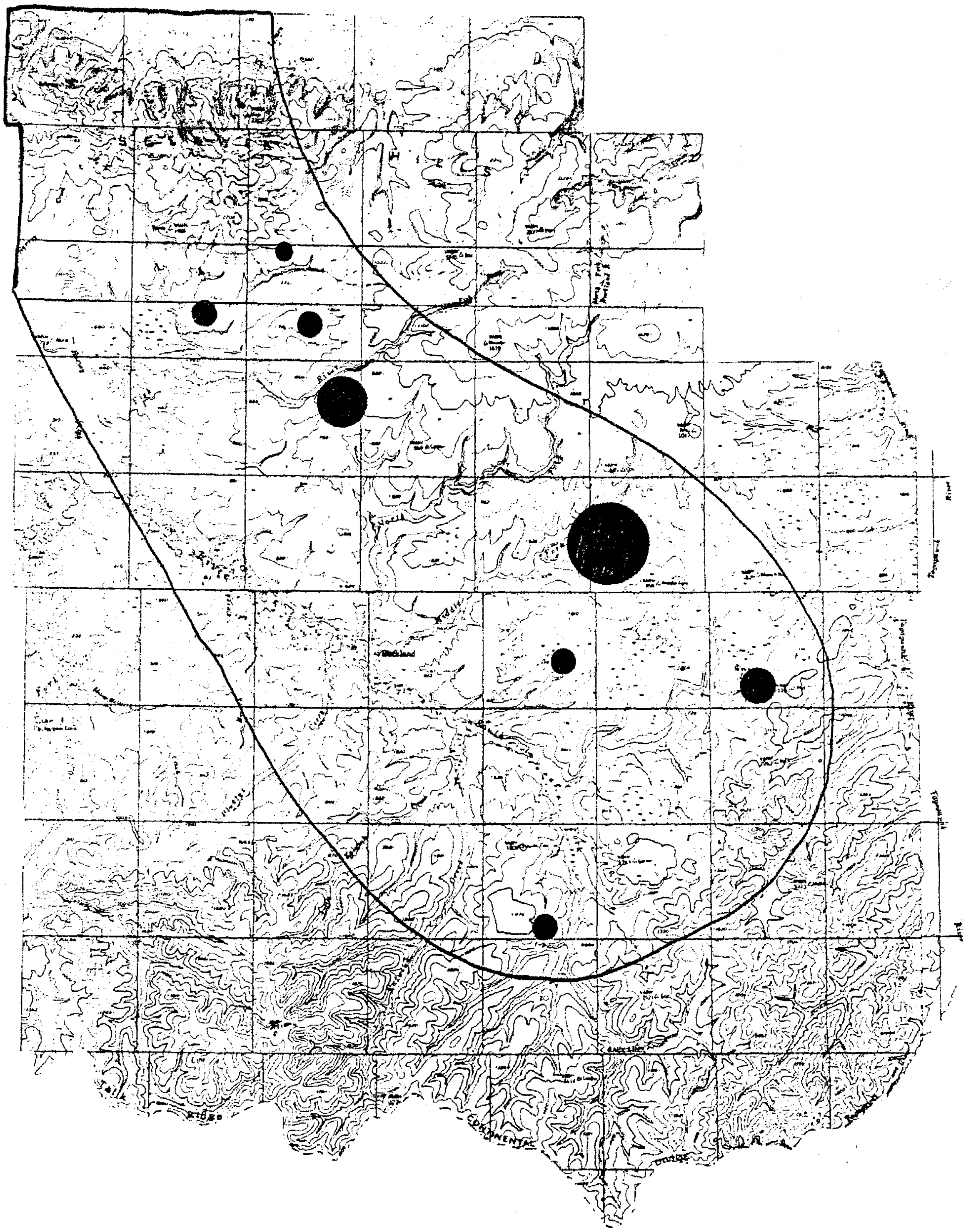
WINTER 1980-1981



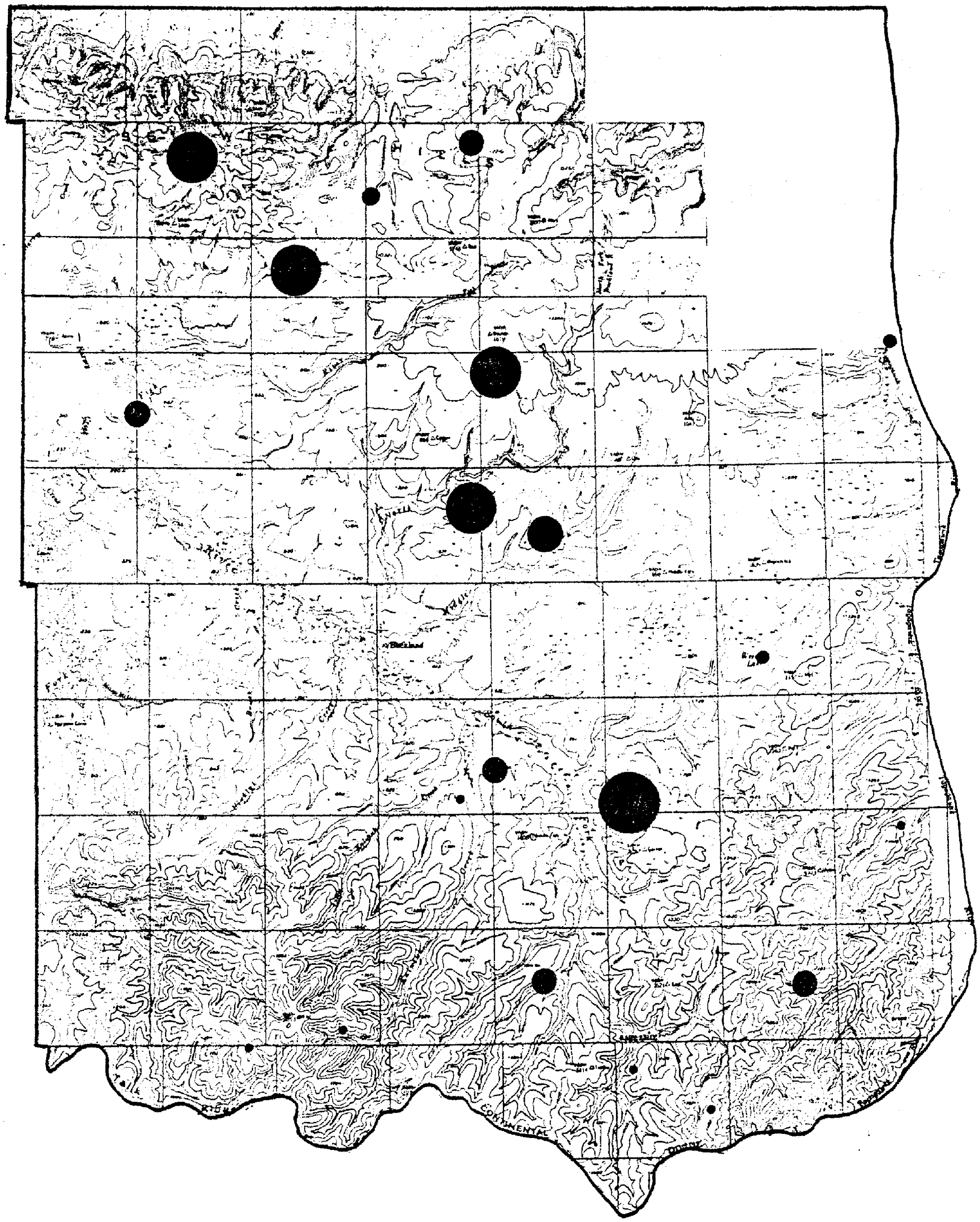
Buckland Valley Caribou Survey-17 December 1980-800 caribou observed.
(300 observed northwest of the study area-see supplemental map).



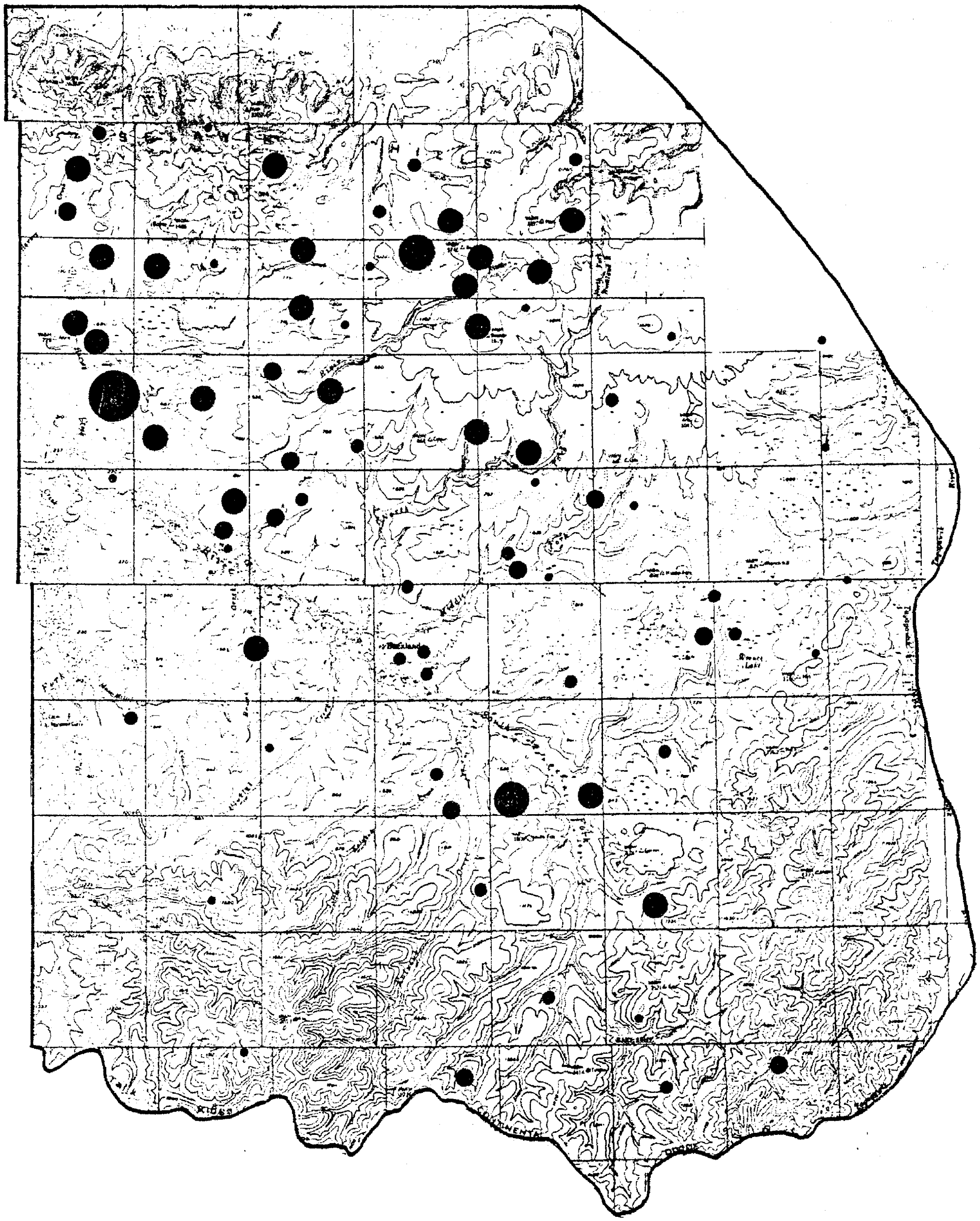
Supplemental map for 17 December 1980 Buckland Valley Caribou Survey.



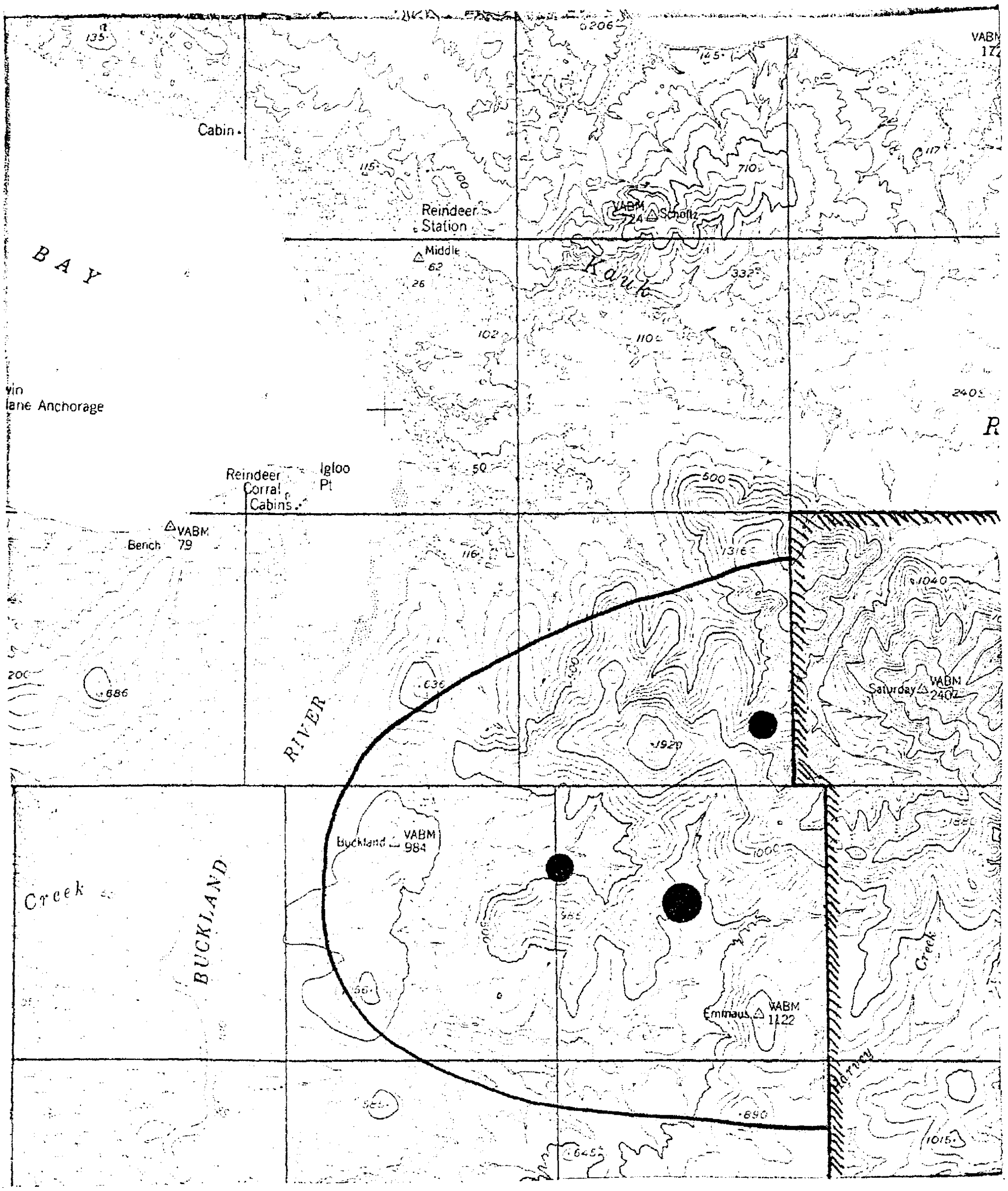
Buckland Valley Caribou Survey-20 January 1981-17,200 animals observed.



