FINAL REPORT
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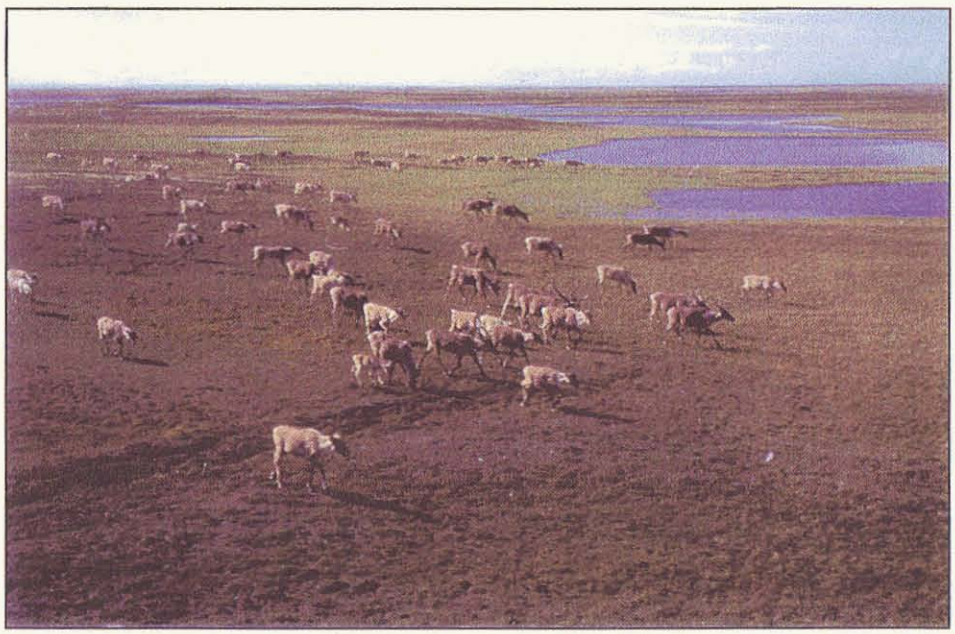

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LARGE MAMMAL DISTRIBUTION IN THE BADAMI STUDY AREA, SUMMER 1999

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Large mammal distribution was documented from the Sagavanirktok River delta on the west to near Bullen Point on the east and inland to latitude 69°54.5'N within the Badami development area North Slope, Alaska, during systematic, strip-transect surveys between 15 June and 19 July 1999. A total of 15,143 caribou (*Rangifer tarandus*) in 665 groups was recorded during seven surveys. Caribou numbers within the study area ranged from 13 on 17 July to 4,209 on 1 July. Mean and 95% Confidence Interval (95%CI) of caribou group size ranged from 1.6 ± 0.77 caribou on 17 July to 168.8 ± 133.61 caribou on 8 July. Cow caribou density in the Badami study area was 0.62 cows/km^2 on 15 June and increased to 0.87 cows/km^2 on 20 June 1999. Calf production on 20 June 1999 was 47 calves:100 cows. The predominant activities of caribou groups during the calving period were feeding 52% and resting 36%. During post-calving surveys, cows and calves were 83% (range 70% to 96%) and bulls were 16% (range 4% to 30%) of classified caribou. Indices of mosquito activity, oestrid fly activity, and sweep net sampling indicated that mosquito activity peaked between 1 July and 10 July 1999. During post-calving period surveys, large caribou groups appeared to be associated with riparian habitats more consistently than with coastal habitats. Caribou density during the post-calving period was highest on 1 July at 3.2 caribou/km^2 and lowest on 17 July at 0.01 caribou/km^2. Mean and 95%CI of caribou density during the post-calving period was 1.86 ± 1.542 caribou/km^2. The proportion of caribou groups feeding during the post-calving period increased with increasing group size with a minimum of 48% for groups of <10 caribou to a maximum of 81% for groups of >100 caribou. To evaluate potential blockage of north-south caribou movements by the Badami pipeline corridor, the proportion of caribou within coastal (1- to 4-km) and inland (5- to 8-km) intervals from the Beaufort Sea coast were compared between the Badami study area and the Bullen Point to Staines River study area to the east. The proportion of caribou within coastal and inland intervals in the Badami and Bullen Point to Staines River study areas were not significantly different. We reviewed five years of aerial survey distribution data for evidence of north-south caribou movements along the Badami pipeline corridor. Based on this data, there was no evidence of consistently used crossing areas. Six muskoxen groups with 87 individuals were observed during aerial surveys, primarily along riparian corridors. One or two grizzly bears were recorded during each survey from 15 June to 8 July, with half of these sightings along riparian corridors.

Key words: Alaska, caribou, Central Arctic Caribou Herd, elevated pipeline, muskoxen, North Slope, oilfield, *Ovibos moschatus, Rangifer tarandus*

INTRODUCTION

Environmental assessments have been completed for the Yukon Gold, Sourdough, and Badami oil exploration and development areas on Alaska's North Slope. Areas between the Sagavanirktok River and Bullen Point and between the Sagavanirktok River and the Staines River were surveyed for large mammal distributions beginning in 1993 to collect baseline distribution information in support of these environmental assessments (Pollard and Noel 1994, 1995; Noel 1998). Construction of the Badami development was completed during winter 1996-1997 and the Badami pipeline was completed during winter 1997-1998.

Two caribou (*Rangifer tarandus*) herds may occur in the area between the Sagavanirktok and Staines rivers: the Porcupine Caribou Herd (PCH) and the Central Arctic Caribou Herd (CAH). Studies of the PCH conducted over the past 20 years have shown that little, or no, calving occurs west of the Staines River, nor is the area used by large numbers of PCH caribou during post-calving and dispersal periods (Clough et al. 1987). During spring migration, CAH caribou move from the northern foothills of the Brooks Range to the coastal plain. In general, cows arrive on the coastal plain to calve between late April and early June, while bulls do not arrive until post-calving in early July (Whitten and Cameron 1980, Jakimchuk et al. 1987). The CAH uses two areas for calving, one west of the Sagavanirktok River (near the Kuparuk and Milne Point oilfields), and one east of the Sagavanirktok River. These are thought to reflect east and west segments of the CAH, although there may be intra- and inter-annual movements of animals between segments (Cronin et al. 1997). Within the eastern and western CAH calving areas, several general areas of concentrated calving have been reported; however the distribution of calving caribou varies annually. Two areas of high-density calving occurred in most years since 1969: between Oliktok Point and the Kuparuk River (Milne Point) and between Bullen Point and the Canning River (Cameron and Whitten 1978, Gavin 1983, Lawhead and Curatolo 1984, Whitten and Cameron 1985, Cameron et al. 1989).

The CAH uses broad areas along the Arctic Coastal Plain between the Colville and Canning rivers for summer range during the post-calving period (Smith 1996). Coastal areas, river deltas, river channels, and wind-swept uplands and ridges are used as insect-relief habitats by mosquito- and oestrid-harassed caribou during the post-calving period. Large groups are often observed near Franklin Bluffs and on the deltas of the Kadleroshilik, Sagavanirktok, Shaviovik, and Staines rivers (Gavin 1983, Carruthers et al. 1984, Pollard et al. 1996b). Large aggregations of caribou seek relief from parasitic insects on or near deltas of the Kuparuk, Shaviovik, and Canning rivers during intense insect harassment; although caribou groups have been observed along the coast within the entire Oliktok Point to Canning River area (Lawhead and Curatolo 1984; Pollard and Noel 1994, 1995; Pollard et al. 1996b; Noel 1998, Noel and Olson 1999). Caribou may also use gravel roads and pads and oilfield facilities as insect-relief habitat (Pollard et al. 1996a, b; Noel et al. 1998).

By the late 1800s, muskoxen (*Ovibos moschatus*) were exterminated from the North Slope of Alaska and information is sparse concerning historic muskoxen population levels (Clough et al. 1987). Muskoxen were reintroduced into the Arctic National Wildlife Refuge (ANWR) in 1969 and 1970 and the population has grown exponentially since 1974 (Reynolds and Ross 1984). Mixed-sex herds have dispersed into areas east of the Aichilik River (Clough et al. 1987), and muskoxen have been regularly sighted as far west as the Sagavanirktok River near the Prudhoe Bay oilfield (Pollard and Noel 1994, 1995; Noel 1998, Noel and Olson 1999). Although muskoxen are non-migratory, they move in response to seasonal changes in snow cover and vegetation. During summer and fall, they are found primarily in riparian habitats, but move to adjacent uplands in winter and spring (Clough et al. 1987). Riparian habitats are important travel corridors and foraging areas. Moose (*Alces alces*) are uncommon on the North Slope, but they were observed in the area during 1994, 1995, and 1998 surveys (Pollard and Noel 1994, 1995, Noel and Olson 1999).

Coastal areas are used seasonally by grizzly bears (*Ursus arctos*). They generally move north from denning areas in the foothills in late May and are most abundant in the study area during June and July. In late July, they gradually return south to the foothills (Clough et al. 1987). Riparian areas are used as travel corridors and contain abundant prey and preferred vegetation. The Alaska Department of Fish and Game (ADF&G) conducts ongoing research and monitoring of grizzly bear numbers, productivity, and movements within the Prudhoe Bay oilfields, and has addressed bear use of the landfill and problem bears. Wolves (*Canis lupus*) are rare on the Arctic Coastal Plain. Three wolf sightings recorded during 1999 were the first documentation of wolves in the study area since LGL began aerial surveys in 1993.

ISSUES

Potential impacts to caribou from oil development in the Badami study area include:

- Blockage of northward or southward movements to and from the Beaufort Sea coast by roads, pipelines, or other facilities and oilfield activities.
- Displacement of caribou from traditional calving and post-calving habitats, or blocked access to such habitats.

Pre- and post-development data needed to assess development impacts to caribou includes distribution and abundance of caribou in the Badami study area during the calving and post-calving periods.

OBJECTIVES

During 1999, LGL Alaska Research Associates, Inc. (LGL) conducted systematic aerial surveys of large mammals within the area of the Badami development and the Badami pipeline corridor. Effort focused on calving and post-calving caribou distributions within the study area. Our objectives were:

1. to determine the number, sex/age composition, and distribution of caribou and other large mammals during caribou calving and post-calving periods, and

2. to evaluate potential blockage of caribou movement and identify caribou crossing areas along the Badami pipeline corridor.

STUDY AREA

The Badami study area is bounded on the west by the Sagavanirktok River, extends east to Bullen Point, north to the Beaufort Sea, and south to approximately latitude 69°54.5'N (Figure 1). The study area lies within Alaska's Arctic Coastal Plain and is characterized by a gently rolling thaw-lake plain landscape (Walker and Acevedo 1987). Tundra in the area gradually rises 20 to 25 feet above the level of streams and river channels, which gives the landscape a gently rolling appearance. This topographic relief results in many well-drained areas, and moist and dry tundra vegetation types are common on high-centered ice wedge polygon terrain. However, drainage is poor away from fluvial gradients and low-centered ice-wedge polygons; strangmoor, thaw-lakes and ponds, and drained lake basins predominate in these areas. The 40-km Badami pipeline extends across the northernmost section of the study area. The pipeline ranges from 1 to 5 km from the coast and extends from the Endicott pipeline on the west to the Badami facility on the east (Figure 1).

METHODS

AERIAL SURVEYS

During June and July 1999, seven systematic strip-transect aerial surveys (Caughley 1977) were conducted from either a Cessna 206 or a Cessna 207 fixed-wing aircraft. Two surveys were completed during the caribou calving period (1–20 June), and 5 surveys were completed during the caribou post-calving period (21 June to 15 August). Two observers recorded large mammal sightings along transect centerlines spaced at 1.6-km intervals, providing for 100% study area coverage (Figure 1). All transects were oriented north-south and centered on township and section lines mapped on 1:63360 scale U.S. Geological Survey (USGS) topographic maps. Surveys were flown 90 m above ground level at 130 km/hr airspeed (Pollard et al. 1992a). During surveys, each observer was responsible for searching an 800-m wide space on one side of

the transect centerline. Aircraft wing struts were marked to enable visual control of transect strip-width (Pennycuick and Western 1972). Observers verified strut markings with inclinometers and by comparison to survey maps. Species, number, sex/age composition, and group location were recorded for each observation. Behavior and habitat descriptions were recorded when possible.

Aerial surveys conducted by LGL in the Prudhoe Bay oilfield and adjacent areas since 1990 (Pollard et al. 1992a, b and others) have used Global Positioning System (GPS) receivers to navigate the aircraft during surveys and to identify the location of the aircraft when animals were observed. Coordinates of animal sightings were then calculated by using the GPS aircraft position offset by a visual estimate of the group's distance from the aircraft. As groups were sighted, all data was entered directly into a notebook computer linked to a GPS receiver (Motorolla Work Horse™ GPS receiver in 1999) using Geolink® software. For each sighting, a GPS-determined position was associated with group attributes (e.g., species, number of individuals, sex/age classification, distance and direction from the aircraft) entered by either one of the observers or by a data recorder.

Caribou were counted and classified as bulls, cows, calves, or unclassified based on body size, antler development, pelage, and calf presence. "Unclassified" caribou were either adults or yearlings, that could not be classified with confidence; caribou near the outer margin of transect strips were the most difficult to classify. When large groups of caribou were encountered, the aircraft left the transect line and circled the group to better facilitate counting and classification. The GPS tracked the aircraft from the line-transect departure point; therefore, survey coverage was not lost as a consequence of transect departures. Muskoxen were classified as adult (unclassified) or juvenile (calves). Moose were classified as bulls, cows, or calves. Grizzly bears were either listed as unclassified or females with young-of-year cubs, and wolves were listed as unclassified sex and age.

GEOGRAPHIC ANALYSIS

Large mammal observation data were combined with base-map data in MapInfo® Geographic Information System (GIS). Spatial data were used to produce maps of distributions for each survey and to conduct spatial analyses in MapInfo® and Vertical Mapper™. Data collected in the study area during 1999 were analyzed using the distribution and abundance of calves and all caribou. These classes of caribou were chosen because previous research has suggested that bulls and maternal cows respond differently to habitat features (Pollard et al. 1992a), and adult bulls and calves were easiest to identify during the surveys. Analyses were based on individual caribou rather than on groups. Individual caribou were used because: (1) during aerial surveys, groups were sometimes difficult to distinguish; (2) groups were

disparate in size, ranging from 1 to more than 2,000 individuals; and (3) groups are not of fixed membership. However, location data are collected for caribou groups, so individual caribou locations are not necessarily independent.

Contours of calving period distributions were created using Vertical Mapper™ software for MapInfo® GIS. Point location data was converted from latitude/longitude, datum World Geodetic Survey 1984 to Universal Transverse Mercator for Alaska Zone 6, North American Datum 1927 for the United States. Grid files were created using the distribution of caribou calves for each year and for all years combined using natural neighbor interpolation. Variables for interpolation were 200-m aggregation distance, sum of values for aggregated points, 200-m cell size, and convex hull boundary. Natural neighbor interpolation method was slope, with skew 1, weight 2 and exponent 2. Grids were then contoured using bins of <0, 0–5, 5–10, 10–25, and >25 calves.

To evaluate blockage of north-south caribou movements, the proportion of caribou occurring within coastal and inland areas with a pipeline and without a pipeline were compared. One-km intervals were constructed by buffering the Beaufort Sea coastline in the Badami and the Bullen Point to Staines River study areas. The Badami pipeline crosses these intervals within 5 km of the coastline primarily within the coastal 1- to 4-km interval. Numbers of caribou were summed for paired aerial survey coverages within the coastal 1- to 4-km interval and within the inland 5- to 8-km interval. The proportions of caribou within the coastal and inland intervals were then compared between study areas. This data was used to test the following hypothesis:

H01: The proportion of caribou in coastal, 1- to 4-km interval, and inland, 5- to 8-km interval, from the Beaufort Sea coastline are not different between the Badami study area and the Bullen Point to Staines River study area.

Test: Wilcoxon Signed Rank Test (non-parametric paired test), Mann-Whitney U test.

To identify caribou crossing sites along the Badami pipeline, intervals extending 1 km north and south of the pipeline were constructed by buffering the Badami pipeline. These intervals were subdivided into pipeline segments corresponding with north-south township and section lines. Caribou observations were summarized by pipeline segment; caribou densities were calculated using the mean annual number of caribou within the segment divided by the total land area for each segment. Land area was calculated as the total segment area minus the area of lakes within the segment based on 1:63360-scale digital base mapping. Habitats at pipeline segments were evaluated as the sum of area by land cover type within a 500-m buffer of the pipeline based on LandSat land cover mapping (Walker and Acevedo 1987).

PARASITIC INSECT ACTIVITY

Predictive models for mosquito (Russell et al. 1993) and oestrid fly (Mörschel 1999) activity were used to identify days with conditions suitable for parasitic insect activity. Index values were calculated for each hour that temperature and wind data were recorded at the Deadhorse Weather Station (ASCC 1999). Sweep net sampling for mosquitoes was conducted from 29 June to 24 July 1999, in conjunction with monitoring at the Badami pipeline. Mosquito and oestrid activity indices for the 1999 field season, and the syntax used to calculate the indices, are presented in Appendix B.

RESULTS

Seven systematic strip-transect surveys of the study area were completed during summer 1999 (Table 1, Appendix A). Coastal fog prevented surveying the entire study area on 20 June such that transects 21 and 22, and the northern portions of transects 23 to 25, were not flown resulting in 88% coverage of the study area (Figures 1 and A-2, Table 1). A total of 15,143 caribou in 665 groups were recorded during the seven surveys (Table 1). During calving-period surveys (15 June and 20 June), cows and calves comprised 98% (2,355 of 2,410) of all classified caribou (2 surveys; 68% cows [1,647 of 2,410], 29% calves [708 of 2,410]). During post-calving surveys, cows and calves were 83% (7,698 of 9,223) of classified caribou (5 surveys; 61% cows [5,594 of 9,223], 23% calves [2,104 of 9,223]). For individual post-calving surveys, cows and calves ranged from 70% (1,554 of 2,225) to 96% (3,077 of 3,215) of classified caribou. Bulls comprised 2% (55 of 2,410) of classified caribou during the calving period and 16% (1,525 of 9,223) of classified caribou for the combined post-calving surveys, ranging from 4% (138 of 3,215) to 30% (671 of 2,225) among individual surveys. Indices of mosquito and oestrid activity and sweep net sampling indicated that mosquito activity peaked between 1 July and 10 July 1999 (Figure 2).

Six muskoxen groups with 87 individuals were observed during aerial surveys (Table 1, Figure A-8). Muskoxen groups were primarily observed along riparian corridors. One or two grizzly bears were recorded during each survey from 15 June to 8 July (Table A-2, Figure A-8). Three of six sightings were along riparian corridors, one on the Kadleroshilik River, one on the Shaviovik River, and one on the Kavik River. Two cow moose were observed on 26 June, and two bull moose were recorded on 8 July, both groups were between the Shaviovik and Kavik rivers (Table A-2, Figure A-8). A total of three wolves were recorded; one on 1 July, and two on 19 July (Table A-2, Figure A-8).

CARIBOU

Calving Period Surveys

Survey 1, 15 June 1999.—Survey conditions were good, with few to scattered clouds, winds at 4.1 to 5.7 meters per second (mps) primarily from the north-northeast (360° to 60°), and temperature 4 to 9 °C from 1100 to 1600 Alaska Daylight Savings Time (ADST, ASCC 1999). The tundra was snow free. A total of 1,149 caribou in 193 groups were recorded in the study area, including 175 cow-calf pairs (Figures 3 and A-1, Tables 1 and A-1). Most caribou groups (85%, 164 of 193) consisted of less than 10 animals. Mean and 95% confidence interval (95%CI) of group size was 6.0 ± 1.08 caribou. One unclassified caribou was observed north of the Badami pipeline, the remaining 192 caribou were south of the pipeline (Table 2). Fifty-three percent (613 of 1,149) of caribou and 58% of calves (101 of 175) were located between the Sagavanirktok and Kadleroshilik rivers. Twenty-eight percent (318 of 1,149) of caribou and 29% of calves (51 of 175) were located between the Kadleroshilik and Shaviovik rivers; and 19% (215 of 1,149) of caribou and 13% of calves (23 of 175) were east of the Shaviovik River. Daily mean temperature was 5 °C and daily mean wind speed was 5.1 mps (Table B-1). Indices of parasitic insect activity indicated that conditions were not suitable for mosquito or oestrid activity on 15 June (Figure 2, Table B-1). Direction of travel was recorded for five caribou groups. Two groups were headed north into the wind, two groups were moving downwind to the south, and one group was headed west (Table 3).

Survey 2, 20 June 1999.—Survey conditions were marginal with overcast clouds and a 300 m broken ceiling, winds at 4.1 to 9.3 mps from the northeast (40° to 60°), and temperature 2 to 4 °C between 1100 and 1800 ADST (ASCC 1999). Coastal fog prevented the completion of some transects. Transects 21 and 22, and the Sagavanirktok Delta portions of transects 23 through 25 were not flown resulting in 88% coverage of the study area. A total of 1,752 caribou in 167 groups were recorded within the survey area (Figures 3 and A-2, Tables 1 and A-1). Mean and 95%CI of group size was 10.5 ± 2.51 caribou per group. Two caribou groups, consisting of a total of 3 cows and 1 calf, were observed north of the pipeline, and the remaining caribou were south of the pipeline (Table 2). The survey was incomplete for areas north of the pipeline. Most caribou (73% of groups, 122 of 167; 84% of caribou, 1,471 of 1,752) were in either the western third or the eastern third of the Badami study area. The western third of the study area, between the Sagavanirktok River and the Kadleroshilik River, contained 35% of groups (59 of 167) and 42% of caribou (729 of 1,752). The eastern third of the study area, east of the Shaviovik River contained 38% of groups (63 of 167) and 42% of caribou (742 of 1,752). The remaining caribou (26% of groups, 44 of 167; 16% of caribou, 279 of 1,752) were between the Kadleroshilik and Shaviovik rivers. One group with more than 100 caribou was located in the southeastern corner of the study area. There were four cow-calf groups with more than 50 caribou (Table A-1). One of these groups (Attribute 17, Table A-1) was located in the southeastern corner of the study

area; and the three other groups (Attributes 9, 12 and 32, Table A-1) were located in the southwestern corner of the study area (Figure A-2). Daily mean temperature was 1.2 °C and daily mean wind speed was 6.5 mps (Table B-1). Indices of parasitic insect activity indicated conditions were not suitable for mosquito or oestrid activity on 20 June (Figure 2, Table B-1). Direction of travel was recorded for ten groups. Three groups were moving east into the northeast winds, four groups were moving downwind to the south and three groups were moving downwind to the west (Table 3).

Calving Period Distributions

The distribution of cow-calf caribou pairs during the calving period (1 to 20 June) has varied both within years and between years since surveys were initiated in 1994 (Figures 3 and 4). Generally, later during the calving period, near 20 June, mean group size is larger. Mean and 95%CI of group size increased from 6.0 ± 1.08 caribou on 15 June to 10.5 ± 2.51 caribou on 20 June during 1999. Calving period surveys in 1994 and 1995 only extended as far south as 70°05' north latitude (Pollard and Noel 1994, 1995). Early surveys during these years, from 1 to 6 June, were completed during 95% to 70% snow cover, and at most, six calves were recorded within this area. On 16 June 1994 with snow-free conditions, six calves were recorded within this study area (Pollard and Noel 1994). In 1998, under snow-free conditions and with the survey area expanded south to 70°00' north latitude, on 10 June, 132 calves were recorded and on 15 June, 318 calves were recorded (Noel and Olson 1999). The snow-free conditions undoubtedly increased observers' ability to detect caribou in 1998, and also indicate conditions were warmer earlier in the calving season. The increase in number of caribou recorded during the 1998 calving period is also attributable to the southern extension of the study area. Sixty-three percent of calves (282 of 450) were recorded south of 70°05' north latitude for the two 1998 calving-period surveys combined. Calving period surveys were snow free again in 1999. The 1999 study area was extended further to the south to 69°54.5' north latitude. Most calves (74%, 527 of 708) were recorded south of 70°05' north latitude, and 37% (259 of 708) were recorded south of 70°00' north latitude during 1999. Toward the end of the calving period, near 20 June 1999, the number of calves north of 70°05' north latitude increased from 70 calves on 15 June to 111 calves on 20 June 1999. Even though the number of calves increased, the proportion of calves within the study area that were north of 70°05' north latitude decreased from 40% (70 of 175) on 15 June to 21% (111 of 533) on 20 June 1999.

Cow caribou density in the Badami study area (1313.60 km^2 land area, 1465.88 km^2 total area) was 0.87 cows/km^2 on 20 June 1999 (1,138 cows, Table 1). Too many caribou were unclassified during the 15 June survey to compute cow caribou density. In the adjacent Bullen Point to Staines River study area (904.53 km^2 land area, 942.08 km^2 total area) cow caribou density was 1.62 cows/km^2 on 14 June 1999 (Noel and King 2000). Calf production on 20 June

1999 in the Badami study area was 47 calves:100 cows. In the adjacent Bullen Point to Staines River study area, calf production was 48 calves:100 cows on 14 June 1999 (Noel and King 2000). This compares to calf production in 1998 of 50 calves:100 cows on 15 June 1998 (Noel and Olson 1999).