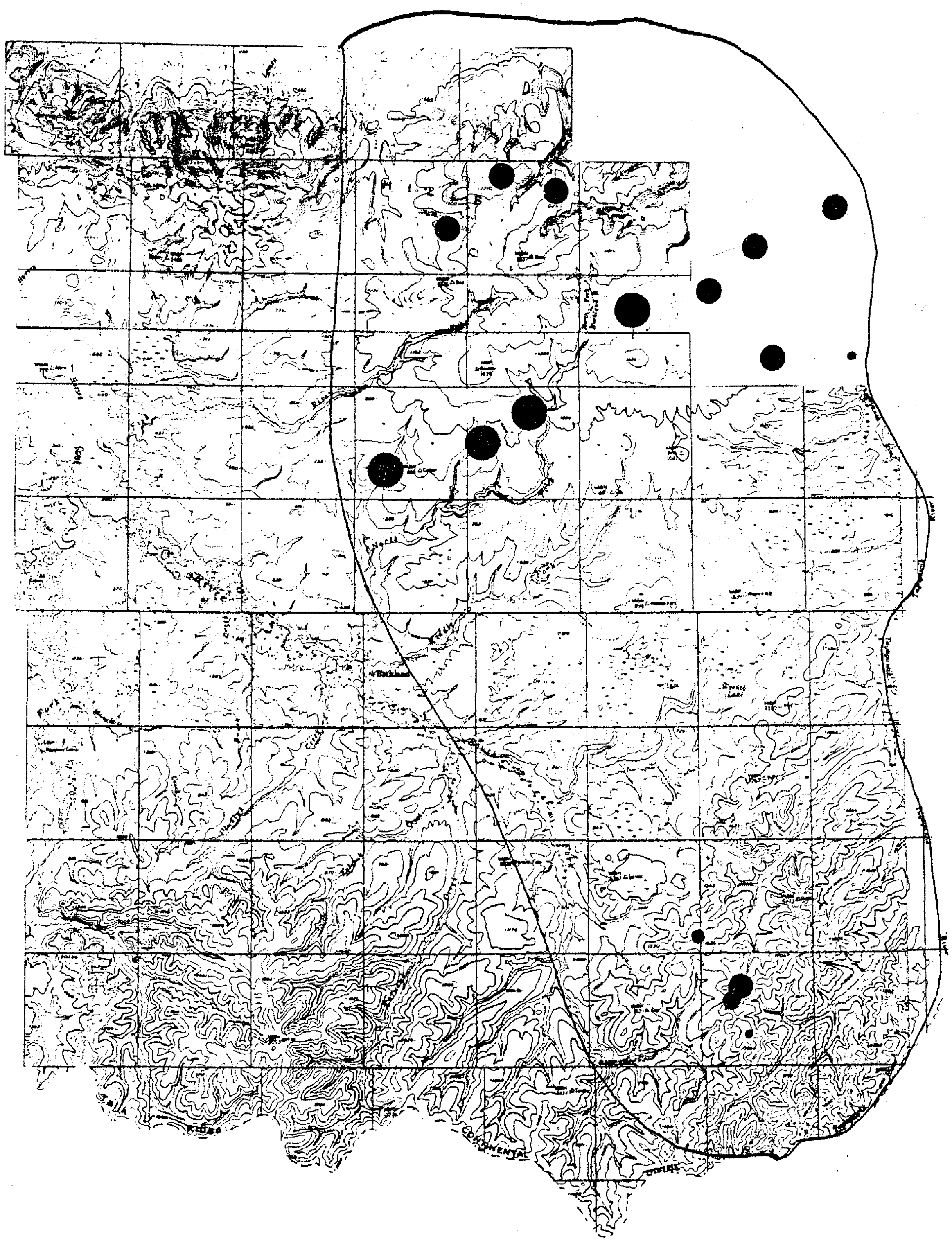
Buckland Valley Caribou Survey-4 February 1981-19,500 animals observed.



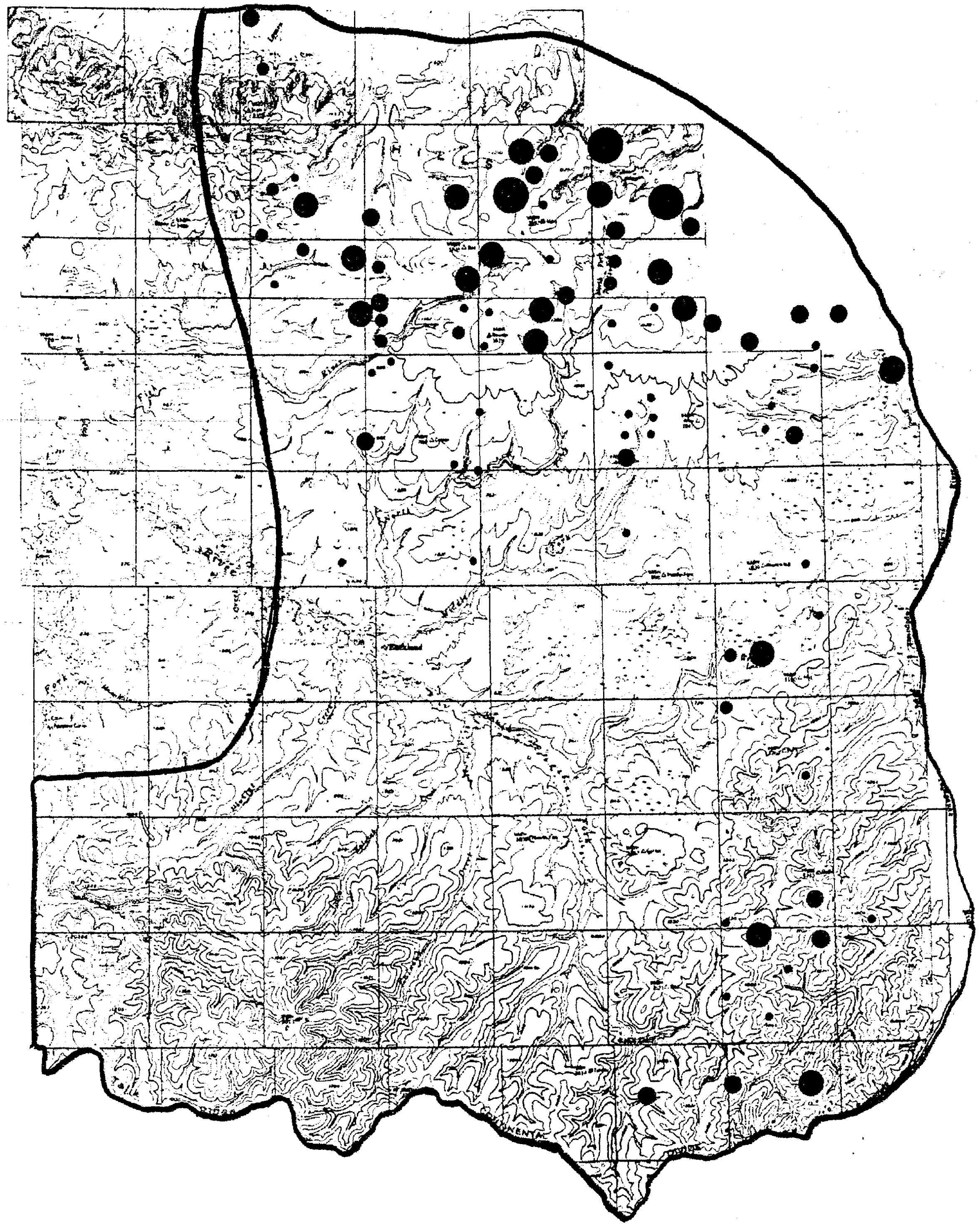
Buckland Valley Caribou Survey-17 & 18 February 1981-13,000 caribou observed (1600 observed west of study area-see supplemental map).



Supplemental map for the 17 & 18 February 1980 Buckland Valley Caribou Survey.

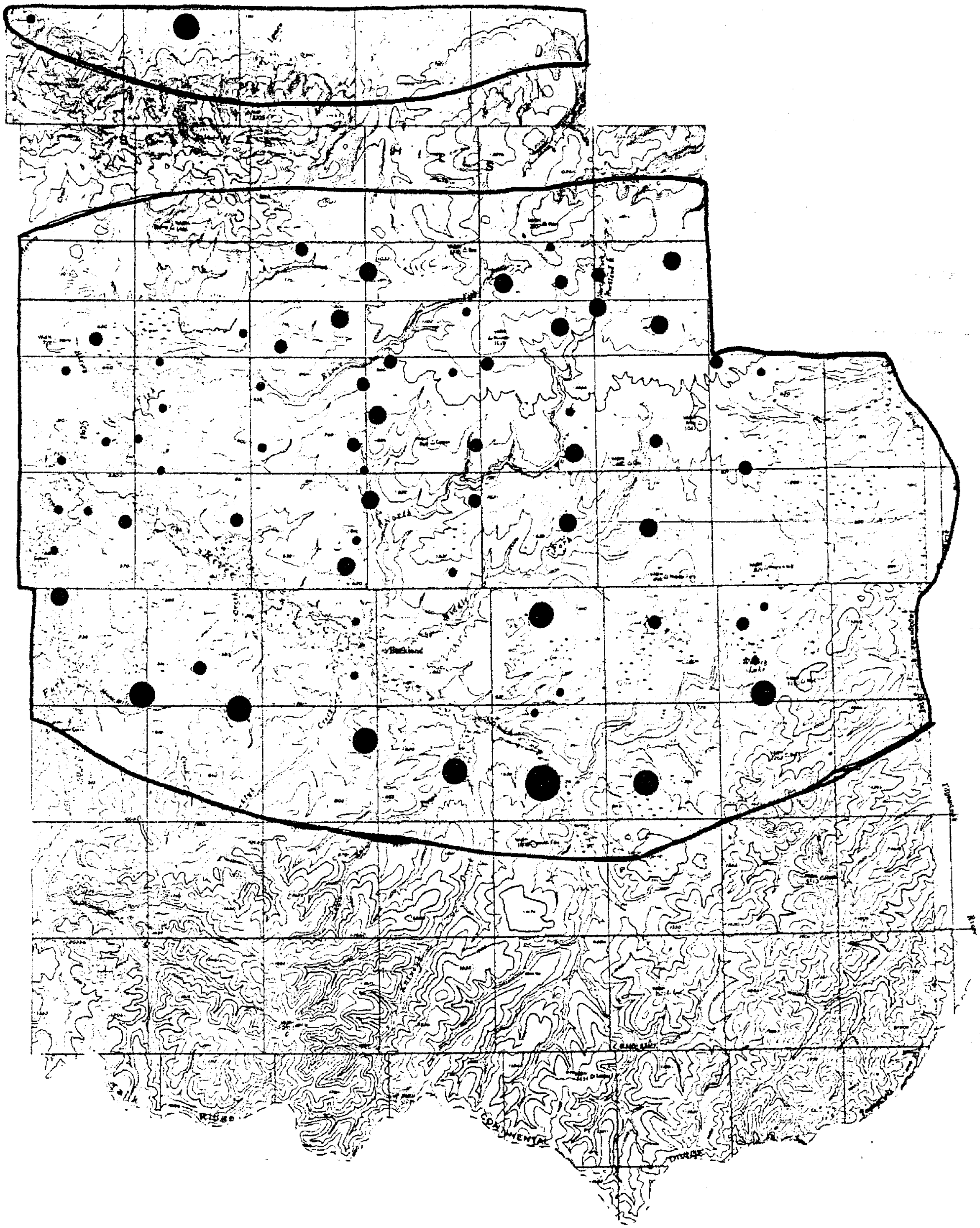


Buckland Valley Caribou Survey-25 March 1981-5200 caribou observed.

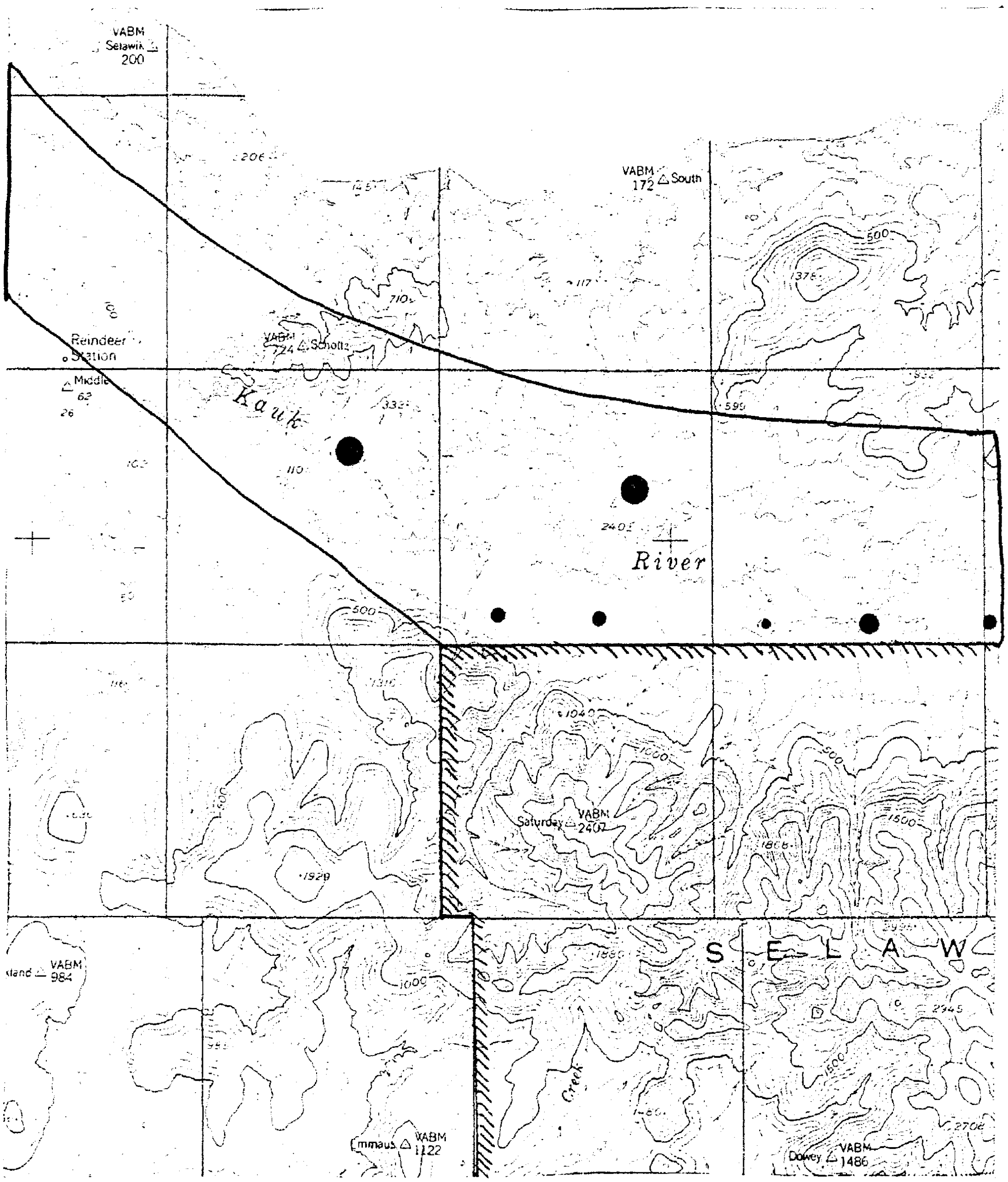


Buckland Valley Caribou Survey-16 & 17 April 1981-8900 caribou observed.