Caribou activity was recorded for 219 groups during the calving period (Table 4). The predominant activities for all group sizes were feeding 52% (114 of 219) and resting 36% (78 of 219, Table 4). Caribou on the move, primarily in groups of <10 caribou, accounted for 9% of group activity (19 of 219). Feeding caribou occurred primarily on moist or dry tundra (91%, 103 of 113, Class V, Tables 5 and 6); and many of these were on moist tussock sedge, dwarf shrub tundra (46%, 52 of 113) and moist sedge, dwarf shrub tundra (31%, 35 of 113). Resting caribou also occurred primarily on moist or dry tundra (83%, 63 of 76, Class V, Tables 5 and 6); and many of these were associated with moist tussock sedge, dwarf shrub tundra (41%, 31 of 76).

Post-Calving Period Surveys

Survey 3, 26 June 1999.—Survey conditions were good with clear skies, winds at 2.6 to 6.2 mps from the north-northeast (10° to 60°), and temperatures 7 to 10 °C between 0900 and 1600 ADST (ASCC 1999). A total of 1797 caribou in 136 groups were recorded within the study area (Figures 5 and A-3, Tables 1 and A-1). Mean and 95%CI of group size was 13.2 ± 5.35 caribou. The composition of classified caribou was 8% bulls, 64% cows, and 28% calves (Table 1). Most caribou (89%, 1,602 of 1,797) were within 10 km of the Beaufort Sea coast, and 110 caribou (6%, 110 of 1,797) were north of the Badami pipeline (Figure A-3, Table 2). Half of the caribou within the study area were in eight cow-calf dominated groups and one bull dominated group of 50 or more total caribou (50%, 906 of 1,797, Table A-1). Daily mean temperature was 6.9 °C and daily mean wind speed was 3.8 mps (Table B-1). Indices of parasitic insect activity indicated conditions were not suitable for mosquito or oestrid activity on 26 June and were also not suitable for mosquito or oestrid activity during the two days prior to the survey (Figure 2, Table B-1). Of 16 moving caribou groups, 13 groups were headed either north or east into the wind (Table 3).

Survey 4, 1 July 1999.—Survey conditions were excellent with clear skies, winds at 4.1 to 6.2 mps from the east (70° to 100°), and temperatures 9 to 16 °C between 0900 and 1600 ADST (ASCC 1999). A total of 4,209 caribou in 88 groups were recorded within the study area (Figures 5 and A-4, Tables 1 and A-1). Mean and 95%CI of group size was 47.8 ± 23.15 caribou. The composition of classified caribou was 4% bulls, 67% cows, and 29% calves (Table 1). Most caribou (90%, 3,803 of 4,209) were less than 10 km from the Beaufort Sea coast; and 364 caribou (9%, 364 of 4,209) in 24 groups were north of the Badami pipeline (Figure A-4, Table 2). Over half of the caribou within the study area (64%, 2,681 of 4,209) were in seven cow-calf dominated groups of 280 to 650 total caribou located in the northeastern corner

of the study area (Figure A-4, Table 1). Seventy-seven percent of caribou in the study area (3,252 of 4,209) were clustered within a 5 km radius west of the Shaviovik River and south of the Badami pipeline (Figures 5 and A-4, Table A-1). Daily mean temperature was 10.8 °C and daily mean wind speed was 4.3 mps (Table B-1). Indices of parasitic insect activity indicated conditions were suitable for mosquito activity one hour of the day, but were not suitable for oestrid fly activity on 1 July (Figure 2, Table B-1). Indices indicated conditions were not suitable for insect activity during the two days prior to the survey. Sweep net sampling also indicated mosquitoes were not active during the survey, or for the two days prior to the survey (Table B-1). However, mosquito abundance peaked on 2 July, based on sweep net sampling, the day following the survey. Insect indices also indicated conditions were suitable for both mosquito and oestrid activity for three hours on 2 July (Figure 2, Table B-1). Direction of travel was recorded for 11 groups. Seven groups were moving toward the coast and three groups were moving away from the coast (Table 3).

Survey 5, 8 July 1999.—Survey conditions were good with scattered clouds, mild winds at 0 to 4.6 mps primarily from the east-northeast (0° to 80°), and temperatures 9 to 13 °C between 1100 and 1800 ADST (ASCC 1999). A total of 2,700 caribou in 16 groups were recorded in the study area (Figures 5 and A-5, Tables 1 and A-1). Mean and 95%CI of group size was 168.8 ± 133.61 caribou. The composition of classified caribou was 30% bulls, 49% cows, and 21% calves (Table 1). Ninety-five percent (2,565 of 2,700) of caribou were within 2.5 km of the Sagavanirktok River, with seven of these ten groups in the river channels on gravel bars or in the water (Table A-1). Four caribou groups (25%, 4 of 16 groups) with 349 caribou (13%, 349 of 2,700) were north of the Badami pipeline. Daily mean temperature was 9.2 °C and daily mean wind speed was 2.4 mps (Table B-1). Indices of parasitic insect activity indicated conditions were not suitable for mosquito or oestrid activity on 8 July (Figure 2, Table B-1). Sweep net sampling, however, indicated mosquitoes were active on 8 July, with a mean of 27 mosquitoes per net (mpn); and caribou behavior and distribution similarly indicate that mosquitoes were active. Indices of insect activity indicated conditions were not suitable for mosquito or oestrid activity for the two days prior to the survey (Table B-1). This is again contradicted by sweep net sampling, which indicated mosquitoes were active on both 6 July (40 mpn) and 7 July (18 mpn, Table B-1). For the four caribou groups with direction of movement records, two groups were headed east into the wind (Table 3).

Survey 6, 17 July 1999.—Survey conditions were good with few clouds, winds at 3.1 to 5.2 mps from the northeast-north (20° to 360°), and temperatures 5 to 6 °C between 0800 and 1500 ADST (ASCC 1999). A total of 13 caribou in 8 groups were recorded within the study area (Figures 5 and A-6, Tables 1 and A-1). Mean and 95%CI of group size was 1.6 ± 0.77 caribou. Seven of the 13 caribou (54%) were in the Sagavanirktok Delta, and five (38%) were between the Kadleroshilik and Shaviovik rivers (Figure A-6, Table A-1). Thirty-eight percent (5 of 13) of

caribou in the study area were north of the Badami pipeline corridor. Daily mean temperature was 6 °C and daily mean wind speed was 4.7 mps (Table B-1). Indices of parasitic insect activity indicated conditions were not suitable for mosquito or oestrid activity on 17 July (Figure 2, Table B-1). However, conditions were favorable for mosquito activity during one hour on 16 July and three hours on 15 July (Figure 2, Table B-1). Sweep net sampling indicated mosquitoes were not active on 17 July (3 mpn) or 15 July (7 mpn), but were active on 16 July (29 mpn, Table B-1). Direction of travel was recorded for two groups, one group of 2 caribou was running to the east and the other group of 3 caribou was moving to the southeast (Table 3).

Survey 7, 19 July 1999.—Survey conditions were fair with few clouds, winds at 2.6 to 6.2 mps from the east-northeast (50° to 80°), and temperatures 5 to 7 °C between 1300 and 1800 ADST (ASCC 1999). A total of 3,523 caribou in 57 groups were recorded within the study area (Figures 5 and A-7, Tables 1 and A-1). Mean and 95%CI of group size was 61.8 ± 35.82 caribou. The composition of classified caribou was 25% bulls, 61% cows, and 14% calves (Table 1). Seventy-three percent of caribou in the study area (2,555 of 3,523) were in four cow-calf dominated and two mixed sex-age groups of between 325 and 625 caribou. Most caribou (82%, 2,879 or 3,523) and many of the calves (73%, 258 of 354) were within 2 km of the Shaviovik and Kavik rivers. Few caribou (2%, 69 of 3,523) in the study area were north of the Badami pipeline corridor (Table 2). Daily mean temperature was 3.9 °C and daily mean wind speed was 3.4 mps (Table B-1). Indices of parasitic insect activity indicated conditions were not suitable for mosquito or oestrid activity on 19 July (Figure 2, Table B-1). Sweep net sampling also indicated mosquitoes were not active. Both indices and sweep net sampling indicate that neither mosquitoes nor oestrids were active on 18 or 17 July. Direction of travel was recorded for three small groups, two inland groups were moving north and the third group was moving northwest (Table 3).

Post-Calving Period Distributions

During the post-calving period on warm calm days, caribou tend to congregate in riparian and coastal insect-relief habitats in response to parasitic insect harassment. During the 1999 post-calving period surveys, large caribou groups appeared to be associated with riparian habitats more consistently than with coastal habitats (Figure 5). Mean group size increased from 13.2 caribou on 26 June to a maximum of 168.8 caribou on 8 July. Between 8 July and the next survey on 17 July, however, virtually all of the 2,700 caribou previously in the study area left the area. Then between 17 July and the next survey on 19 July (less than 48 hours) 3,500 caribou moved back into the study area, apparently traveling from inland areas northward following the Shaviovik and Kavik riparian corridors (Figure 5, Table 1).

The indices of mosquito and oestrid activity appeared to be well correlated with the sweep net counts, although the indices may be conservative (Figure 2). The relationship between

caribou group distribution and insect activity are not as obvious. The scattered distribution and small mean group size on 26 June suggests caribou were not responding to insect harassment (Figure 5) and indices and sweep net samples verify that insects were not active. The formation of larger groups and concentration of caribou closer to the coast on 1 July suggests that caribou were responding to mosquito harassment, although indices indicate mosquitoes would be active for only one hour on 1 July. Sweep net counts, mosquito and oestrid indices however, all peaked on 2 July. The most striking concentration in riparian habitats occurred on 8 July, with most of the caribou in the study area in or near the east channel of the Sagavanirktok River. Again, indices indicated that mosquitoes and oestrids were not active but sweep net counts did suggest mosquitoes were active on 8 July. And as for the 1 July survey, the day after the 8 July survey, 9 July, the mosquito index and sweep net counts peaked (Figure 2, Table B-1).

Caribou density during the 1999 post-calving period was highest within the Badami study area on 1 July at 3.2 caribou/km^2 and was lowest on 17 July at 0.01 caribou/km^2. Mean and 95%CI of caribou density during the post-calving period in 1999 was 1.86 ± 1.542 caribou/km^2. Mean and 95%CI of caribou density were similar to the adjacent Bullen Point to Staines River study area during 1999 at 1.73 ± 1.926 caribou/km^2 for the post-calving period (Noel and King 2000).

Caribou group activity was recorded for 222 caribou groups during the post-calving period (Table 4). The predominant activities for all group sizes were feeding 57% (127 of 222) and resting 24% (54 of 222). The proportion of caribou groups feeding increased with increasing group size with a minimum of 48% (73 of 151) for groups of <10 caribou to a maximum of 81% (17 of 21) for groups of >100 caribou. Conversely the proportion of groups resting decreased with increasing group size from a maximum of 29% (44 of 151) for groups of <10 caribou to a minimum of 14% (3 of 21) for groups of >100 caribou. The proportion of groups moving at any pace also decreased with increasing group size from a maximum of 20% (30 of 151) for groups of <10 caribou to a minimum of 5% (1 of 21) for groups of >100 caribou (Table 4). Feeding caribou occurred primarily on moist or dry tundra (89%, 108 of 121, Class V, Tables 5 and 6); and many of these were on moist sedge, dwarf shrub tundra (52%, 63 of 121) and dry, dwarf shrub, crustose lichen tundra (28%, 34 of 121). Resting caribou occurred primarily on moist or dry tundra (84%, 43 of 51, Class V, Tables 5 and 6); and many of these were on moist sedge, dwarf shrub tundra (43%, 22 of 51) and dry dwarf shrub, crustose lichen tundra (35%, 18 of 51). For 35 groups that were recorded moving at any pace, 40% (14 of 35) were on moist sedge, dwarf shrub tundra; 14% (5 of 35) were on dry, dwarf shrub, crustose lichen tundra; 11% (4 of 35) were on river gravels; and 9% (3 of 35) were in water (Table 5).

Caribou Distribution and the Badami Pipeline Corridor

To evaluate potential blockage of north-south caribou movements by the Badami pipeline, the proportions of caribou within the coastal 1- to 4-km interval and the inland 5- to 8-km interval from the Beaufort Sea coast were compared between the Badami study area and the Bullen Point to Staines River study area. The numbers of caribou within the paired study areas was quite variable, but the proportions within 1- to 4-km and 5- to 8-km intervals followed the same trends between the two study areas (Table 7). For five of six paired surveys, there were higher proportions of caribou in the 5- to 8-km interval for both study areas, and during flight six, both study areas had a higher proportion of caribou in the 1- to 4-km interval. An appropriate paired survey was not available for the 20 June survey. If caribou movements were blocked or delayed, proportions within the coastal (1- to 4-km interval) and inland (5- to 8-km interval) intervals should be different for the paired surveys. The proportion of caribou within coastal and inland intervals in the Badami and Bullen Point to Staines River study areas were not significantly different (Wilcoxon Signed Rank Test $n = 6$, $P = 0.4017$; Mann-Whitney U Test $n = 12$, $U = 21.0$, $P = 0.6889$; Table 7).

To identify areas where caribou may cross the Badami pipeline corridor, mean annual density 1 km north and 1 km south of the pipeline in 1.6-km wide segments were calculated based on five years of aerial survey distribution data (Figures 6 and 7, Tables 8 and 9). This data includes three years of surveys prior to pipeline construction and two years of data after pipeline construction. Because habitat may influence where caribou cross the pipeline corridor, habitat by pipeline segment was quantified based on LandSat land cover mapping (Walker and Acevedo 1987). Most segments were mixtures of various proportions of water, wet herbaceous tundra, and moist or dry herbaceous tundra (Figure 8, Table 10). Pipeline segments with river crossings all included a proportion of barren and sparse vegetation (Figure 8). No consistently used crossing corridors were obvious. In fact, for the five years of data, caribou occurred in only one segment north of the pipeline for four of the five years of data, and for three of these years only one caribou was within this segment (Table 8, Segment 5). Caribou occurred within four segments north of the pipeline for three of five years (Table 8, Segments 1, 2, 7 and 8) and within two segments for zero of five years (Table 8, Segments 12 and 22). Peak numbers of caribou north of the pipeline occurred in Segment 21 in 1995 and in Segment 2 in 1999 (Figure 6, Table 8). Peak numbers of caribou south of the pipeline occurred in Segment 22 in 1994 and in Segment 10 in 1998 (Figure 7, Table 9).

OTHER LARGE MAMMALS

Six muskoxen groups with 87 total individuals were observed during aerial surveys (Figure A-8, Table 1). It appears likely, based on the total number of muskoxen and number of calves in each group, that these represent three distinct muskoxen groups or herds (Figure A-8,

Table A-2). If this is the case, Herd A with 16 adults, moved from the Kadleroshilik River to the Sagavanirktok River between 15 June and 20 June, a distance of 20 km, and then Herd A must have left the study area (Figure A-8, Table A-2). Herd B, with 14 adults and 4 calves, was on the Sagavanirktok River on 15 June, moved 12 km to the Sagavanirktok Delta on 26 June; and then headed south for 38 km to just outside the southern boundary of the study area (Figure A-8, Table A-2). This herd was feeding in moist sedge, dwarf shrub tundra by the Sagavanirktok River on 15 June, standing on gravel on 26 June, and again feeding on moist sedge, dwarf shrub tundra on 1 July (Table A-2). If this is in fact the same muskoxen herd, a calf was lost between 26 June and 1 July (Figure A-8, Table A-2). Herd C consisted of 2 adult muskoxen sighted on the Kadleroshilik River standing in dry, dwarf shrub, crustose lichen tundra on 1 July 1999 (Figure A-8, Table A-2).

Two bull moose were observed on 26 June feeding on dry, dwarf shrub, crustose lichen tundra near the Kavik River; and two cow moose were observed on 8 July resting on moist sedge, dwarf shrub tundra between the Shaviovik and Kavik rivers (Figure A-8, Table A-2).

One or two grizzly bears were recorded during each survey from 15 June to 8 July (Figure A-8, Table A-2). Three of six sightings were along riparian corridors, one on the Kadleroshilik River, one on the Shaviovik River, and one on the Kavik River. One bear was feeding on moist sedge, dwarf shrub tundra near the Shaviovik River on 20 June (Table A-2); and one bear was feeding on moist tussock sedge, dwarf shrub tundra near the Kadleroshilik River on 1 July (Table A-2). The two bears sighted on 8 July were both moving. The bear on the Kavik River was headed to the west and the bear between the Sagavanirktok and Kadleroshilik rivers was running to the east (Table A-2). A total of three wolves were recorded; one wolf was observed running to the west in the southeastern corner of the study area on 1 July, and two wolves were observed moving to the west on river gravel in the Kavik River on 19 July (Table A-2, Figure A-8).

DISCUSSION

During seven systematic strip-transect surveys in 1999, between 13 and 4,209 caribou were recorded in the Badami study area (Table 1). The 1997 estimated CAH size was 20,000 caribou (1997 count: 19,730), with an estimated 8,000 caribou (1997 count: 7,733) in the eastern of the CAH (E. Lenart, ADF&G, pers. comm.). Caribou calving between Bullen Point and the Canning River are generally considered part of the eastern segment of the CAH (Cameron and Whitten 1978, Lawhead and Curatolo 1984, Whitten and Cameron 1985, Cameron et al. 1989). Based on these population estimates, the estimated 43.9% fall cow composition in 1996 (Hicks 1997), and assuming the herd size was similar in 1999; from 9% to 13% of CAH cows and from 23% to 32% of eastern segment CAH cows used the Badami study area during the calving period. This

is an increase of approximately 6% over the 1998 percentages of 3% to 7% of CAH cows; and an increase of approximately 15% over the 1998 percentages of 7% to 15% of eastern segment CAH cows in the Badami study area. These increases are primarily due to the southern extension of the study area in 1999. Extension of the 1999 study area from 70°00' to 69°54.5' north latitude accounted for an increase of ~250 cows on 15 June, or 3% of the CAH cows, and 7% of the eastern segment CAH cows. Extension of the study area accounted for an increase of 481 cows on 20 June, or 6% of the CAH and 14% of the eastern segment of the CAH.

During the 1999 post-calving period <1% to 21% of CAH caribou and <1% to 53% of the eastern segment CAH caribou used the Badami study area. Composition of classified caribou varied between surveys, but for the combined post-calving period surveys, 16% were bulls, 61% were cows, and 23% were calves. This was comparable to combined post-calving period composition during 1998 of 15% bulls, 62% cows, and 23% calves (Noel and Olson 1999).

During the post-calving period, weather-moderated insect activity probably influences caribou distribution, movements, and behavior more than any other environmental factor (White et al. 1975, Roby 1978, Dau 1986, Johnson and Lawhead 1989). Caribou move to coastal areas to ameliorate insect harassment (Roby 1978; Dau 1986; Johnson and Lawhead 1989; Pollard et al. 1996a, b), and tend to drift inland and feed during periods of low temperatures and/or high wind velocities, which suppress mosquito activity (White et al. 1975, Curatolo et al. 1982, Dau 1986, Pollard et al. 1996a). From the patterns of caribou distributions within the study area from 17 July to 19 July 1999, it appears that caribou moved inland out of the study area and then returned to the study area following the Shaviovik and Kavik drainages north toward the coast. During 1999, caribou within the Badami study area appeared to be more closely associated with riparian areas than with coastal areas during the post-calving period.

Caribou group size generally increases after the peak of calving, and mosquito harassment apparently is a major factor causing large aggregations (Roby 1978, Johnson and Lawhead 1989). During 1999, mean and 95%CI of group size increased from 10.5 ± 2.51 caribou on 20 June to 168.8 ± 133.61 caribou on 8 July. Calculated mosquito activity, oestrid activity, and sweep net sampling indicated mosquito activity peaked on 2 July, 5 July, and again on 9 July. These dates are consistent with mosquito data collected in 1992 and 1993 in the Prudhoe Bay oilfield that identified peaks in mosquito activity during the first week of July (Pollard et al. 1996a). Sweep net sampling, but not modeled insect activity, also indicate that peaks in early July are higher in magnitude than peaks later in July and that mosquito activity tapers off after about 15 July, again consistent with Pollard et al. (1996a).

The models for mosquito and oestrid activity, and sweep net mosquito sampling do not explain on a survey-by-survey basis the shifts in caribou distribution within the study area.

According to these data, insects were inactive during the 1 July and 8 July surveys. The formation of large caribou groups, their distribution within 10 km of the coast, and clustering near riparian habitats on these days, however, suggest that caribou were responding to mosquito harassment (Figure 5; White et al. 1975, Dau 1986, Johnson and Lawhead 1989). Interestingly, both indices and sweep net sampling indicated insect activity peaked following these two surveys. Had these surveys been flown one day later, peaks in caribou numbers and mean group size may very well have been coincident with peaks in insect activity. The increase in caribou numbers and increase in mean group size within the study area on 19 July is more difficult to interpret. There are three plausible explanations for the lack of coincidence between the modeled insect activity, measured insect activity, and caribou distributions. First, the indices do not appear capable of predicting peak levels of mosquito activity, although they do seem to accurately indicate presence or absence of mosquitoes and oestrids (Mörschel 1999). Second, the Deadhorse weather data may not accurately represent conditions within the study area or perhaps conditions further inland that may cause caribou to alter their distributions. And third, caribou distributions on any particular day may not reflect current conditions, but may represent conditions prior to the actual survey date.

Observations of caribou north of the Badami pipeline between the Endicott pipeline and the Badami facility indicate that a minimum of 364 caribou crossed the Badami pipeline corridor during the post-calving period in 1999 (Table 2). The numbers of caribou within the paired Badami and Bullen Point to Staines River study areas was quite variable, but the proportions within coastal 1- to 4-km and inland 5- to 8-km intervals were not different between the two study areas (Table 7). For five of six paired surveys, there were higher proportions of caribou in the inland interval for both study areas, and during flight six, both study areas had a higher proportion of caribou in the coastal interval. If caribou movements were blocked or significantly delayed by the presence of the Badami pipeline, proportions of caribou within the coastal intervals between the Badami and the Bullen Point to Staines River study areas should be different for the paired surveys. We reviewed aerial survey distribution data for evidence of north-south caribou movements along the Badami pipeline corridor both before and after the pipeline was constructed. Based on this data, there was no evidence that any specific pipeline segment was consistently used to cross the pipeline corridor.

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LITERATURE CITED

ASCC (Alaska State Climate Center). 1999. Deadhorse Weather Station, May to September 1999 data. Environment and Natural Resources Institute, University of Alaska Anchorage, Anchorage, Alaska, USA.

Cameron, R.D., and K.R. Whitten. 1978. Third interim reports on the effects of the Trans-Alaska Pipeline on caribou movements. Special Report Number 22. Joint State/Federal Fish and Wildlife Advisory Team, Anchorage, Alaska, USA. 29 p.

Cameron, R.D., W.T. Smith, and S.G. Fancy. 1989. Distribution and productivity of the Central Arctic Caribou herd in relationship to petroleum development. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration Program Report Projects W-23-1 and W-23-2, Study 3.35. Juneau, Alaska, USA. 52 p.

Carruthers, R.D., R.D. Jakimchuk, and S.H. Ferguson. 1984. The relationship between the Central Arctic caribou herd and the Trans-Alaska Pipeline. Report to Alyeska Pipeline Service Company by Renewable Resources Consulting Services Limited, Sidney, British Columbia, Canada. 207 p.

Caughley, G. 1977. Sampling in aerial survey. Journal of Wildlife Management 41:605–615.

Clough, N.K., P.C. Patton, and A.C. Christiansen, editors. 1987. Arctic National Wildlife Refuge, Alaska, coastal plain resource assessment-report and recommendation to the Congress of the United States and final environmental impact statement: Washington, D.C., U.S. Fish and Wildlife Service, U.S. Geological Survey, and Bureau of Land Management, Volume 1. 208 p.

Cronin, M.A., B.J. Pierson, S.R. Johnson, L.E. Noel, and W.B. Ballard. 1997. Caribou population density in the Prudhoe Bay region of Alaska. J. Wildl. Res. 2(1):59–68.

Curatolo, J.A., S.M. Murphy, and M.A. Robus. 1982. Caribou responses to the pipeline/road complex in the Kuparuk oil field, Alaska, 1981. Final Report by Alaska Biological Research, Incorporated, Fairbanks, Alaska, for ARCO Alaska, Inc., Anchorage, Alaska, USA. 62 p.

Dau, J.R. 1986. Distribution and behavior of barren-ground caribou in relation to weather and parasitic insects. M.S. thesis, University of Alaska, Fairbanks. 149 p.

Gavin, A. 1983. Spring and summer caribou movements, Prudhoe Bay, Alaska, 1969–1979. Report to Atlantic Richfield Company, Los Angeles, California, USA. 50 p.

Hicks, M.V. 1997. Federal aid in wildlife restoration, annual performance report, survey inventory activities, 1 July 1996 – 30 June 1997. Alaska Department of Fish and Game, Division of Wildlife Conservation, Juneau, Alaska, USA. 28 p.

Jakimchuk, R.D., S.H. Ferguson, and L.G. Sopuck. 1987. Differential habitat use and sexual segregation in the Central Arctic caribou herd. Canadian Journal of Zoology 65:534–541.

Johnson, C.B., and B.E. Lawhead. 1989. Distribution, movements, and behavior of caribou in the Kuparuk oil field, summer 1988. Final report to ARCO Alaska, Incorporated, and Kuparuk River Unit, Anchorage, by Alaska Biological Research, Incorporated, Fairbanks, Alaska, USA. 71 p.

Reynolds, P.E., and D.E. Ross. 1984. Population status of muskoxen in the Arctic National Wildlife Refuge, Alaska. Biol. Pap. Univ. Alaska. Spec. Rep. No. 4:63(1984) Abstract.

Roby, D.D. 1978. Behavioral patterns of barren–ground caribou of the Central Arctic Herd adjacent to the Trans-Alaska Pipeline. M.S. thesis, University of Alaska, Fairbanks, USA. 200 p.