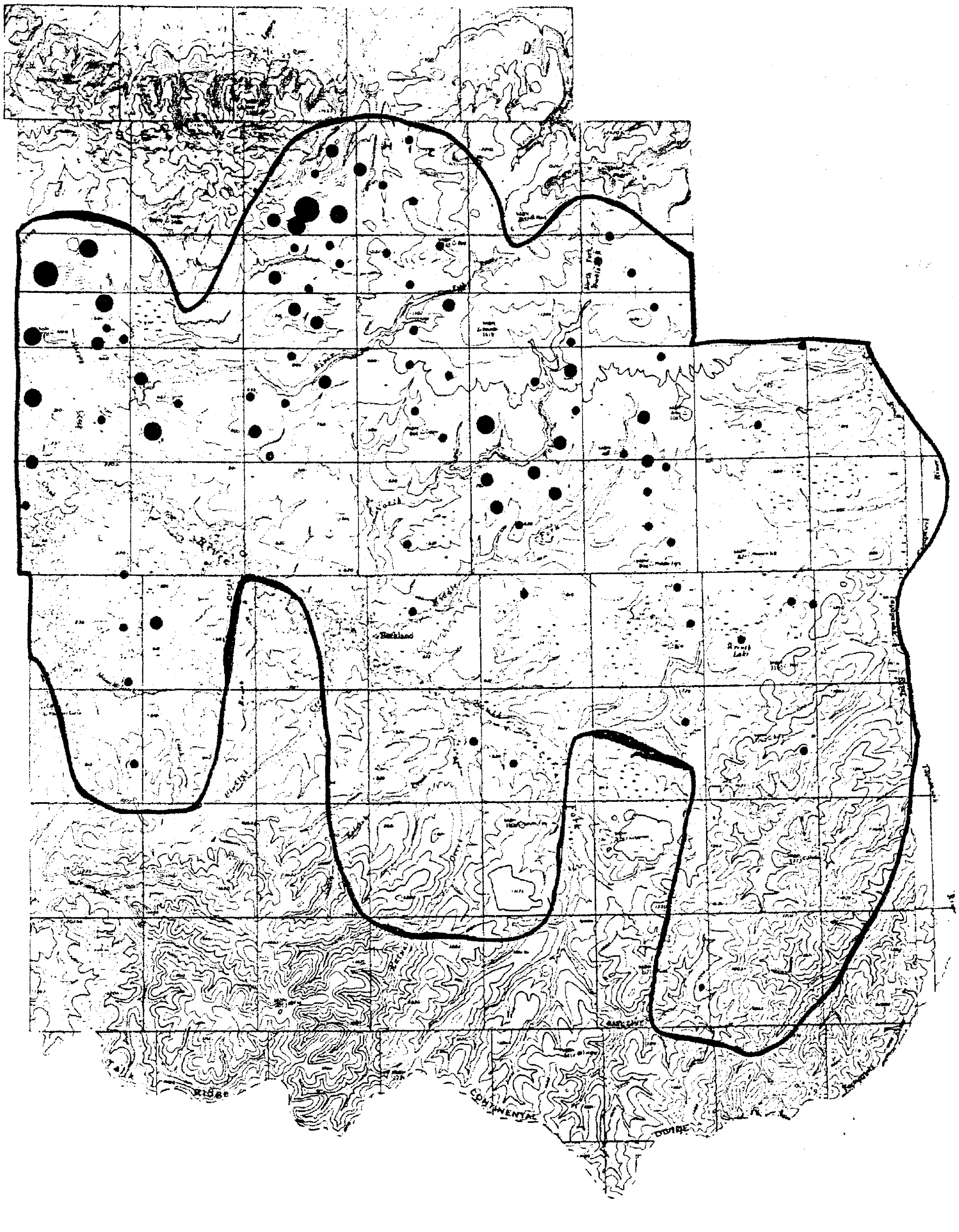
WINTER 1981-1982



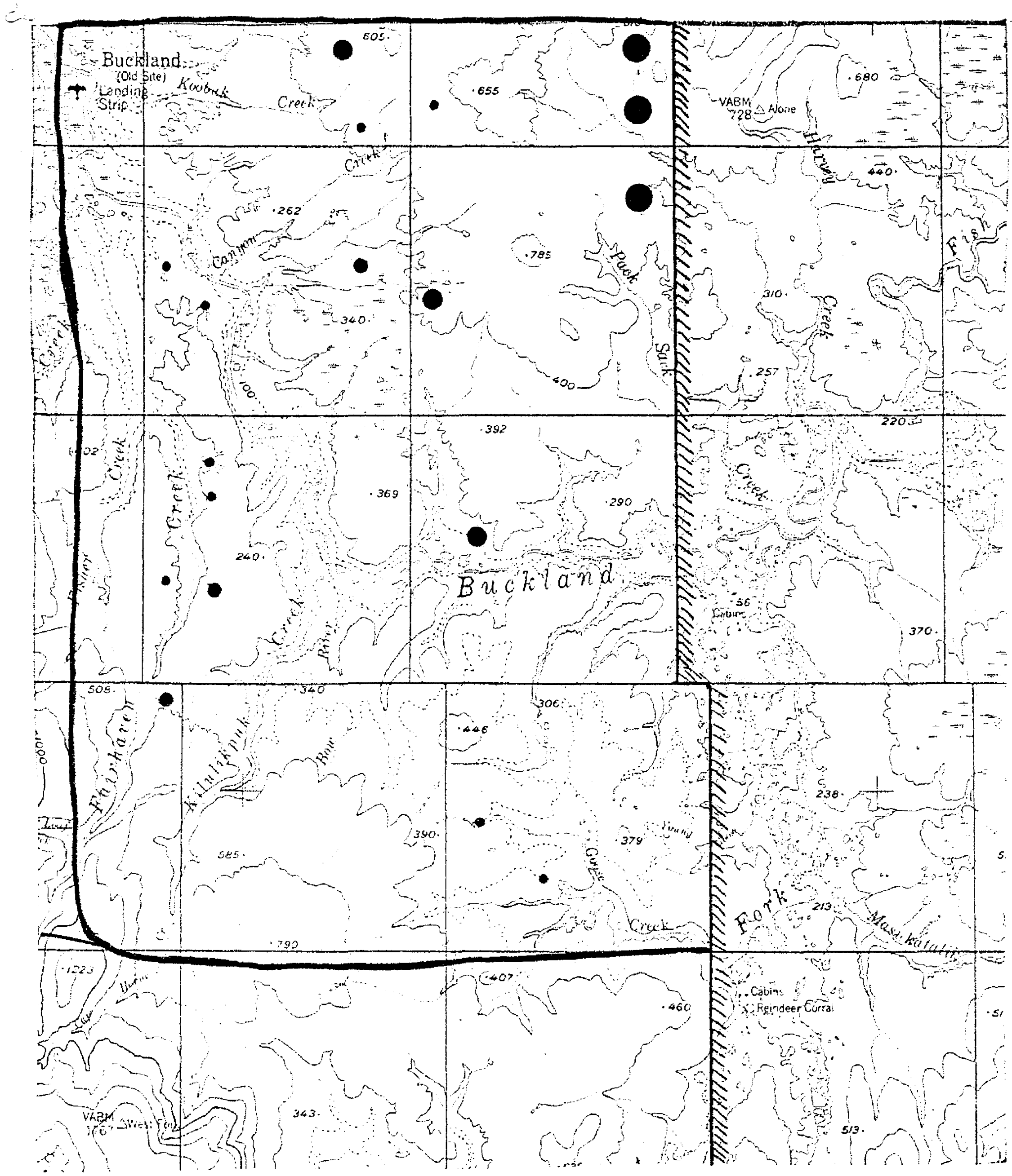
Buckland Valley Caribou Survey-29 October 1981-2600 animals observed.
(800 observed north of study area-see supplemental map).



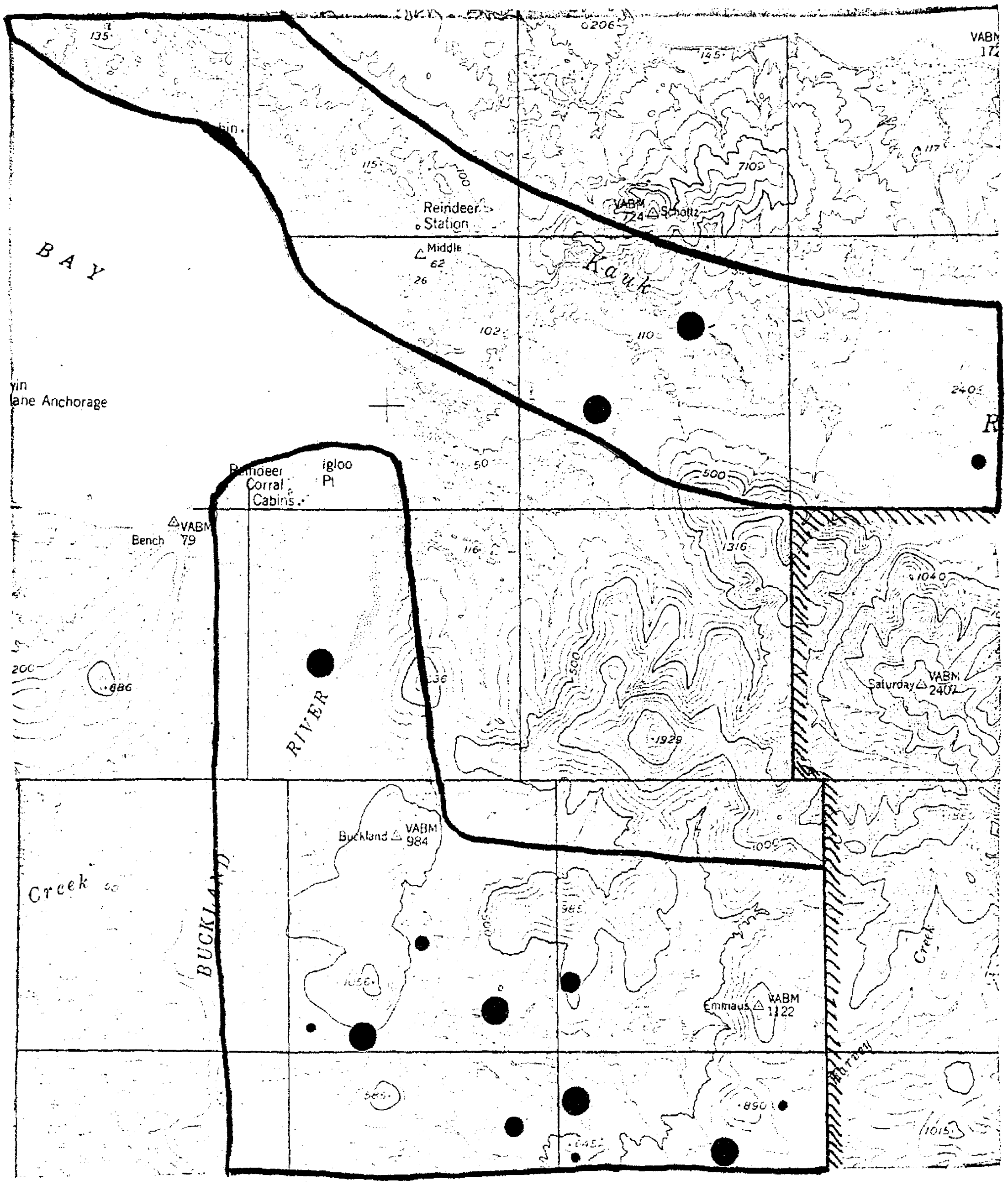
Supplemental map for 29 October 1981 Buckland Valley Caribou Survey.



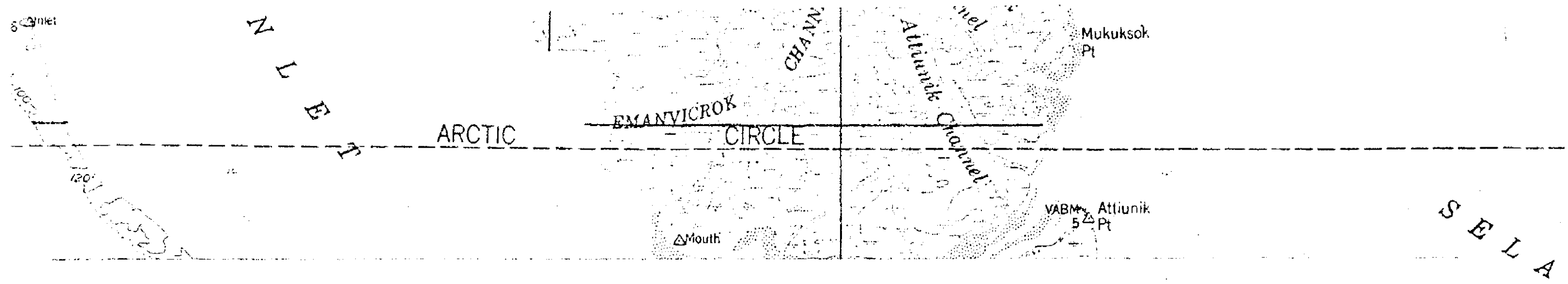
Buckland Valley Caribou Survey-16 November 1981-2900 caribou observed.
(1300 observed north and west of study area-see supplemental map).