Russell, D.E., A.M. Martell, and W.A.C. Nixon. 1993. Range ecology of the Porcupine caribou herd. Rangifer, Special Issue Number 8:3–167.

Smith, M.D. 1996. Distribution, abundance, and quality of forage within the summer range of the Central Arctic Caribou Herd. M.S. thesis, University of Alaska Fairbanks, Fairbanks, Alaska, USA. 43 p.

Walker, D.A. 1983. A hierarchical tundra vegetation classification especially designed for mapping in northern Alaska. Pages 1332-1337 *in* Proceedings of the 4th International Conference on Permafrost, July 17-22, 1983, Fairbanks, AK. National Academy Press, Washington, D.C.

Walker, D.A., and W. Acevedo. 1987. Vegetation and a LandSat-derived land cover map of the Beechey Point Quadrangle, Arctic Coastal Plain, Alaska. CRREL Report 87-5, U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire, USA.

White, R.G., B.R. Thomson, T. Skogland, S.J. Person, D.E. Russell, D.F. Holleman, and J.R. Luick. 1975. Ecology of caribou at Prudhoe Bay, Alaska. Pages 151–187 *in* J. Brown, editor. Ecological investigations of the tundra biome in the Prudhoe Bay region, Alaska. Biological Paper, University of Alaska, Special Report Number 2. University of Alaska, Fairbanks, Alaska, USA.

Whitten, K.R., and R.D. Cameron. 1980. Composition and harvest of the Porcupine caribou herd. Federal Aid in Wildlife Restoration Progress Report, Projects W-17-9, W-17-11, W-17-21. Job 3.23R. Alaska Department of Fish and Game, Juneau, Alaska, USA.

Whitten, K.R., and R.D. Cameron. 1985. Distribution of caribou calving in relation to the Prudhoe Bay oil field. Pages 35–39 *in* A.M. Martell and D.E. Russell, editors. Proceedings of the 1st North American Caribou Workshop. Canadian Wildlife Service Special Publications, Ottawa, Canada.

Lawhead, B.E., and J.A. Curatolo. 1984. Distribution and movements of the central arctic herd, summer 1983. Final report by Alaska Biological Research, Fairbanks, Alaska, to ARCO Alaska, Incorporated, Anchorage, Alaska, USA. 52 p.

Mörschel, F.M. 1999. Use of climatic data to model the presence of oestrid flies in caribou herds. J. Wildl. Manag. 63(2):588–593.

Noel, L.E. 1998. Large mammal distribution in the Badami study area, summer 1997. Final Report to BP Exploration (Alaska) Incorporated, by LGL Alaska Research Associates, Inc., Anchorage, Alaska, USA. 19 p + Appendices.

Noel, L.E., and J.C. King. 2000. Bullen Point to Staines River large mammal distribution, summer 1999. Report to BP Exploration (Alaska) Incorporated, by LGL Alaska Research Associates, Inc., Anchorage, Alaska, USA. 31 p + Appendices.

Noel, L.E., and T.L. Olson. 1999. Large mammal distribution in the Badami study area, summer 1998. Final Report to BP Exploration (Alaska) Incorporated, by LGL Alaska Research Associates, Inc., Anchorage, Alaska, USA. 19 p + Appendices.

Noel, L.E., R.H. Pollard, W.B. Ballard, and M.A. Cronin. 1998. Activity and use of active gravel pads and tundra by Caribou, *Rangifer tarandus granti*, within the Prudhoe Bay oil field, Alaska. Can. Field-Nat. 112(3):400–409.

Pennycuick, C.J., and D. Western. 1972. An investigation of some sources of bias in aerial transect sampling of large mammal populations. East African Wildlife Journal 10:175–191.

Pollard, R.H., and L.E. Noel. 1994. Large mammal surveys of the Badami development area, summer 1994. Final Report to BP Exploration (Alaska) Incorporated, by LGL Alaska Research Associates, Inc., Anchorage, Alaska, USA. 17 p + Appendix.

Pollard, R.H., and L.E. Noel. 1995. Distribution of large mammals between the Sagavanirktok and Staines Rivers, Alaska, summer 1995. Final Report to BP Exploration (Alaska) Incorporated, by LGL Alaska Research Associates, Inc., Anchorage, Alaska, USA.

Pollard, R.H., M.E. Miller, and R.C. Wilkinson. 1992a. Caribou distribution in Prudhoe Bay oil field, summer 1990. Final report by LGL Alaska Research Associates, Inc., Anchorage, AK for BP Exploration (Alaska) Inc., Anchorage, AK, USA.

Pollard, R.H., W.B. Ballard, L.E. Noel, and M.A. Cronin. 1996a. Parasitic insect abundance and microclimate of gravel pads and tundra within the Prudhoe Bay oil field, Alaska, in relation to use by caribou. Canadian Field-Naturalist 110:649–658.

Pollard, R.H., W.B. Ballard, L.E. Noel, and M.A. Cronin. 1996b. Summer distribution of caribou, *Rangifer tarandus granti*, in the area of the Prudhoe Bay oil field, Alaska, 1990–1994. Canadian Field-Naturalist 110:659–674.

Pollard, R.H., P.C. Lent, M.E. Miller, and R.C. Wilkinson. 1992b. Caribou Distribution in the Prudhoe Bay, Kuparuk, and Mine Point Oil Fields, Summer 1991. Final Report by LGL Alaska Research Associates, Inc., Anchorage, AK for BP Exploration (Alaska) Inc., Anchorage, Alaska, USA.

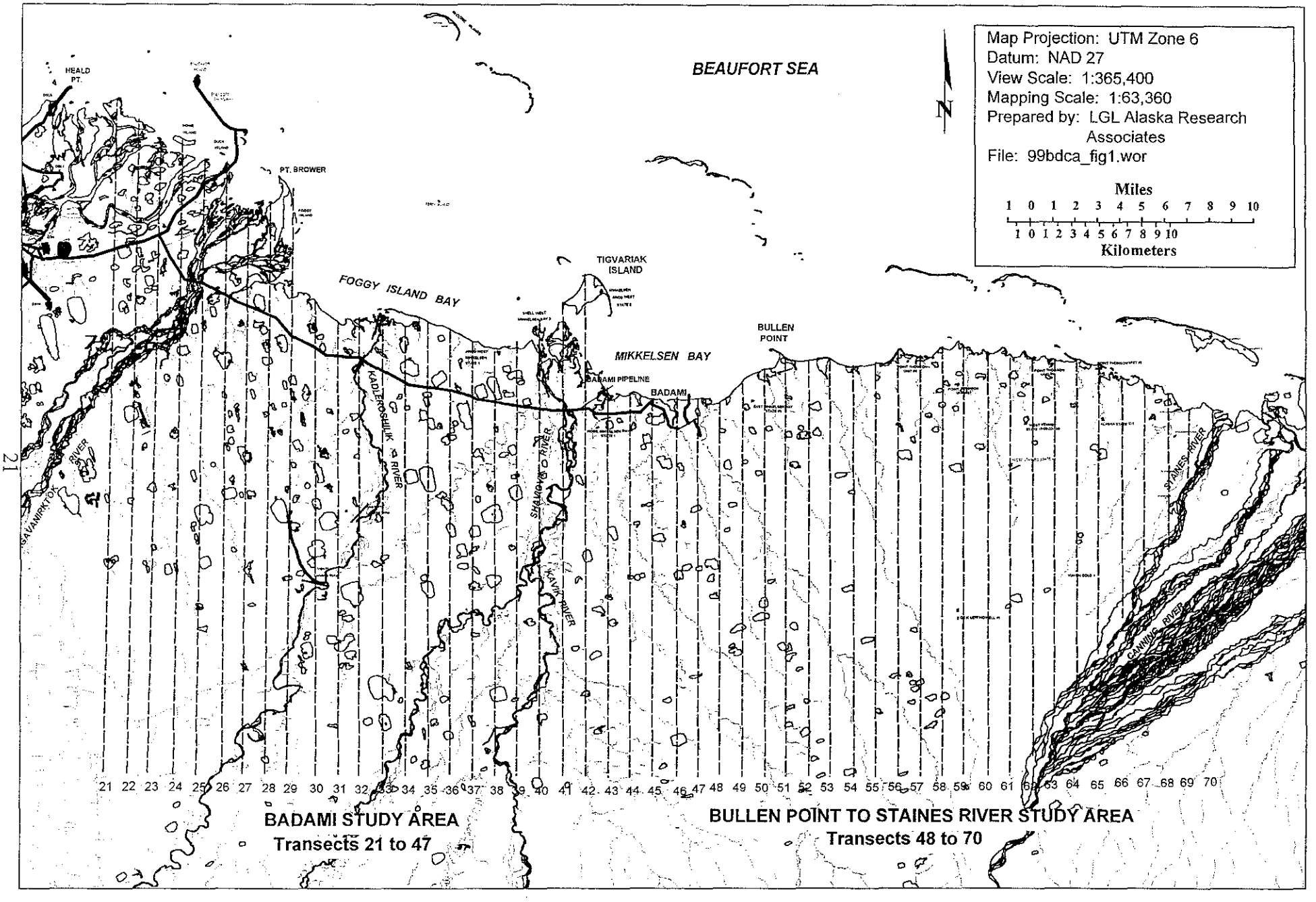


Figure 1. Survey transects in the Badami and Bullen Point to Staines River study areas, Alaska, summer 1999.

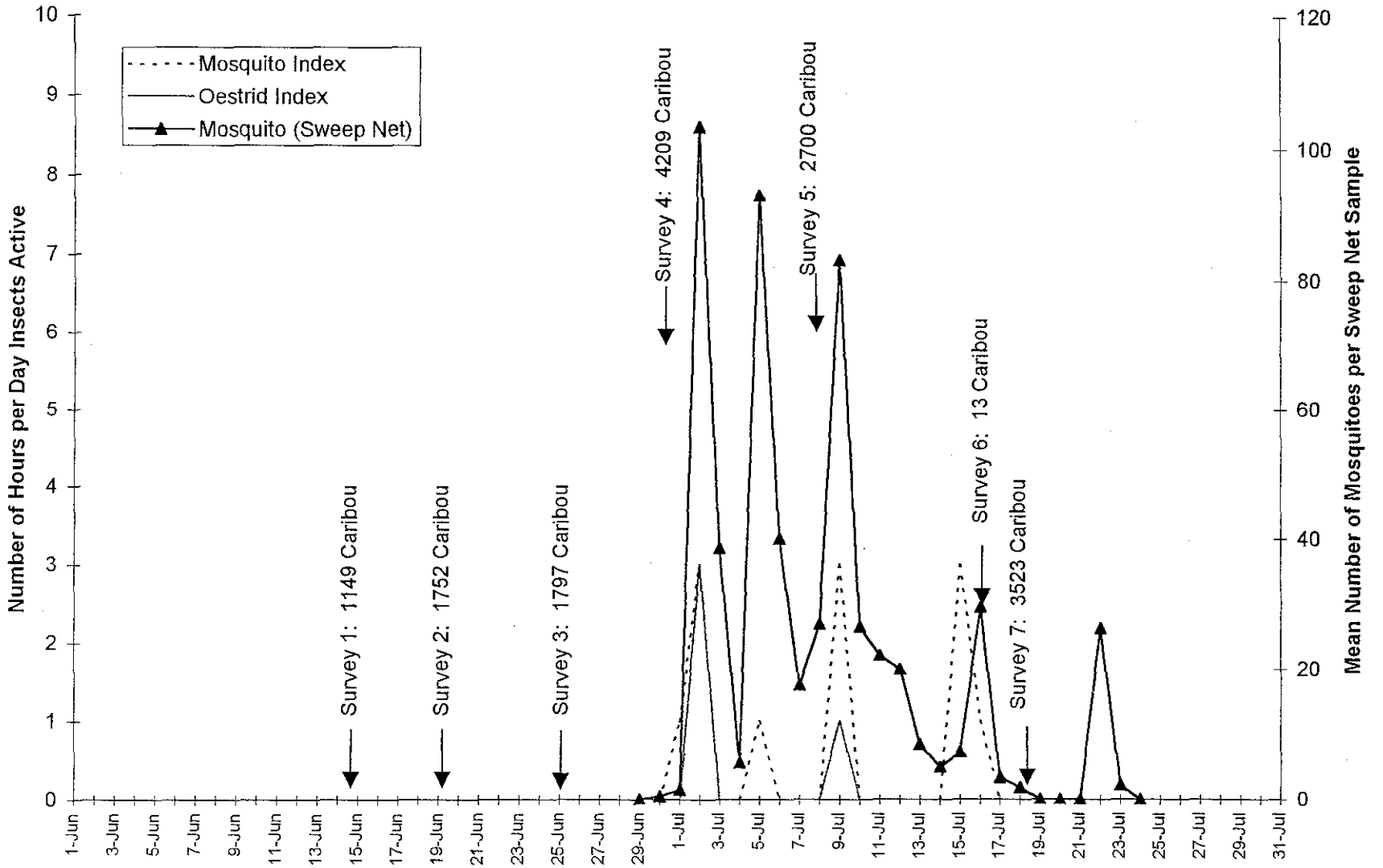


Figure 2. Mosquito and oestrid activity indices based on hourly weather data collected at the Deadhorse Weather Station, mean sweep net mosquito counts, and 1999 aerial survey caribou counts, Badami study area, Alaska, summer 1999.

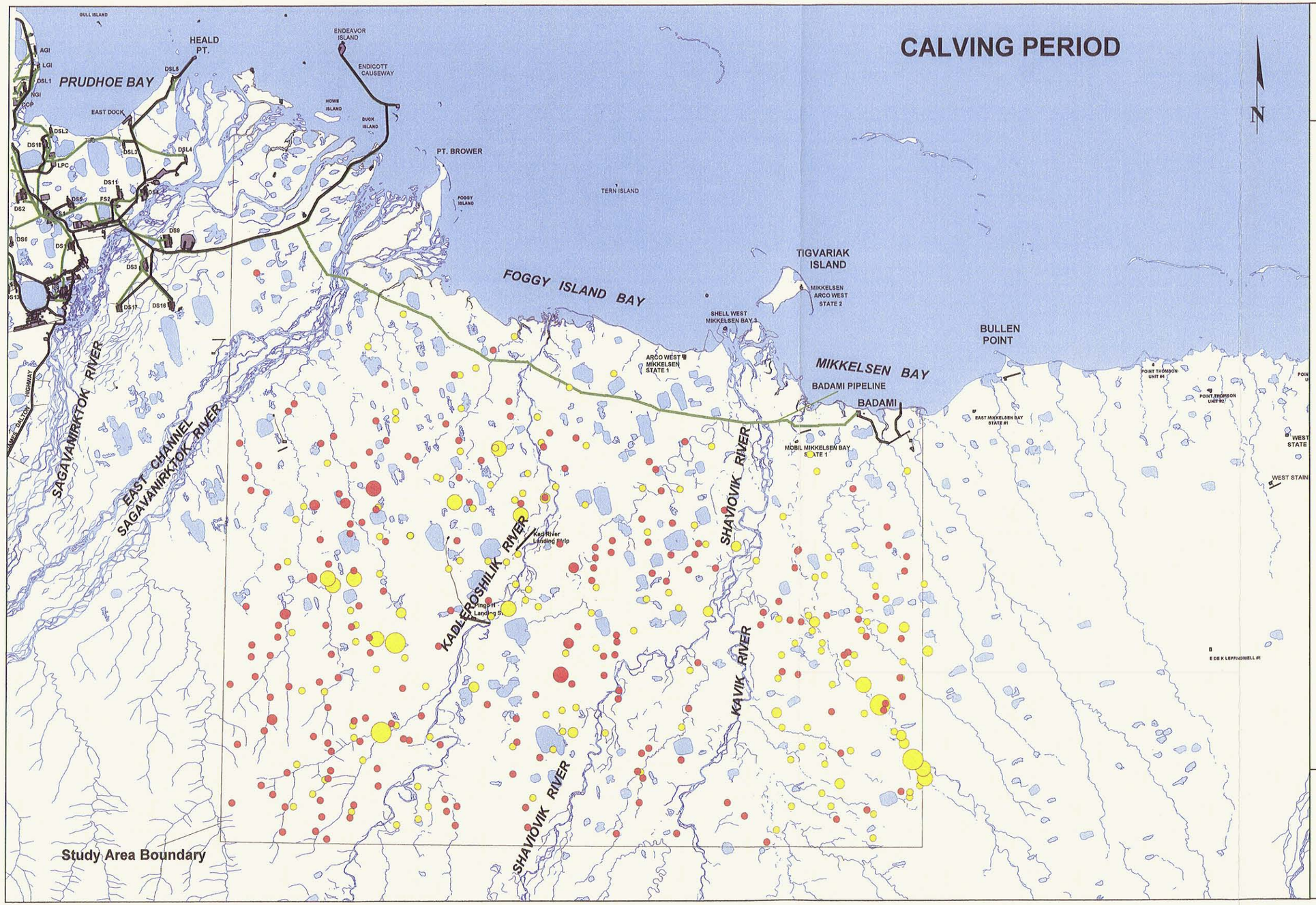


Figure 3

Distribution of caribou calves observed in the Badami study area, Alaska, on 15 and 20 June 1999.

Caribou Group Size
Number of Calves

15 June	Groups
Less than 5	184
5 to 10	7
10 to 20	2
Greater than 20	0

20 June	Groups
Less than 5	138
5 to 10	14
10 to 20	11
Greater than 20	4

Pipelines

Roads

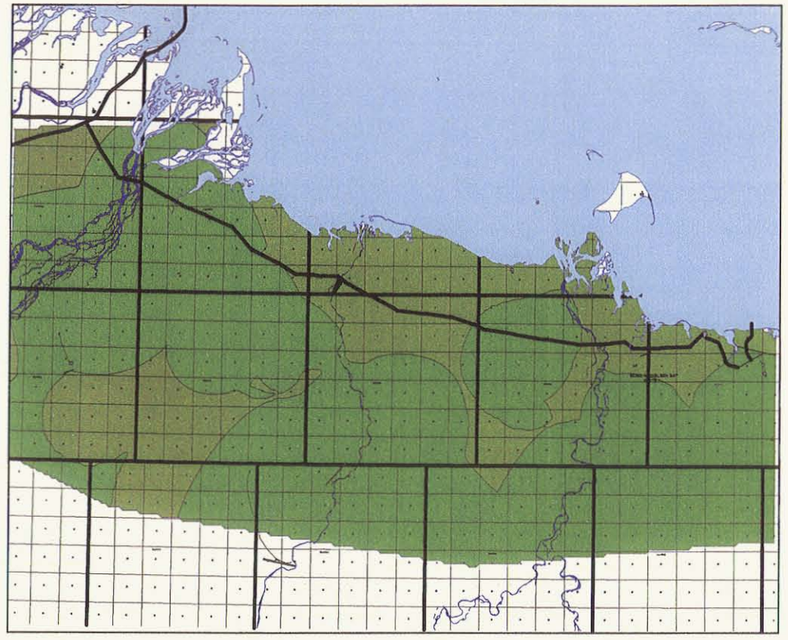
Oil Production and Service Facilities

Miles
1 0 1 2 3 4 5
1 0 1 2 3 4 5
Kilometers

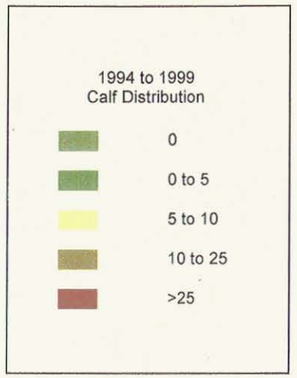
Map Projection: UTM Zone 6
Datum: NAD 27
View Scale: 1:253,000
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 99BDca_Fig.3.wor

Figure 4

Distribution of caribou calves during the calving period (before 20 June) as contours of the total number of calves by year and for combined 1994 to 1999 distributions (8 surveys), in the Badami study area, Alaska.

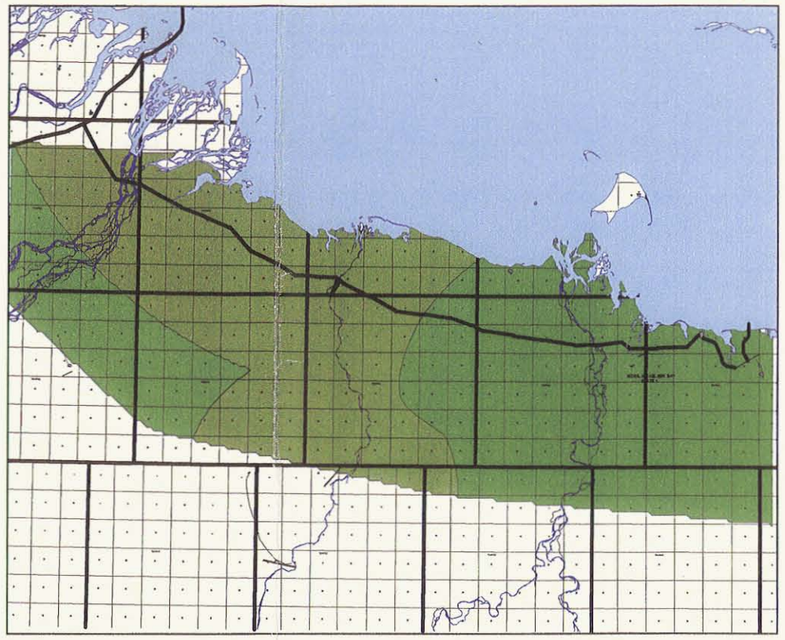


1994 Calving Period (3 surveys)

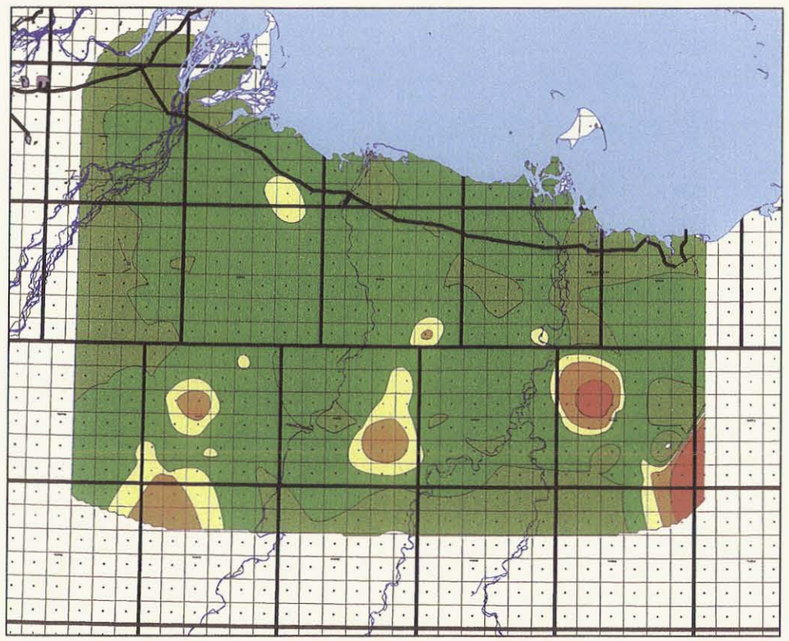


Projection: UTM Zone 6
Datum: NAD 27
View Scale 1:335,000 (94 and 95)
View Scale 1:410,100 (98,99 and 94 to 99)
Mapping Scale: 1:63,360
File:99BD_Fig4.wor

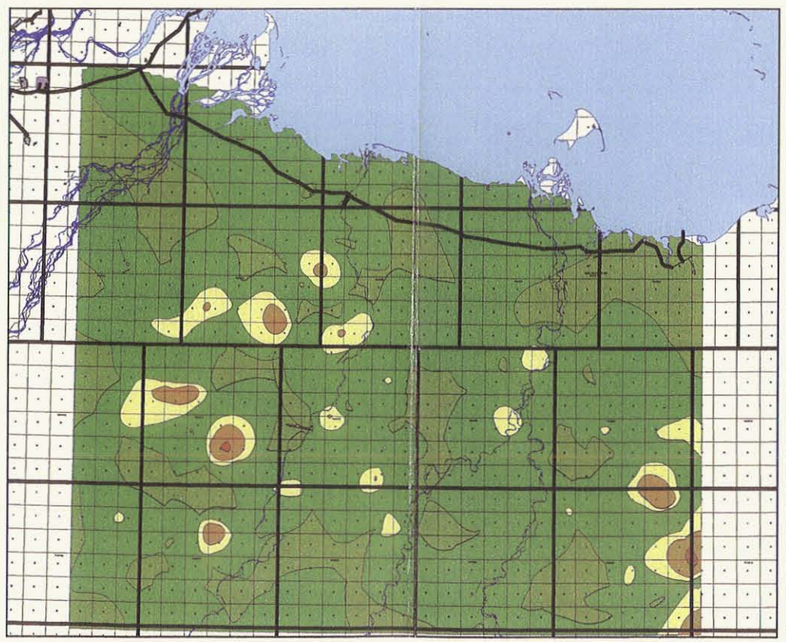
Note:
1. 1993 surveys were 50% coverage within the western half of the study area. This data was excluded from analyses.
2. 1994 and 1995 transects extended south to 70° 05' north latitude.
3. Calving period surveys were not flown during 1997.
4. 1998 transects extended south to 70° 00' north latitude.