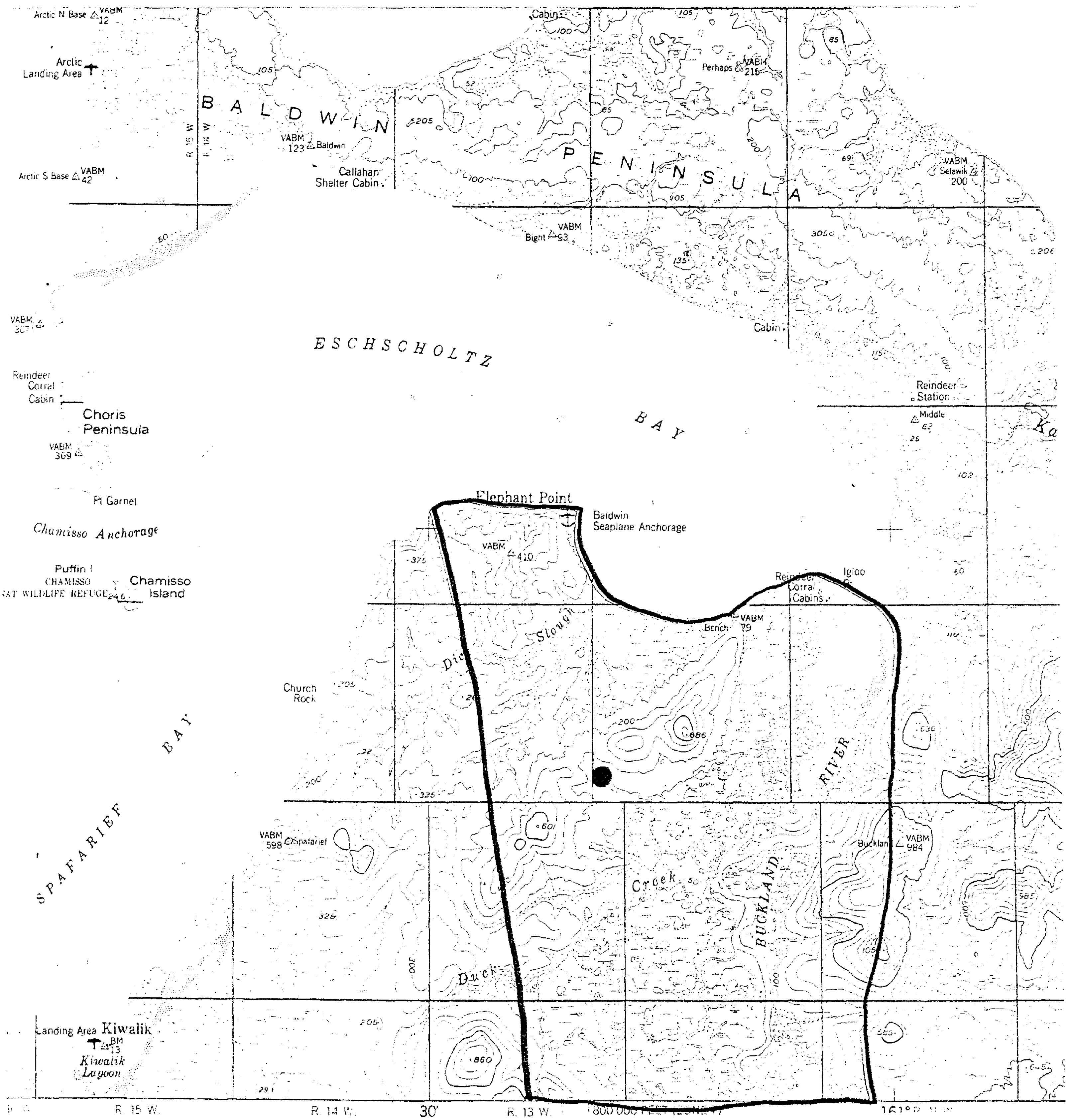
Supplemental map for 16 November 1981 Buckland Valley Caribou Survey.



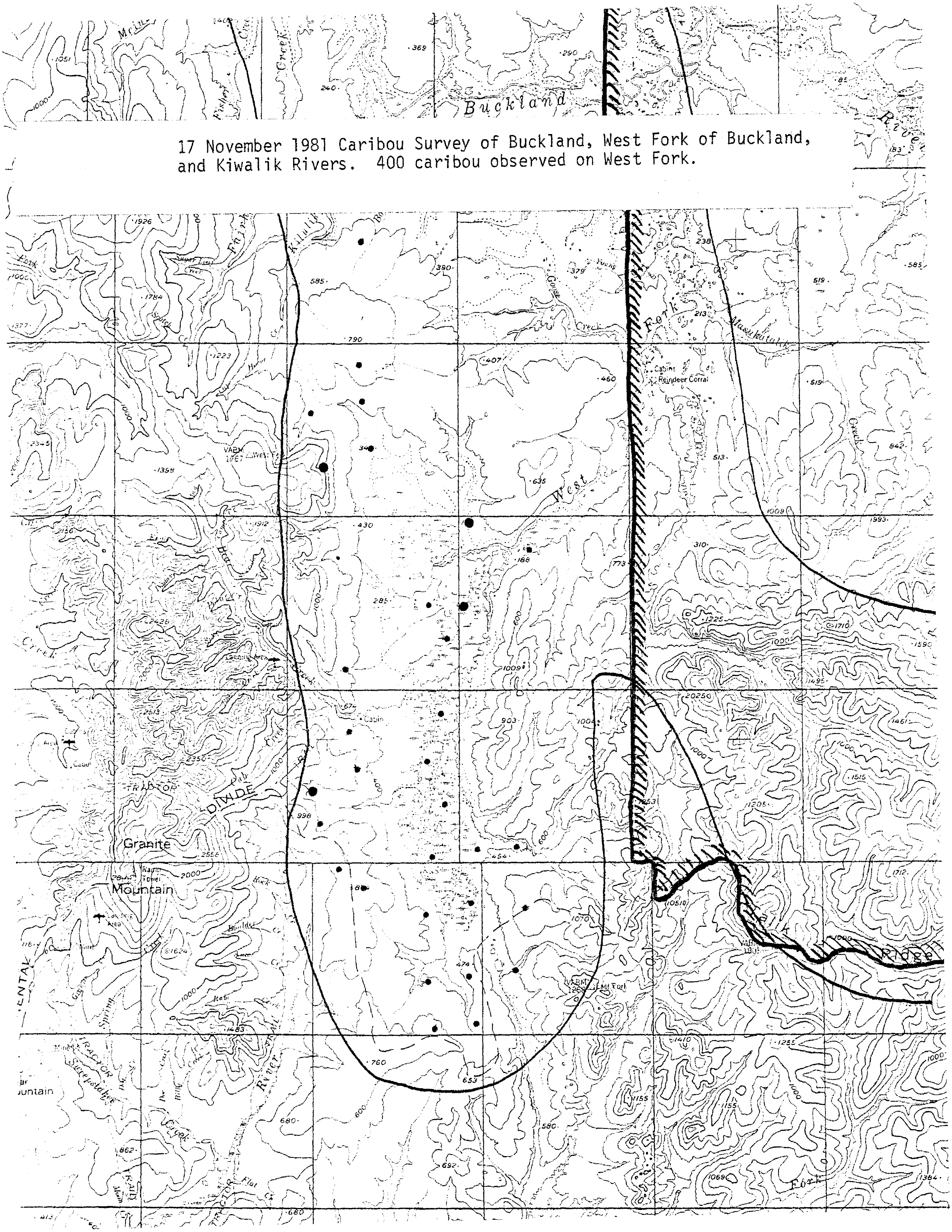
Supplemental map for 16 November 1981 Buckland Valley Caribou Survey.

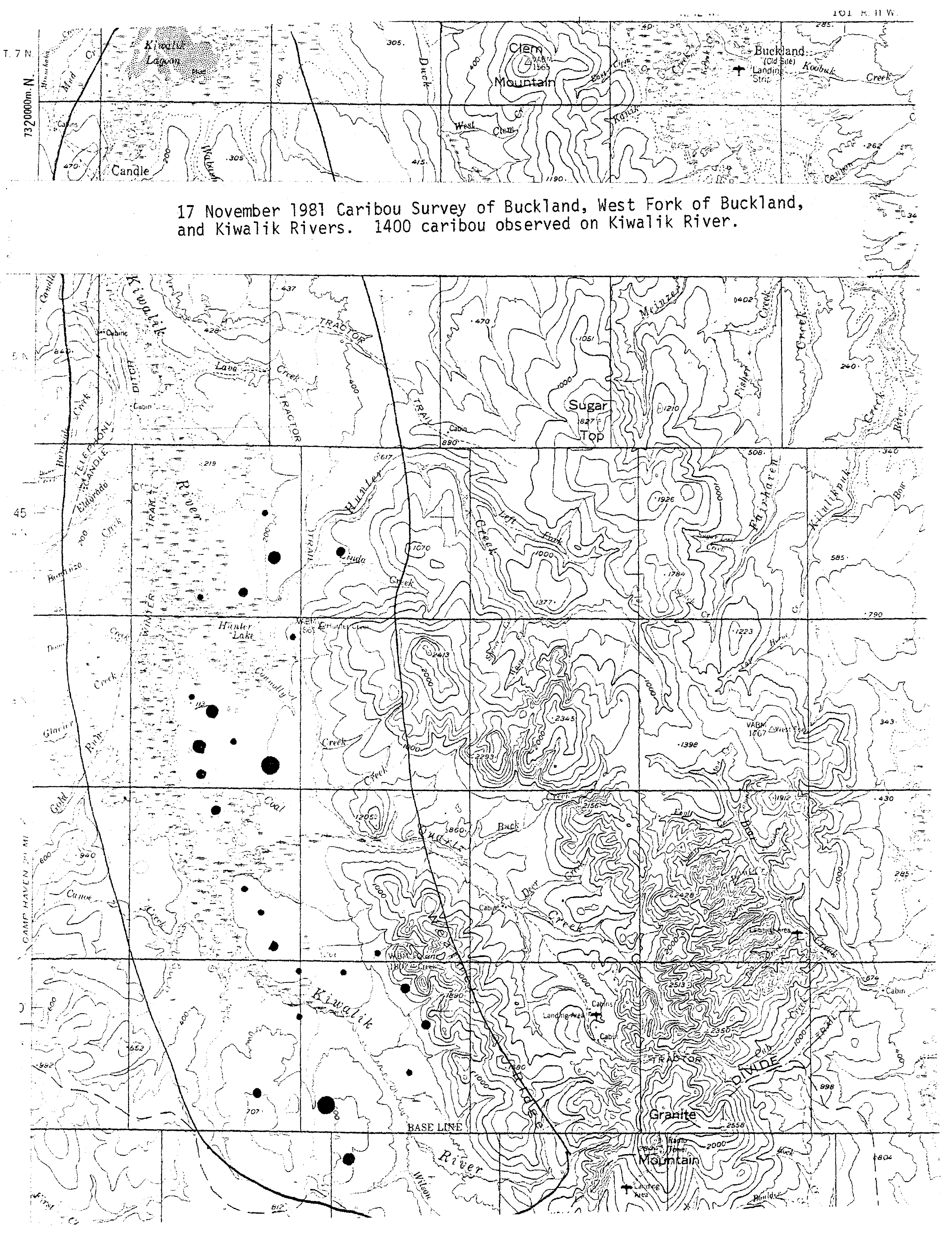


17 November 1981 Caribou Survey of Buckland, West Fork of Buckland, and Kiwalik Rivers. I50 caribou observed near mouth of Buckland River.

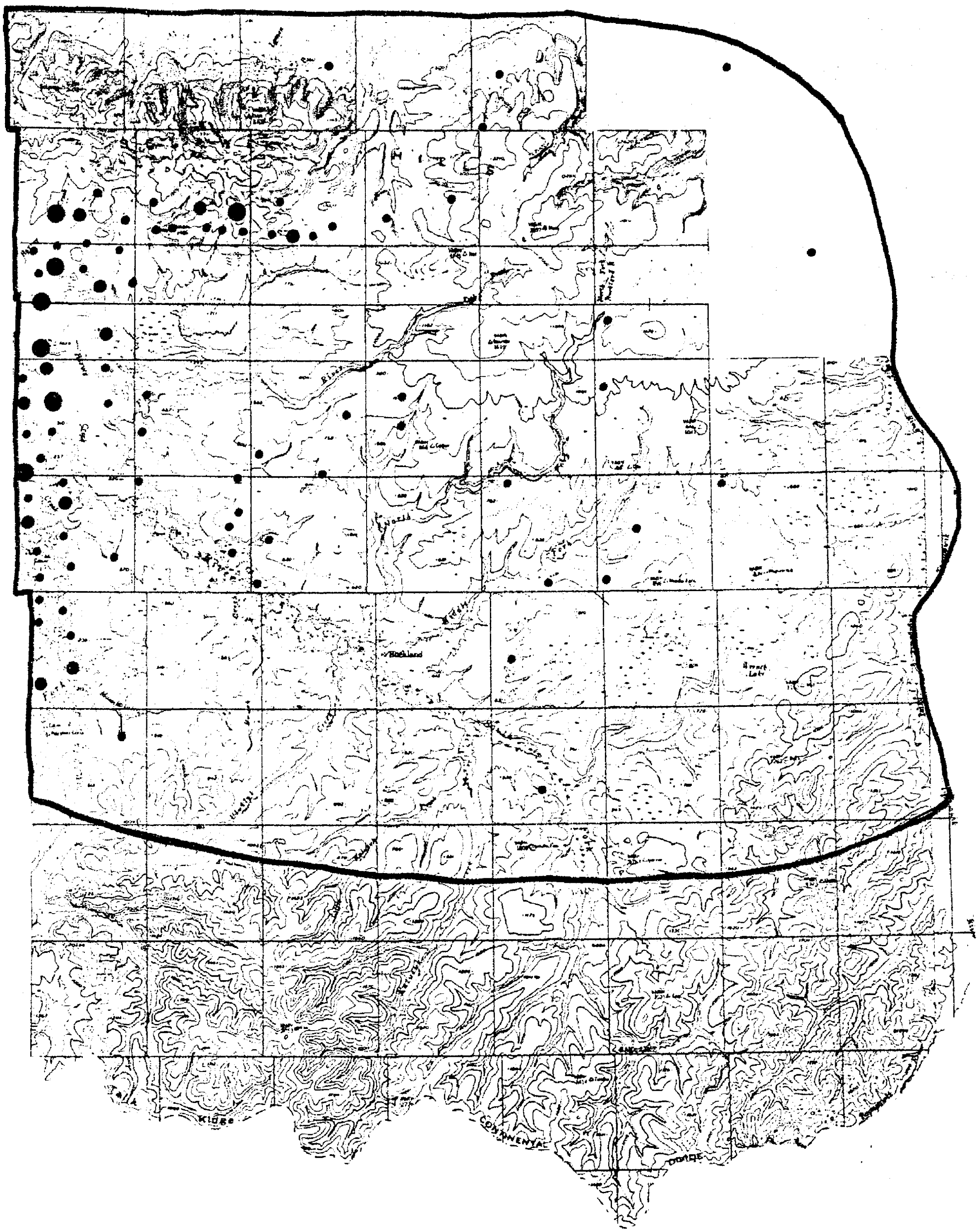


17 November 1981 Caribou Survey of Buckland, West Fork of Buckland, and Kiwalik Rivers. 400 caribou observed on West Fork.

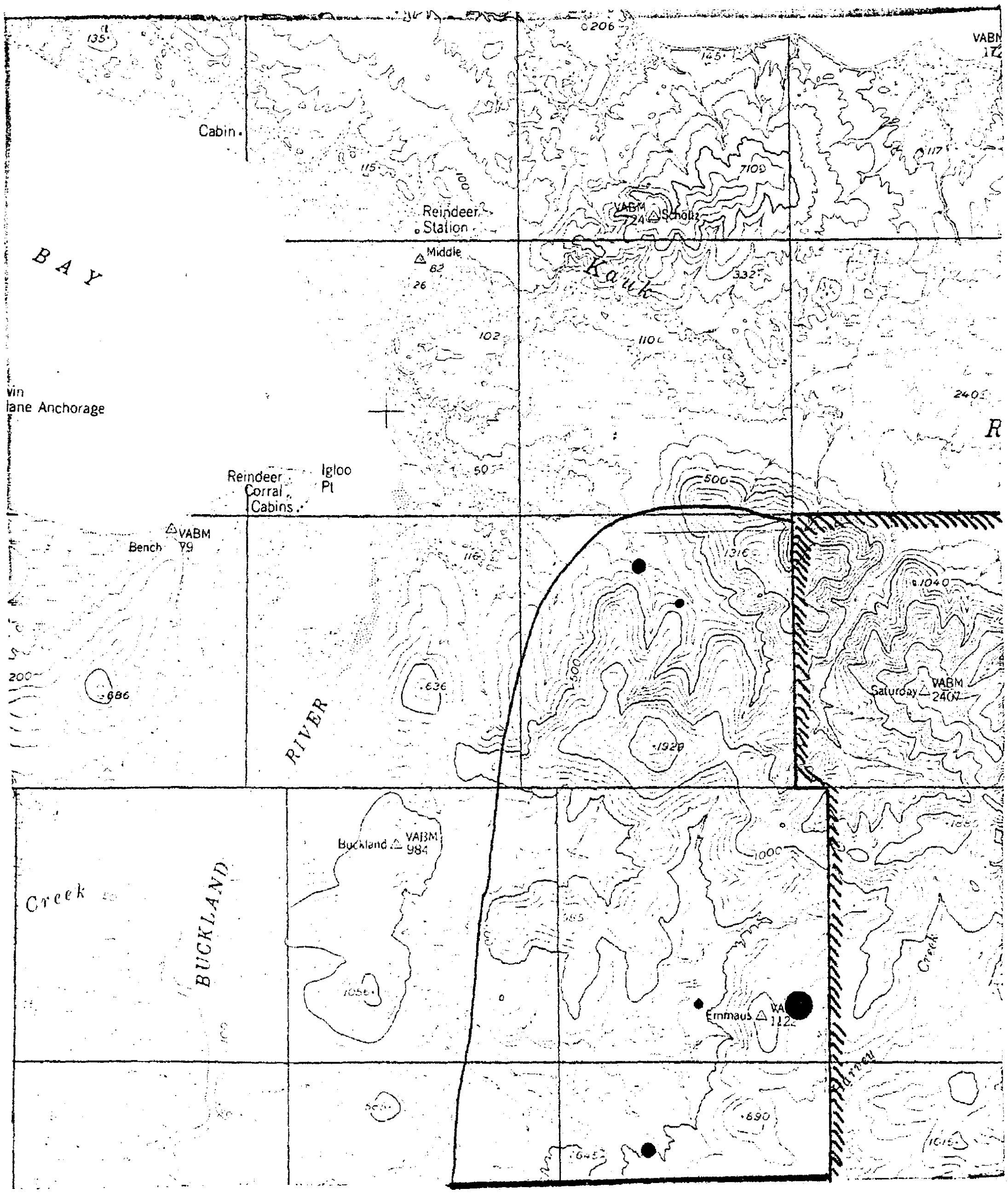




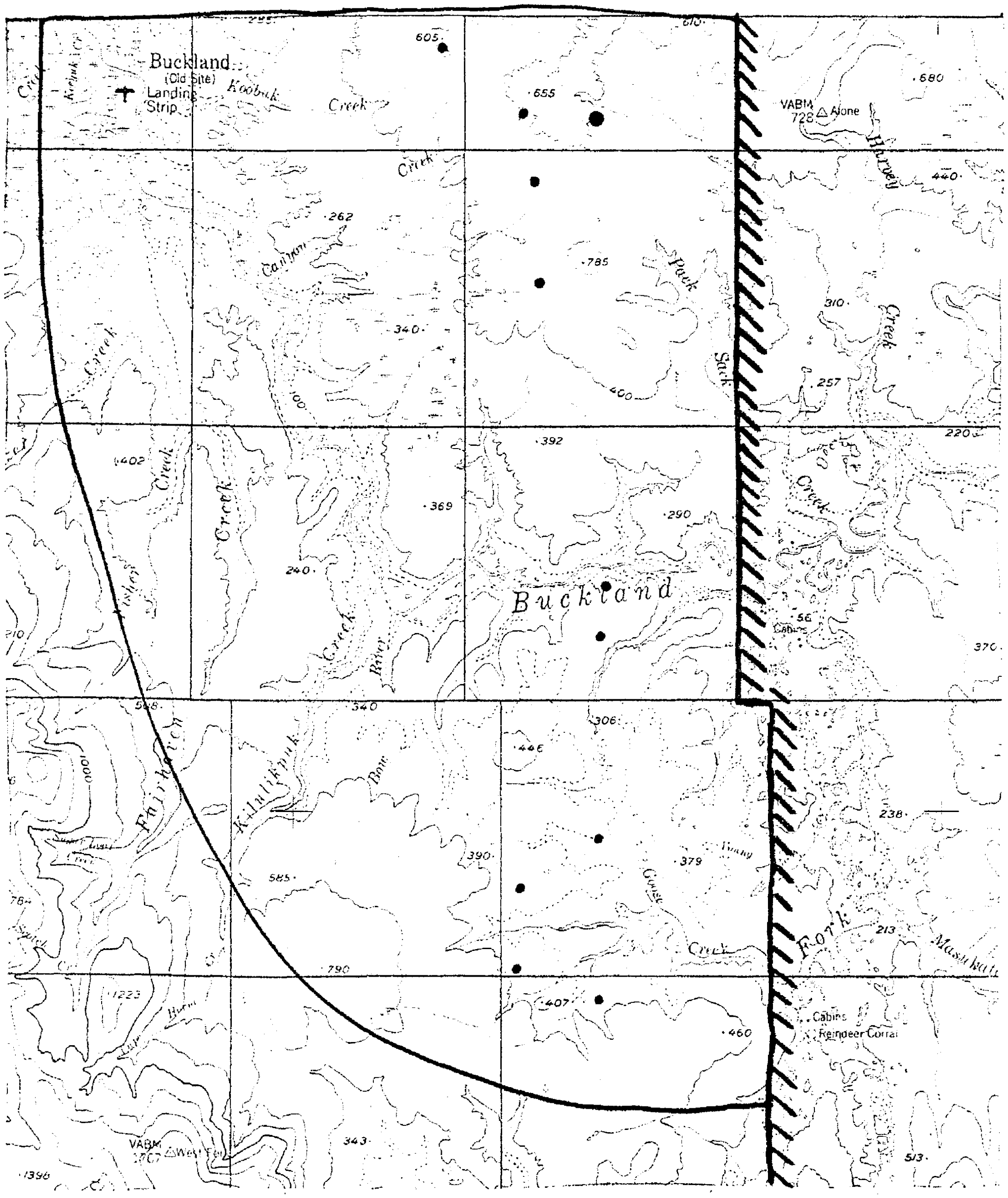
17 November 1981 Caribou Survey of Buckland, West Fork of Buckland, and Kiwalik Rivers. 1400 caribou observed on Kiwalik River.



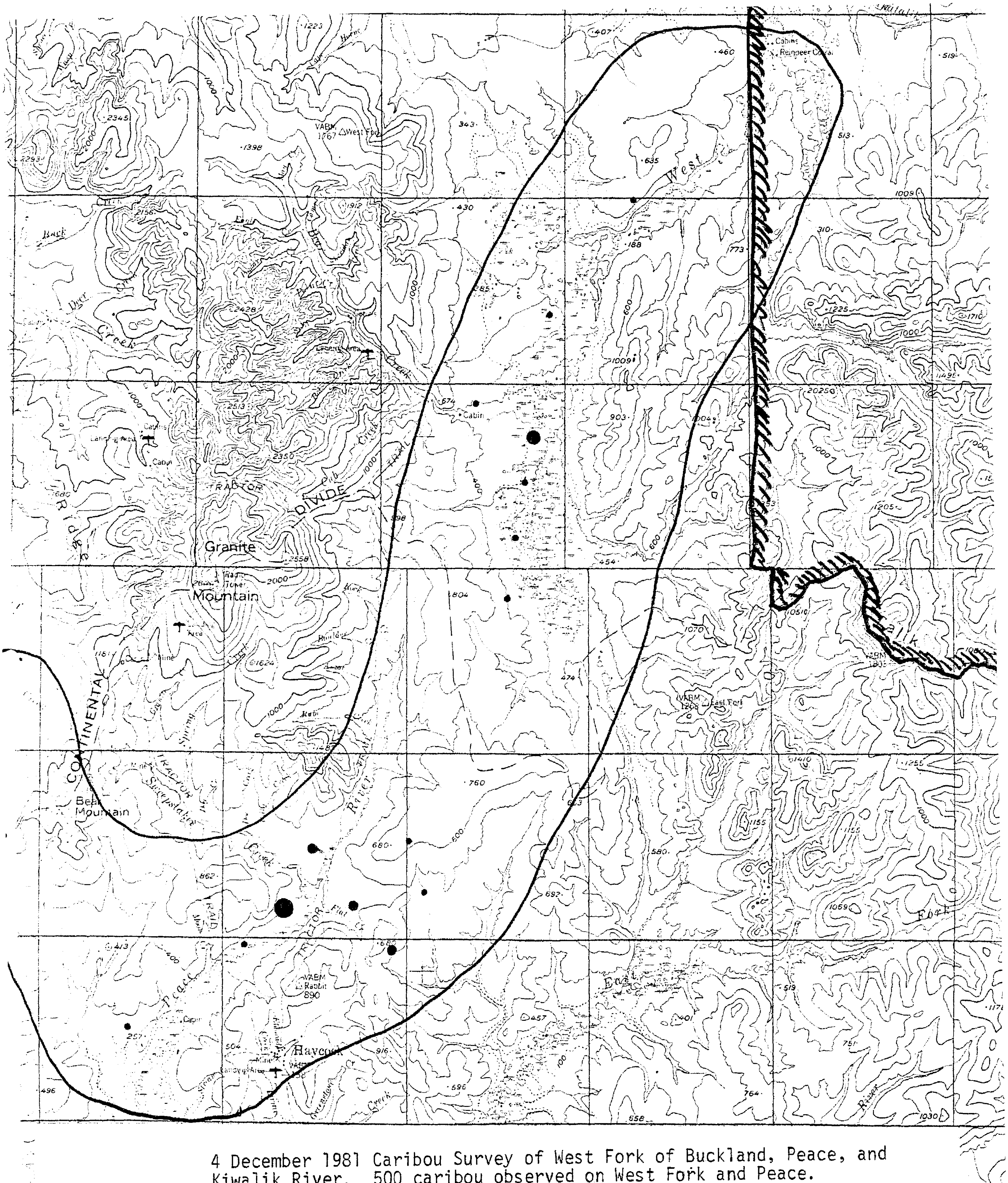
Buckland Valley Caribou Survey-3 & 4 December 1981-2100 caribou observed. (400 observed west of study area-see supplemental map).



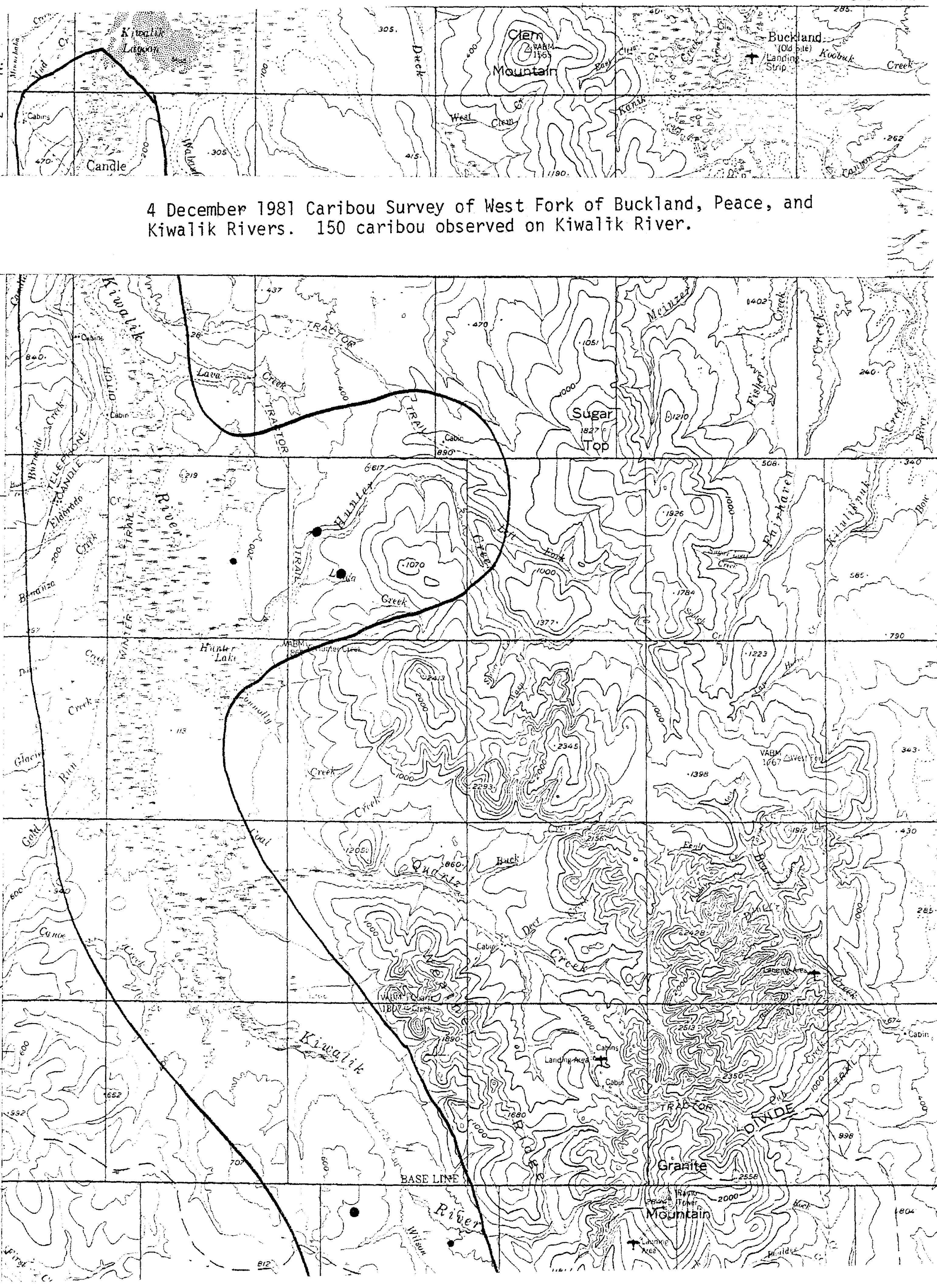
Supplemental map for 3 & 4 December 1981 Buckland Valley Caribou Survey.