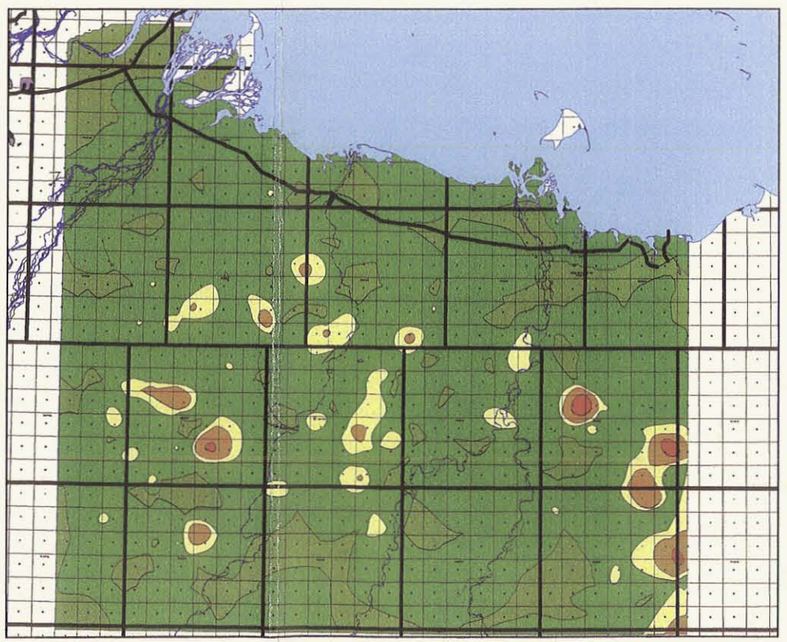
1995 Calving Period (1 survey)



1998 Calving Period (2 surveys)



1999 Calving Period (2 surveys)



1994 to 1999 Calving Period Surveys (8 surveys)

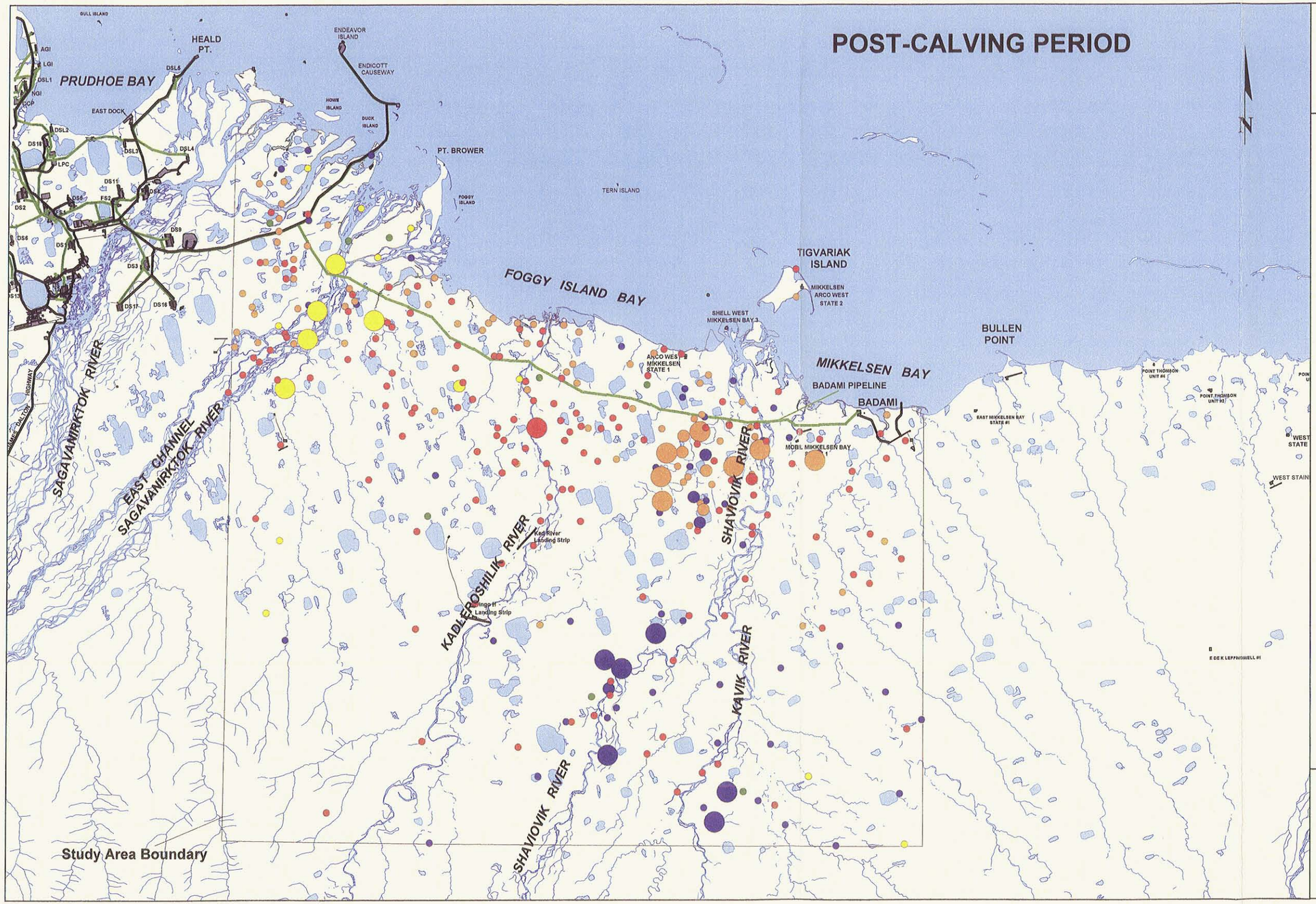


Figure 5

Distribution of caribou observed in the Badami study area, Alaska, during 1999 post-calving period surveys.

Caribou Group Size

26 June	Groups
Less than 100	134
100 to 250	1
Greater than 250	1

1 July	Groups
Less than 100	77
100 to 250	4
Greater than 250	7

8 July	Groups
Less than 100	10
100 to 250	1
Greater than 250	5

17 July	Groups
Less than 100	8
100 to 250	0
Greater than 250	0

19 July	Groups
Less than 100	47
100 to 250	4
Greater than 250	6

Pipelines
Roads
Oil Production and Service Facilities

1 0 1 2 3 4 5 Miles
1 0 1 2 3 4 5 Kilometers

Map Projection: UTM Zone 6
Datum: NAD 27
View Scale: 1:253,000
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 99BDca_Fig.5.wor

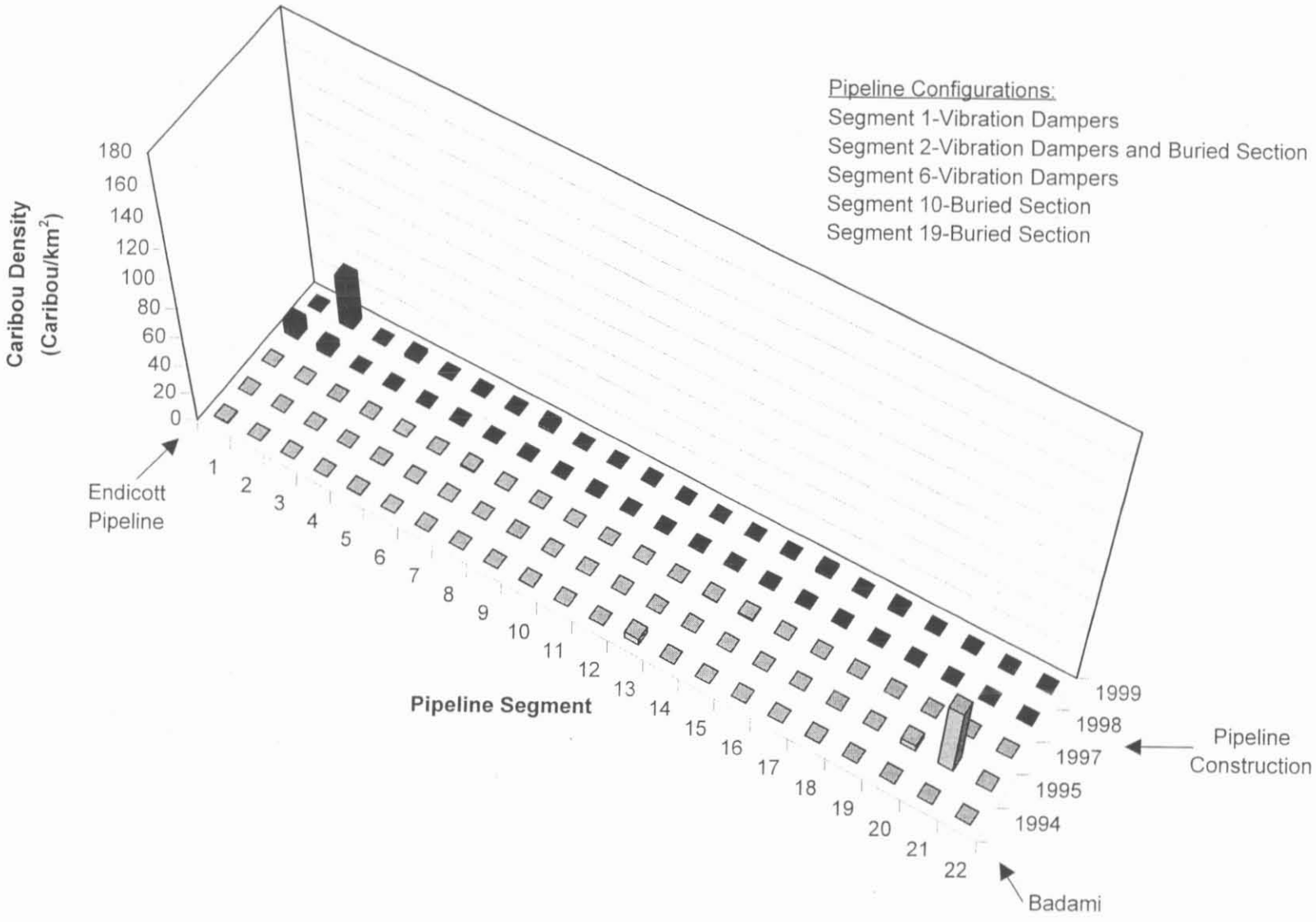


Figure 6. Caribou density by pipeline intervals within 1 km north of the Badami pipeline based on aerial survey point locations for surveys before and after winter 1997-1998 construction of the Badami pipeline.

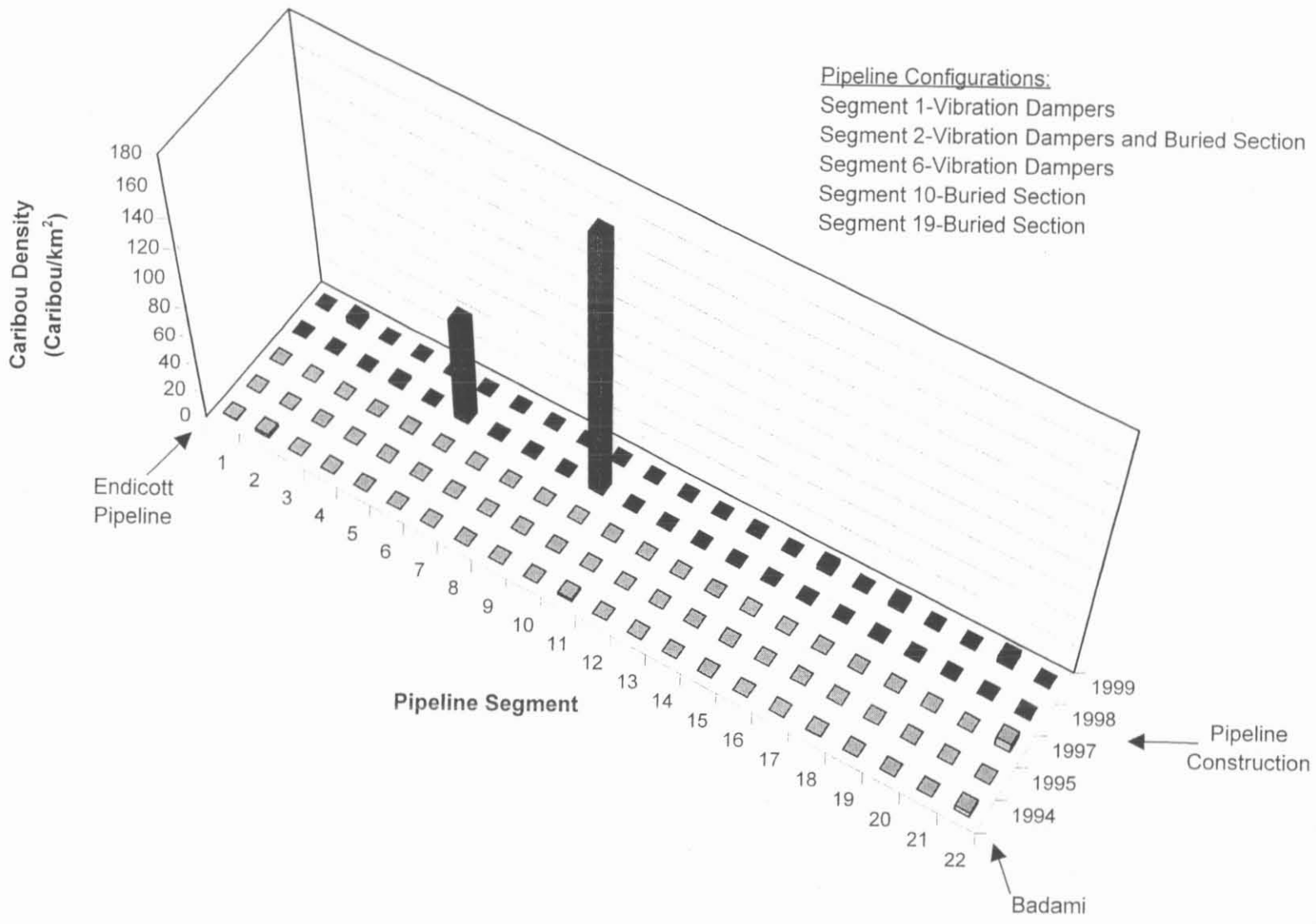


Figure 7. Caribou density by pipeline segments within 1 km south of the Badami pipeline based on aerial survey point locations for surveys before and after winter 1997-1998 construction of the Badami pipeline.