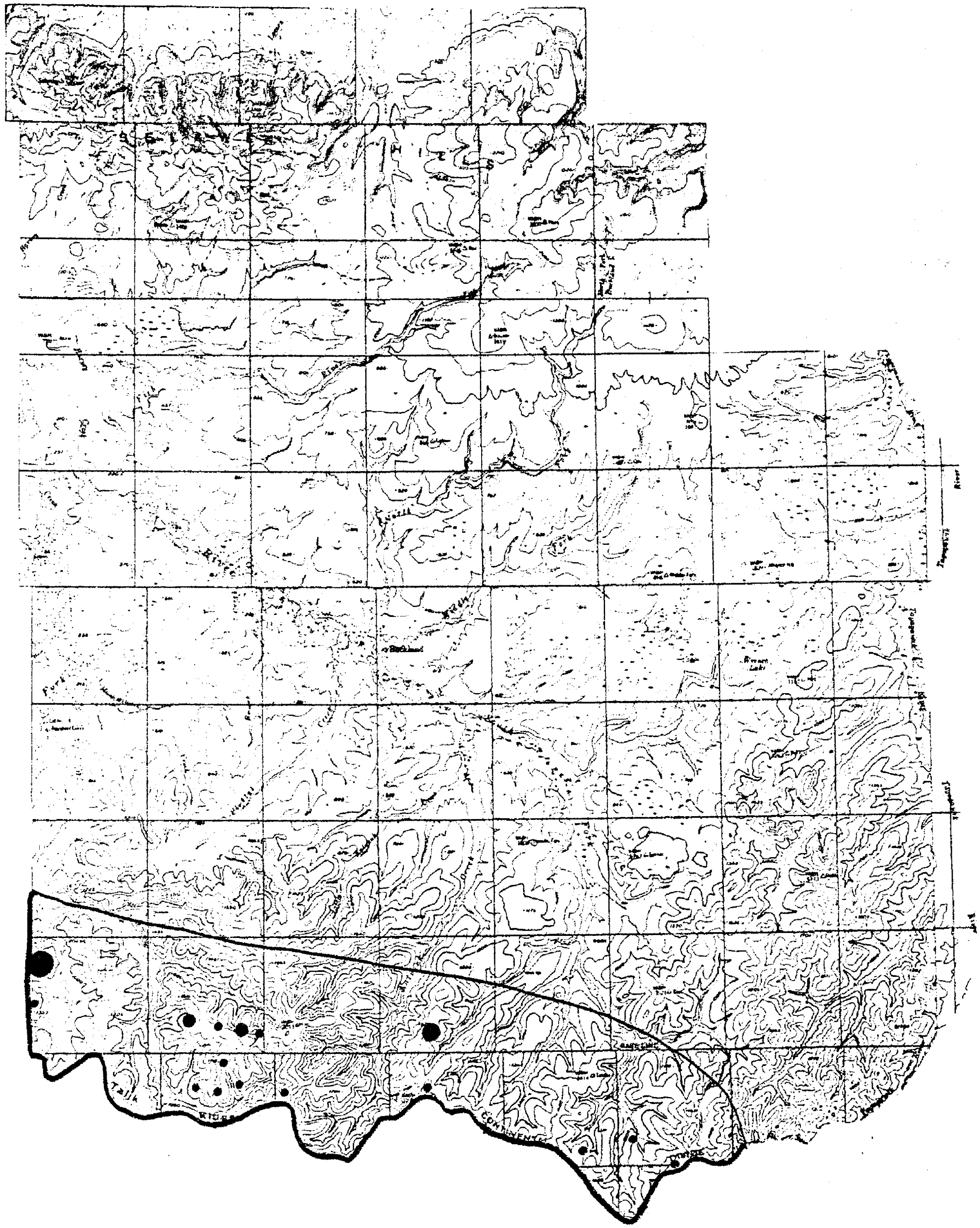
Supplemental map for the 3 & 4 December 1981 Buckland Valley Caribou Survey.



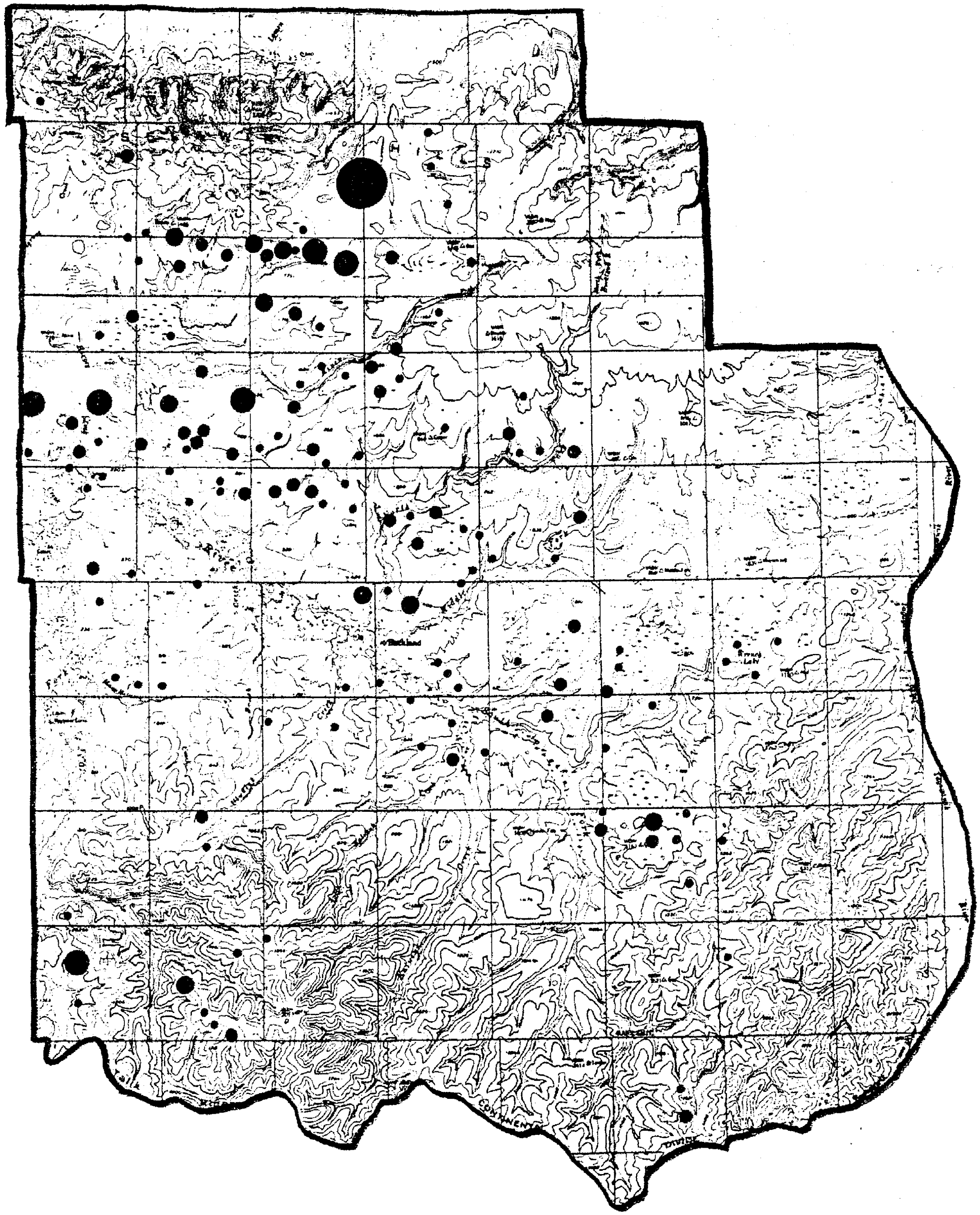
4 December 1981 Caribou Survey of West Fork of Buckland, Peace, and Kiwalik River. 500 caribou observed on West Fork and Peace.



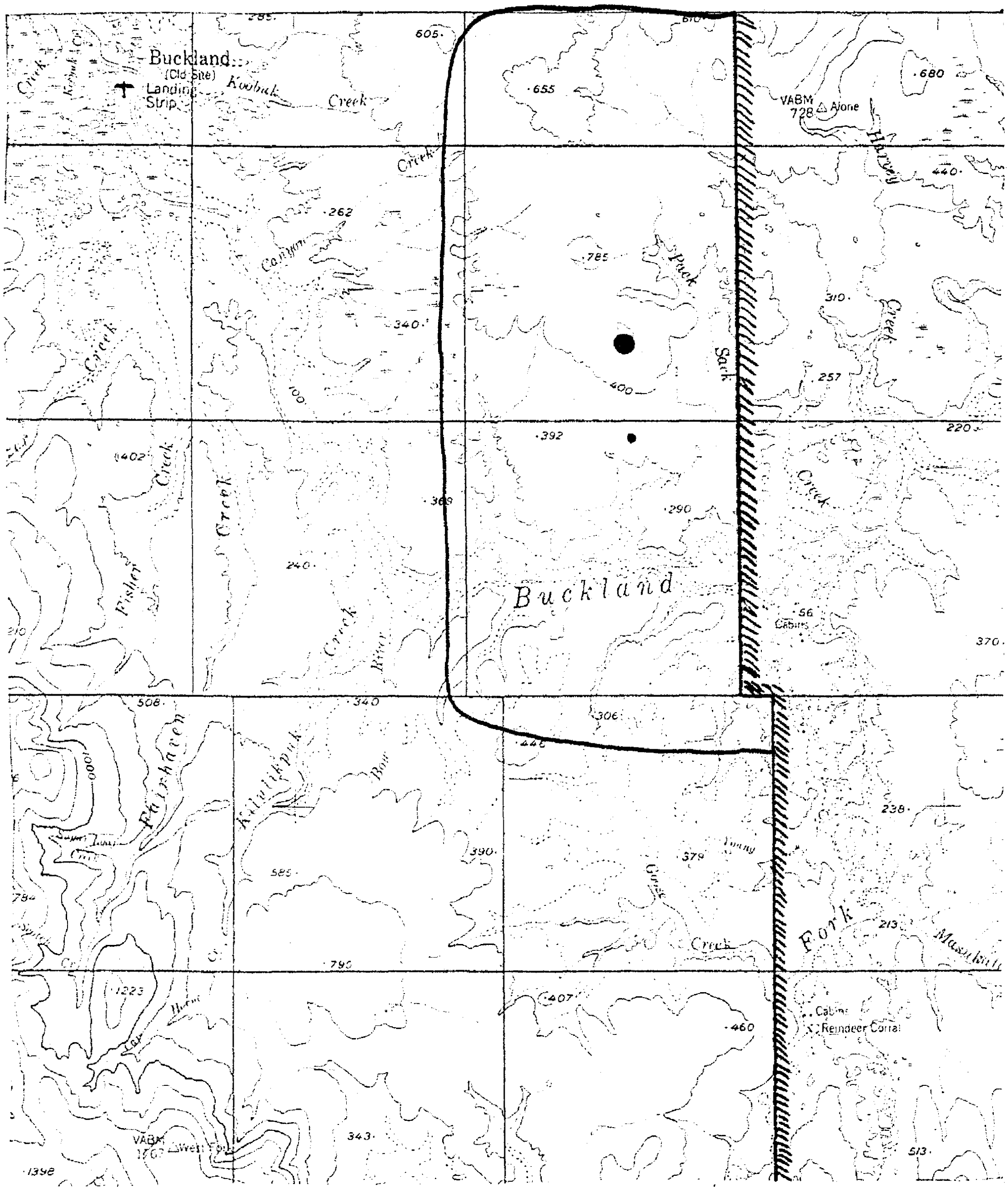
4 December 1981 Caribou Survey of West Fork of Buckland, Peace, and Kiwalik Rivers. 150 caribou observed on Kiwalik River.



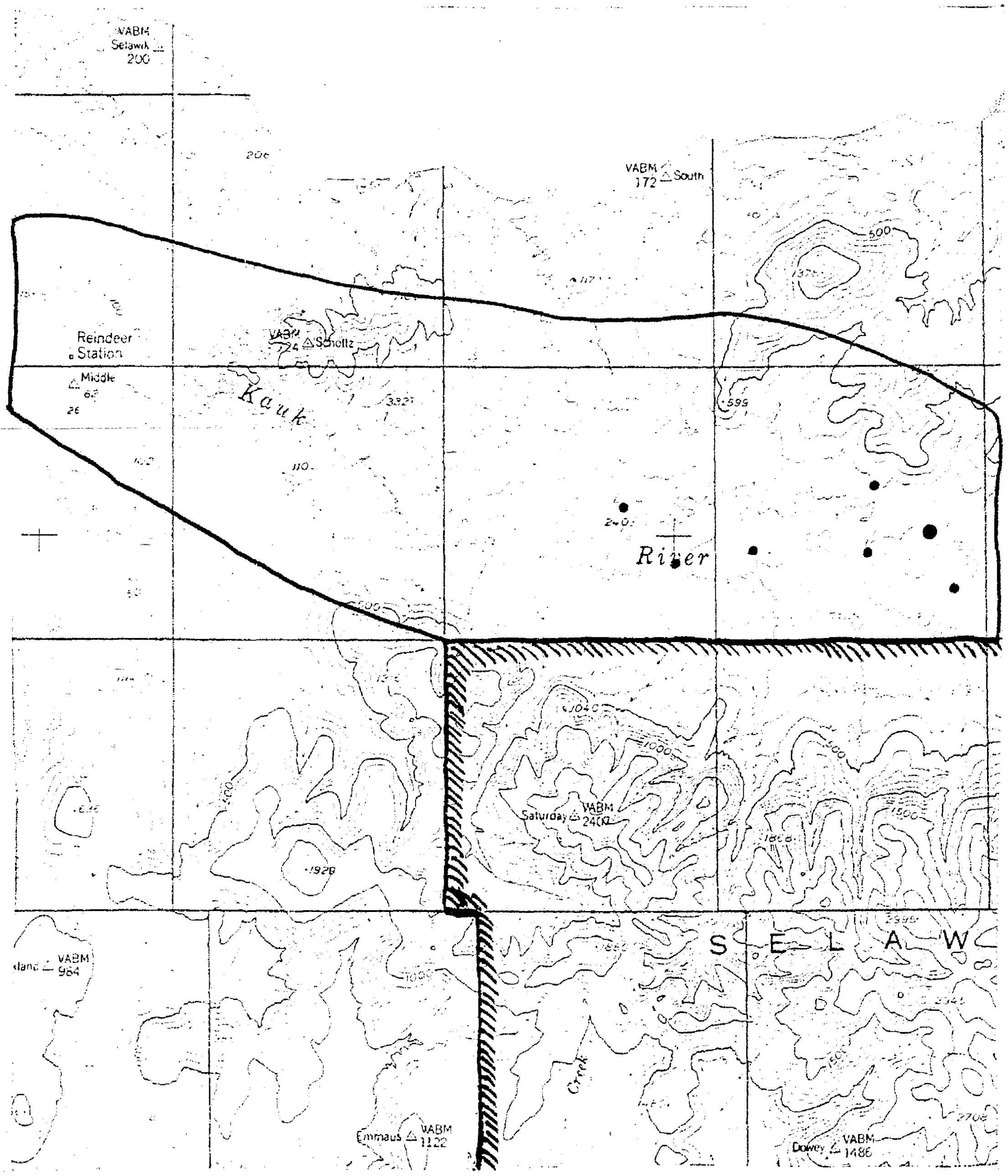
Buckland Valley Caribou Survey-11 February 1982-400 caribou observed.



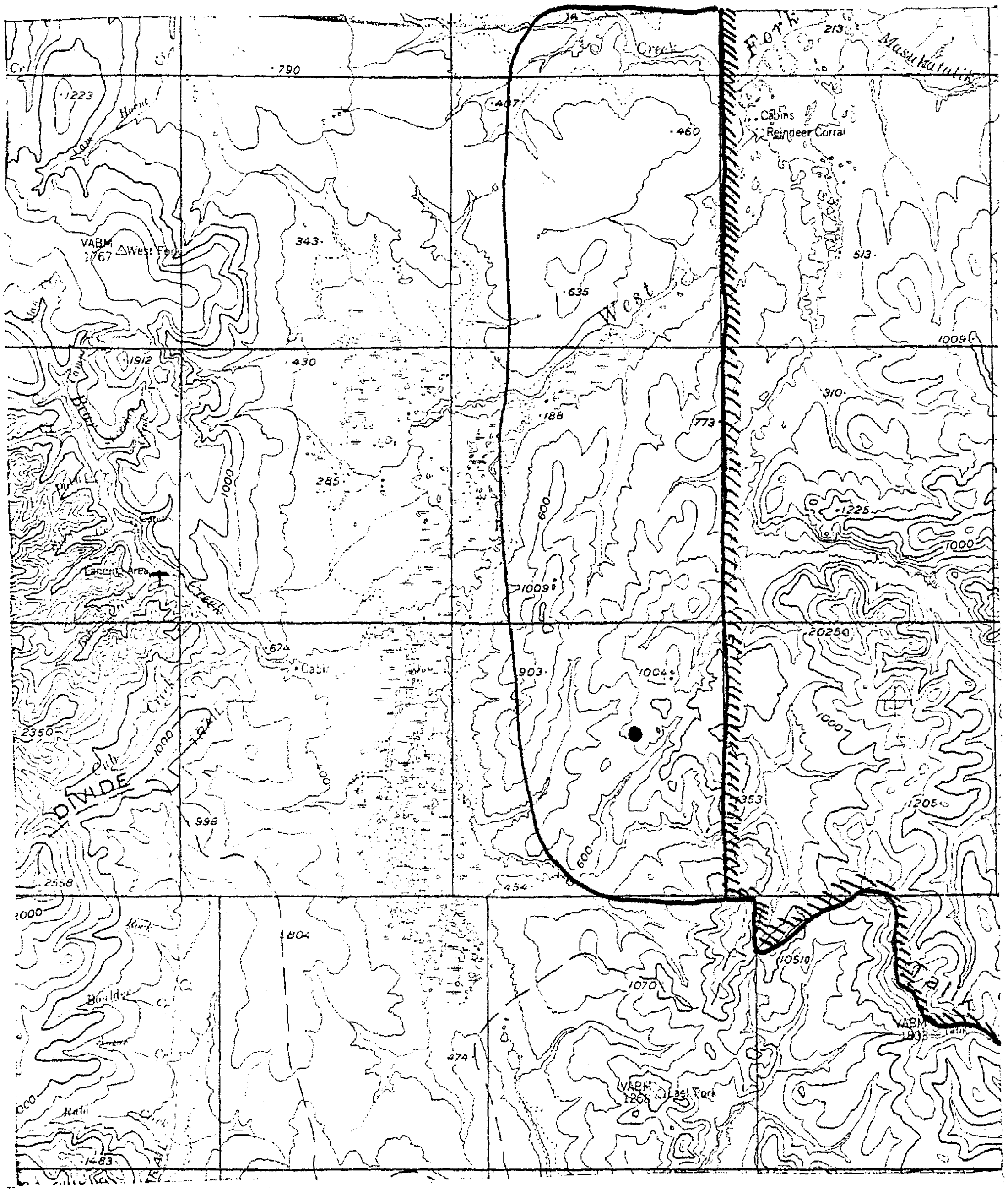
Buckland Valley Caribou Survey-24 & 25 February 1982-8400 caribou observed (300 observed north and west of study area-see supplemental map).



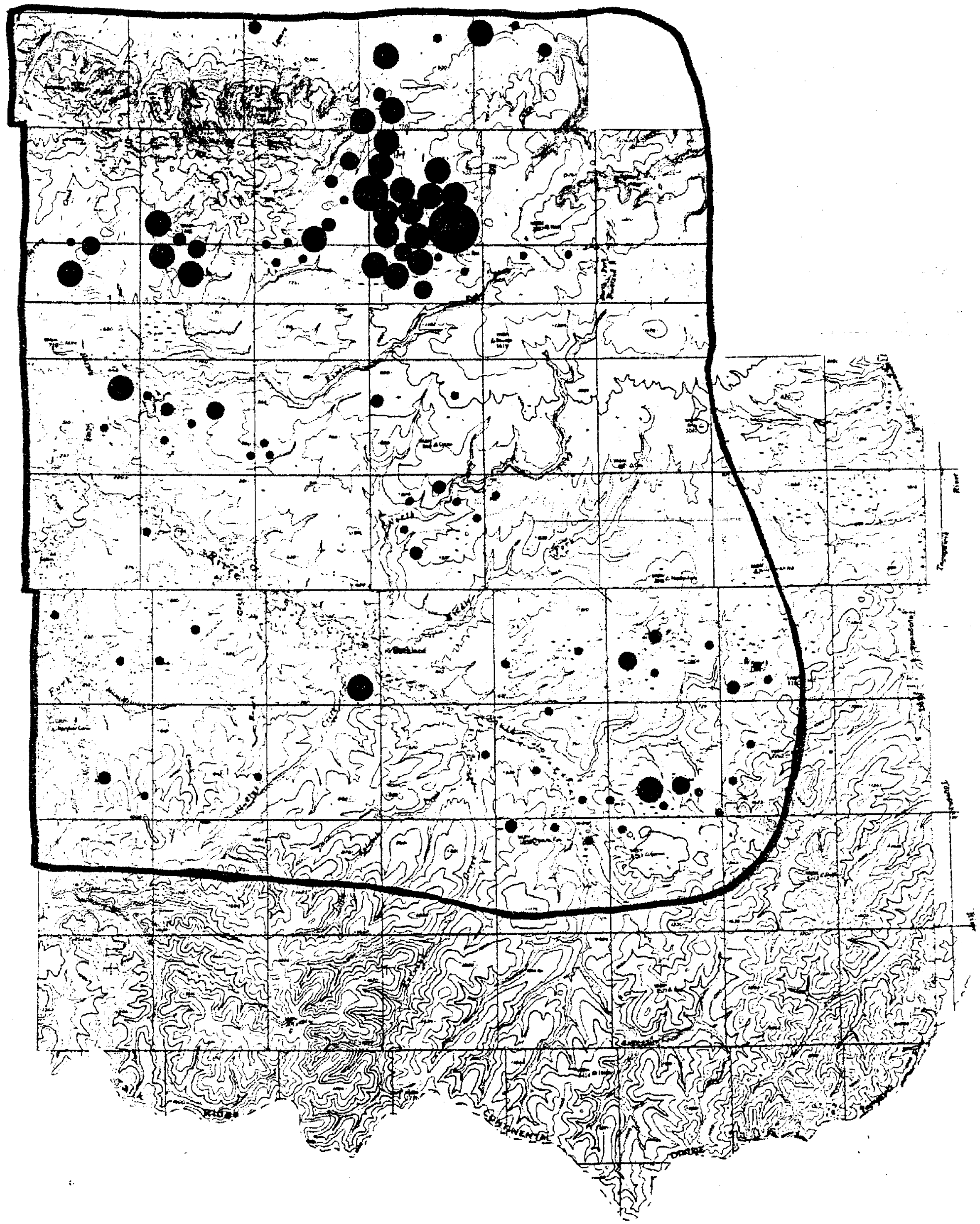
Supplemental map for 24 & 25 February 1982 Buckland Valley Caribou Survey.



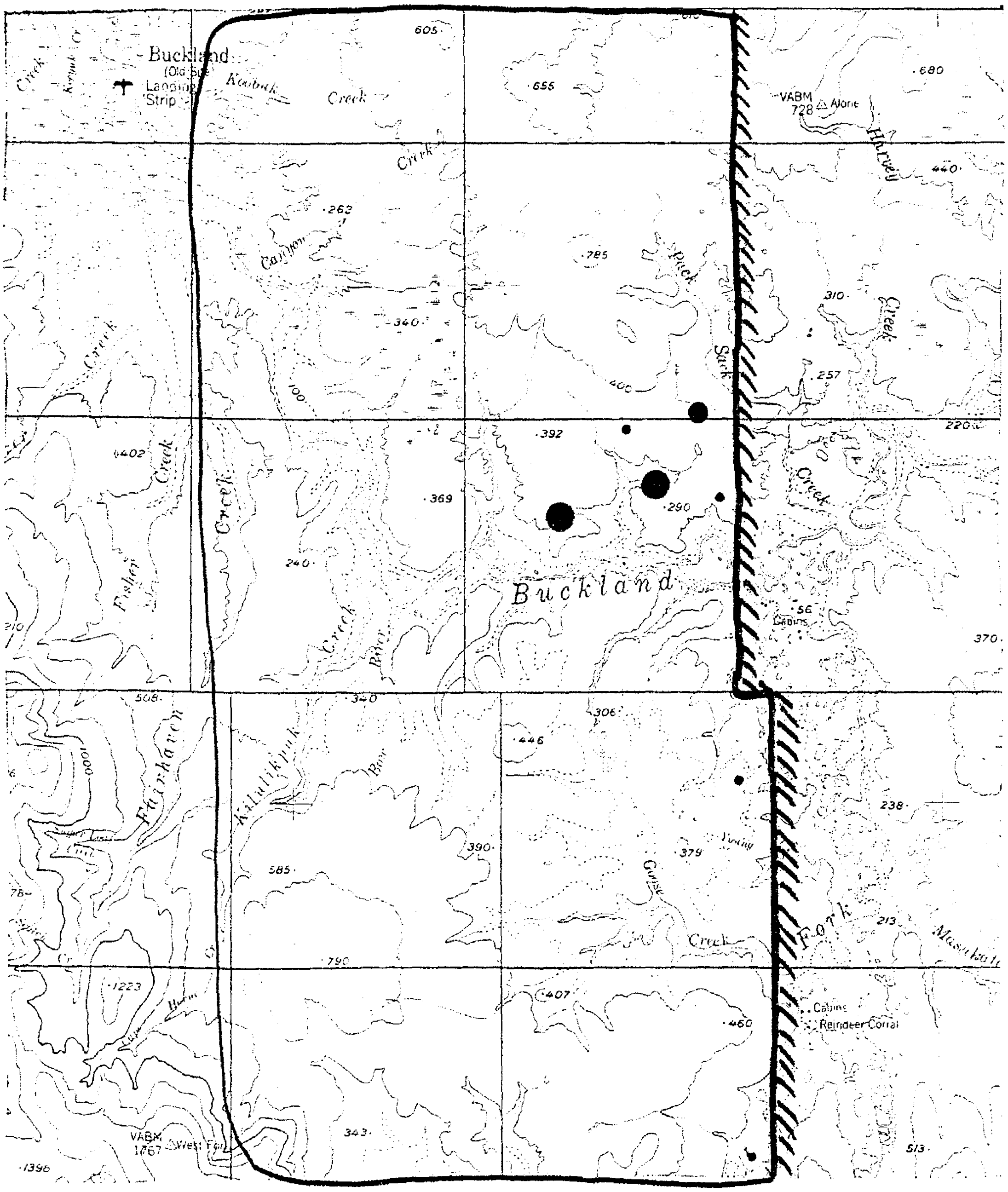
Supplemental map for 24 & 25 February 1982 Buckland Valley Caribou Survey.



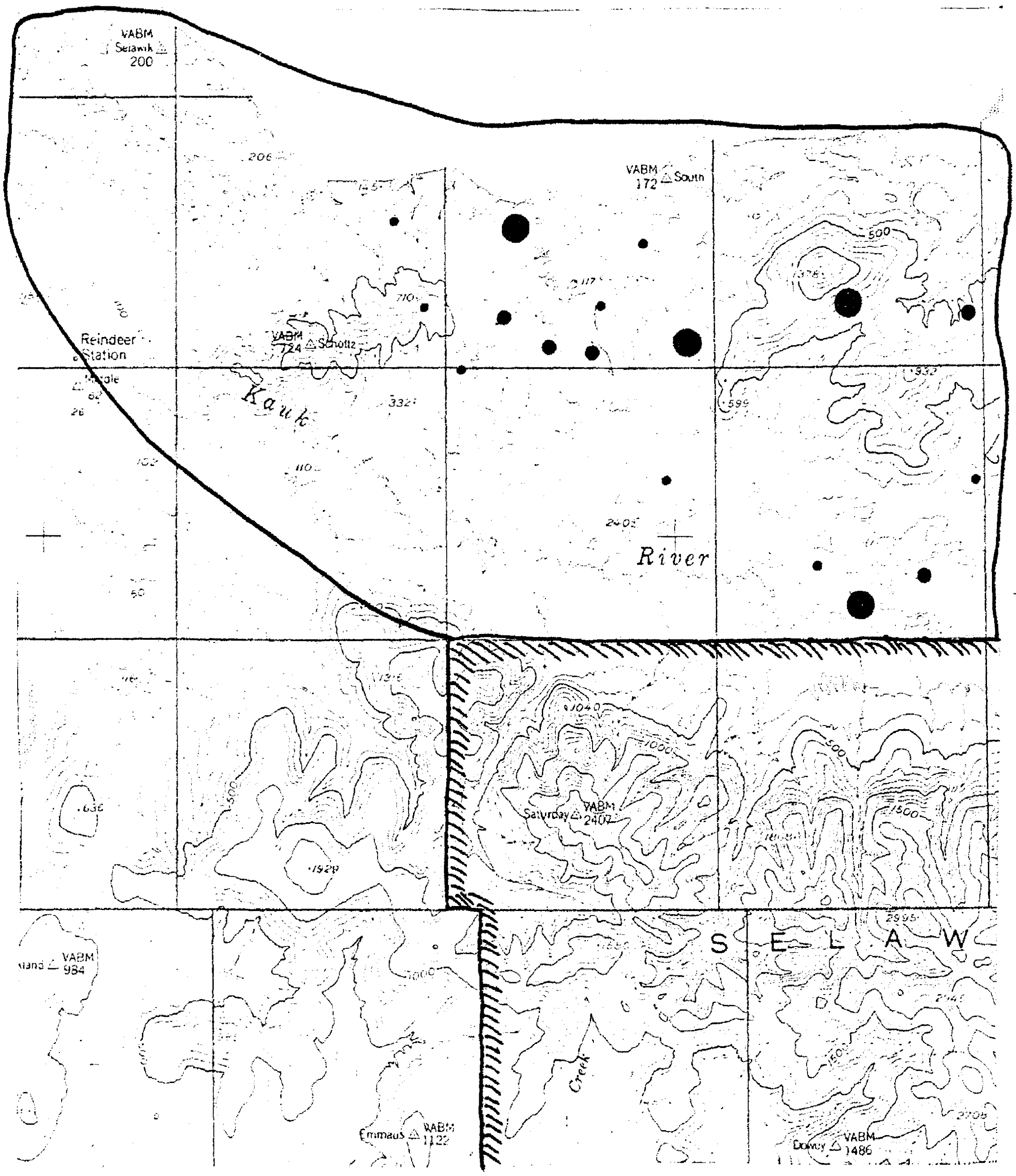
Supplemental map for the 24 & 25 February 1982 Buckland Valley Caribou Survey.



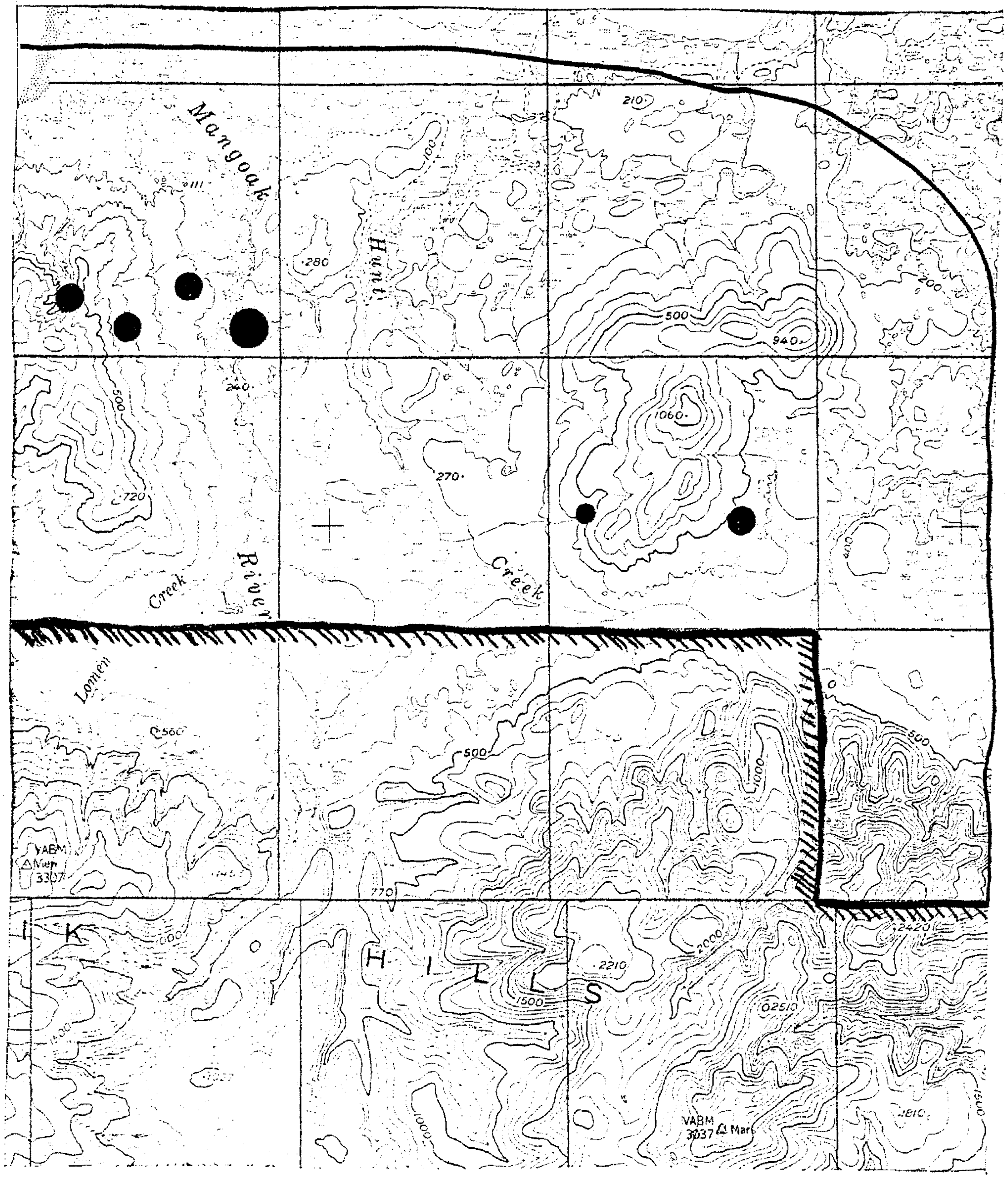
Buckland Valley Caribou Survey-15 & 16 March 1982-11,400 caribou observed (4000 observed north and west of study area-see supplemental maps).



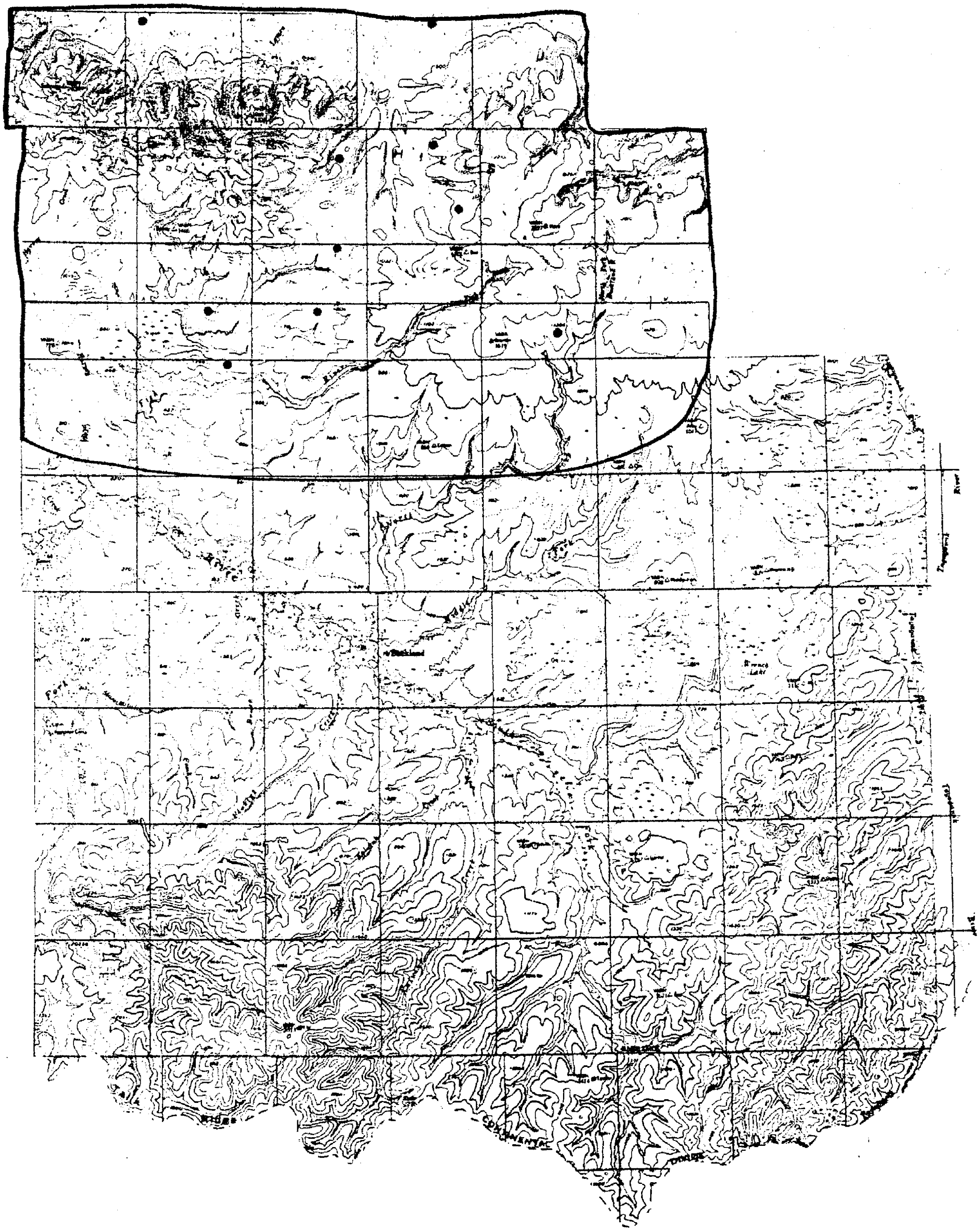
Supplemental map for 15 & 16 March 1982 Buckland Valley Caribou Survey.



Supplemental map for 15 & 16 March 1982 Buckland Valley Caribou Survey.



Supplemental map for 15 & 16 March 1982 Buckland Valley Caribou Survey.



Buckland Valley Caribou Survey-28 April 1982-70 caribou observed.

ADAMS

APPENDIX 2

Synopsis of Documented History of Caribou Herds in the Buckland River Vicinity

Year	Observation	References
1784	Caribou tracks present on Seward Peninsula when Cook explored Norton Sound	Cook and King 1784:478
1833-1870	Caribou abundant on Seward Peninsula and hills east of Norton Sound until early 1870's	Vanstone 1959 Lutz 1960 Ray 1975 Skoog 1968
1850-1900	Caribou herds on Seward Peninsula were decreasing. The reasons for decline are not clear, but it is possible that these animals were an overflow from the Western Arctic Caribou Herd and that this population shifted its range northwards and eastwards to the herd's center of habitation in the Central Brooks Range (or shifted to other areas)	Skoog 1968 Burch 1972 Stern et al 1977 Nelson & True 1887 Ray 1975 Wilimovsky & Wolfe 196 Schwatka 1885
1880's-1900	Caribou were rare along Alaska's west coast from the Seward Peninsula to Cape Lisburne. Jackson noted starving condition of local natives and introduced reindeer to Seward Peninsula in 1892	Skoog 1968 Stern et al 1977
1892-1914	Introduction of reindeer herding to Alaska	Stern et al 1977
1920-1937	Reindeer herds increased to very large populations. Range deterioration was observed and herds went into decline	Skoog 1968 Davis et al 1978 Lantis 1950
1930's	Caribou were once again sighted along Chukchi coast north of the Seward Peninsula. Reindeer herds began to experience serious losses of deer to wandering caribou	Rood 1942 Skoog 1968 Stern et al 1977 Davis et al 1978
1950-1971	Arctic Caribou herd wintered mostly to south each year. Wintering areas extended from Waring Mountain area east to Wiseman	Lent 1966 McGowan 1966 Glenn 1967 Skoog 1968 Hemming & Glenn 1968 Hemming & Pegau 1970
1950-1970	Caribou using western migration routes wintered along the lower and middle Kobuk River valley and in the Selawik Flats and Buckland Hills. Since 1950 the Selawik Flats and surrounding hills have provided more sustenance for wintering caribou than any other area	Davis et al 1978

	Herd between 1959-1975 includes Selawik Flats/Buckland Hills area during all but 1962-63, 1968-69 and "a few" in 1970-71 (see attached table and maps)	
1955	11/55 20,000 caribou arrived at headwaters of Buckland River	Olson 1957
1961	15,000 Caribou on winter range south of Selawik River	Wilimovsky & Wolfe 1
1963-64	Large portion of herd wintered at base of the Seward Peninsula	Skoog 1964
1965-66	50-55,000 animals moved up the Kobuk River and a large segment moved into the Buckland River	McGowan 1966
	The caribou were joined by approximately 250 reindeer from a herd at Cape Kousenstern and 500-750 more from reindeer herds on the northern part of Baldwin Peninsula	McGowan 1966
1966	All the herds (reindeer) east of Kotzebue Sound failed by 1966, caribou largely being held responsible for the failures	Stern at al 1977
1972	A major portion of the (Western Arctic Caribou) herd wintered southeast of Buckland	Survey & Inventory Report-Pegau
1974-75	The major winter concentrations of caribou during 1975 were located in the Selawik Flats along the Selawik and Kugarak Rivers and southwest to the vicinity of Buckland	Davis et al 1978
1975	Fall: After they crossed the Kobuk River, the caribou presumedly continued to the Selawik Flats-Buckland Hills area	Davis et al 1978
1976-77	About one-half of the herd wintered on the Arctic coastal plain and many others moved to a traditional major wintering area adjacent to the Selawik Flats	Davis et al 1978
1976	Many thousands of caribou reached the upper Buckland River	Davis et al 1978
1977	November: 30,000 caribou east of Buckland	Big Game Distribution Index File at Dept. o Fish and Game
1978-79	Concentrations of caribou are using the upper Buckland River, nearby hills, Selawik Hills, and Selawik Flats	Unpublished data, AK Dept. of Fish and Gam

Reported location of major wintering areas of Western Arctic caribou between 1959 and 1975.

lower Kobuk lower Noatak	Baird Mtns Squirrel R	Delong Mtns Mulgrave Hills	Arctic Coastal Plain*	upper Koyukuk	middle Koyukuk	Dolbi Flats Huslia Area	Selawik Flats Buckland Hills	Ray Mountains	Rema:
	X			X			X		
X			X				X		
X		X		X			X		
X	X								
		X		X			X	X	widesp distrib
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X		X		X	X		X		
		X	X		X		X		
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		X					X		few
					X	X	a few		few
						X	X		
	X		X				X		
	X						X	X	
		X					X		

iable observations. It is likely that some caribou wintered on the coastal plain in most years.

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