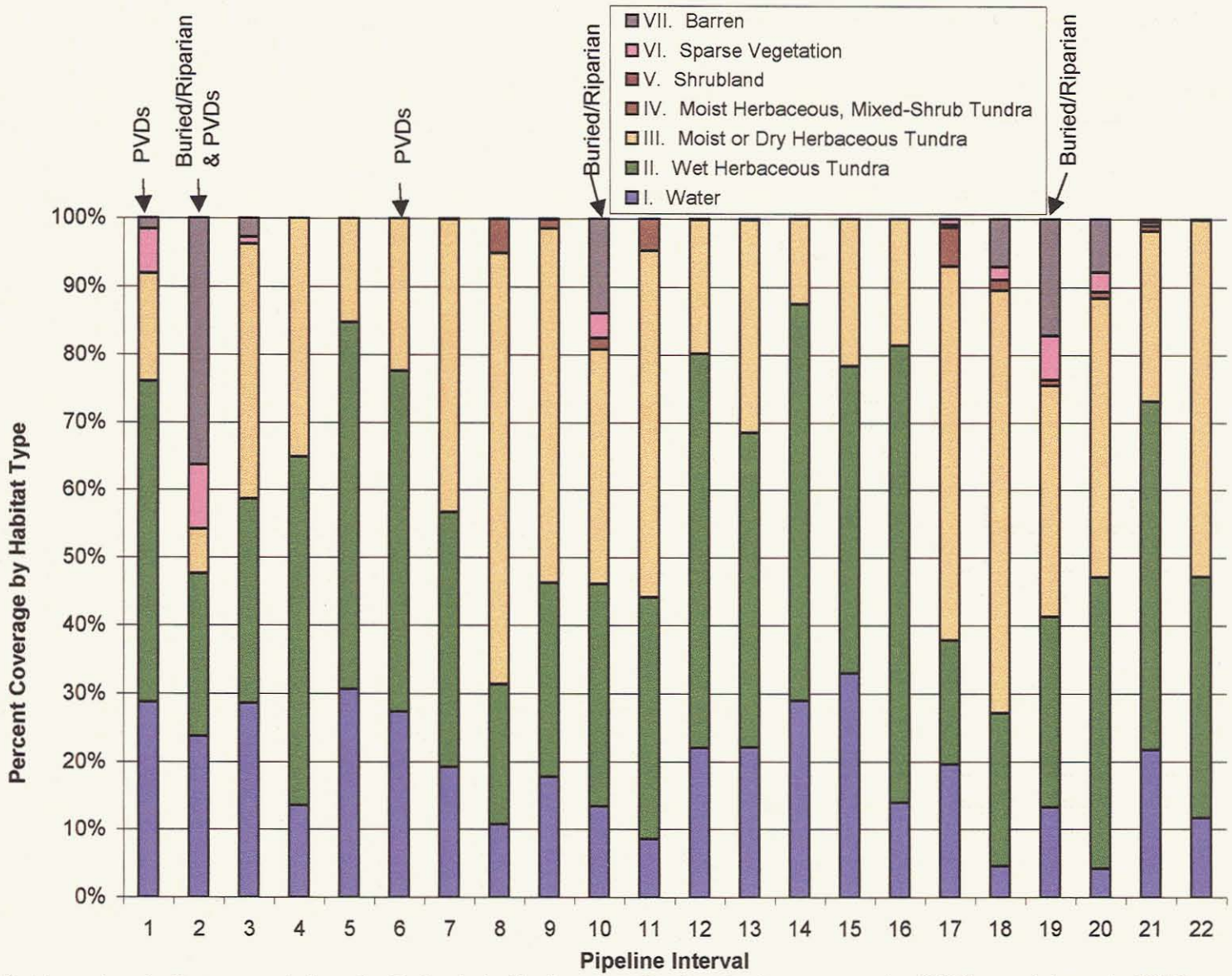


Figure 8. Habitat types by pipeline segment along the Badami pipeline based on Landsat land cover mapping (Walker and Acevedo 1987).

Table 1. Sex and age classification of caribou and muskoxen observed during systematic aerial surveys in the Badami study area, Alaska, 15 June to 19 July 1999.

Flight	Date	Number of Caribou					Number of Groups	Mean Group Size
		Bulls	Cows	Calves	Unclassified	Total		
Caribou Sightings								
1	15 Jun 99	54	509	175	430	1,149	193	6.0
2[a]	20 Jun 99	1	1,138	533	80	1,752	167	10.5
3	26 Jun 99	106	835	361	495	1,797	136	13.2
4	1 Jul 99	138	2,160	917	994	4,209	88	47.8
5	8 Jul 99	671	1,083	471	475	2,700	16	168.8
6	17 Jul 99	2	9	1	1	13	8	1.6
7	19 Jul 99	608	1,507	354	1,054	3,523	57	61.8
Muskoxen Sightings								
1	15 Jun 99	0	4	4	26	34	2	17.0
2[a]	20 Jun 99	0	0	0	16	16	1	16.0
3	26 Jun 99	0	4	4	10	18	1	18.0
4	1 July 99	0	0	3	16	19	2	9.5

[a]Coastal fog prevented surveying all transects, resulting in approximately 88% coverage of the study area.

Table 3. Caribou group movements recorded on systematic aerial surveys during the calving and post-calving periods in the Badami study area, Alaska, 15 June to 19 July 1999.

Date	Direction							Total	Wind Direction
	E	N	NE	NW	S	SE	W		
Calving Period (1 to 20 June)									
15 Jun 99		2			2		1	5	NNE
20 Jun 99	3				4		3	10	NE
Total	3	2	0	0	6	0	4	15	
Post-calving Period (21 June to 15 August)									
26 Jun 99	3	9			1	1	2	16	NNE
01 Jul 99	1	5	1	1	3			11	E
08 Jul 99	2			1		1		4	ENE
17 Jul 99	1					1		2	NE
19 Jul 99		2		1				3	ENE
Total	7	16	1	3	4	3	2	36	

Table 2. Sex and age classification of caribou and muskoxen observed north of the Badami pipeline corridor during systematic aerial surveys in the Badami study area, Alaska, 15 June to 19 July 1999.

Flight	Date	Number of Caribou					Number of Groups	Mean Group Size
		Bulls	Cows	Calves	Unclassified	Total		
Caribou Sightings								
1	15 Jun 99	0	0	0	1	1	1	1.0
2[a]	20 Jun 99	0	3	1	0	4	2	2.0
3	26 Jun 99	17	49	15	29	110	16	6.9
4	1 Jul 99	38	189	69	68	364	24	15.2
5	8 Jul 99	67	121	71	90	349	4	87.3
6	17 Jul 99	1	4	0	0	5	3	1.7
7	19 Jul 99	20	38	9	2	69	8	8.6
Muskoxen Sightings								
3	26 Jun 99	0	4	4	10	18	1	18.0

[a]Coastal fog prevented surveying all transects, resulting in approximately 88% coverage of the study area.

Table 4. Caribou activity by group size recorded on systematic aerial surveys during the calving and post-calving periods in the Badami study area, Alaska, 15 June to 19 July 1999.

Group Size	Activity								
	Calving Period (1 to 20 June)								
	Rest	Stand	Feed	Walk	Trot	Run	Move	Play	Total
Groups <10	58	6	84	10	3	4	1	1	167
Groups 10–100	20	1	29	0	0	1	0	0	51
Groups >100	0	0	1	0	0	0	0	0	1
All Groups	78	7	114	10	3	5	1	1	219
	Post-Calving Period (21 June to 15 August)								
	Rest	Stand	Feed	Walk	Trot	Run	Move	Play	Total
Groups <10	44	4	73	16	3	4	7	0	151
Groups 10–100	7	0	37	3	0	2	1	0	50
Groups >100	3	0	17	0	0	0	1	0	21
All Groups	54	4	127	19	3	6	9	0	222

Table 5. Caribou group sightings by activity and habitat types (Walker 1983, see Table 6) recorded on systematic aerial surveys during the calving and post-calving periods in the Badami study area, Alaska, 15 June to 19 July 1999.

Activity	Water	Wet Sedge Tundra	Wet Sedge/Moist Sedge, Dwarf Shrub Tundra Complex	Wet Sedge/Moist Sedge/Barren Complex	Moist/Wet Sedge Complex	Moist Sedge, Dwarf Shrub Tundra	Moist Tussock Sedge, Dwarf Shrub Tundra	Dry, Dwarf Shrub, Crustose Lichen Tundra	Moist Graminoid, Dwarf Shrub Tundra/Barren Complex	River Gravels	Gravel Roads and Pads	Wet Mud	Snow Covered Tundra	Total
	Ia	IIIa	IIId	IIIe	IVa	Va	Vb	Vc	Ve	Xa	Xe	XIa	XIIb	
Calving Period (1 June to 20 June)														
Rest		1			8	20	31	10	2	4				76
Stand		1				1		3		1	1			7
Feed		4		2	4	35	52	14	2					113
Walk					4	3	2	1						10
Trot						2	1							3
Run					1		2	1						4
Move						1								1
Play						1								1
Total	0	6	0	2	17	63	88	29	4	5	1	0	0	215
	Ia	IIIa	IIId	IIIe	IVa	Va	Vb	Vc	Ve	Xa	Xe	XIa	XIIb	Total
Post-Calving Period (21 June to15 August)														
Rest					3	22	2	18	1	3		1	1	51
Stand	1					1		1			1			4
Feed		2	1			63	11	34		8		2		121
Walk	1				2	6	1	4		3	1			18
Trot							1		1					2
Run						4		1		1				6
Move	2		1		1	4						1		9
Total	4	2	2	0	6	100	15	58	2	15	2	4	1	211

Table 6. Hierarchical vegetation categories in the Badami area based on Walker's (1983) vegetation classification.

LEVEL A Small-Scale Units	LEVEL B Landsat-Scale Units	LEVEL C Photo-Interpreted Map Units	LEVEL D Typical Plant Communities
A. Water	I. Water	Ia. Water (ponds, lakes, rivers, streams, saltwater)	No vegetation
B. Wet Tundra	II. Very Wet Tundra	IIb. Aquatic Graminoid Tundra (emergent vegetation)	Aquatic *Arctophila fulva* Grass Tundra Aquatic *Carex aquatilis* Sedge Tundra
		IId. Water/Tundra Complex (pond complex with emergent vegetation)	Typical communities listed in IIb, IIIa, and Va
	III. Wet Tundra	IIIa. Wet Sedge Tundra	Wet *Carex aquatilis, Scorpidium scorpioides* Sedge Tundra (wettest facies of wet alkaline tundra) Wet *Carex aquatilis, Eriophorum angustifolium, Pedicularis sudetica, Drepanocladus brevifolius* Sedge Tundra (wet alkaline tundra) Wet *Eriophorum angustifolium, Dupontia fisheri, Campylium stellatum* Graminoid Tundra (wet acidic tundra, coastal areas)
		IIIb. Wet Graminoid Tundra (wet saline tundra, saltmarsh)	Wet *Carex subspathacea, Puccinellia phryganodes, Stellaria humifusa, Cochlearia officinalis* Sedge Tundra
		IIIc. Wet Sedge Tundra/Water Complex (pond complex, no emergent vegetation)	Typical communities listed in IIIa and Va
		IIId. Wet Sedge/Moist Sedge, Dwarf Shrub Tundra Complex (wet patterned-ground complex)	Typical communities listed in IIIa and Va, and sometimes IIb
		IIIe. Wet Sedge/Moist Sedge/Barren complex (wet frost-scar tundra complex)	Typical communities listed in IIIa , Va and Ve
C. Moist Tundra	IV. Moist/Wet Tundra Complex	IVa. Moist Sedge, Dwarf Shrub/Wet Graminoid Tundra Complex (moist patterned ground complex)	Typical communities listed in IIIa and Va
	V. Moist or Dry Tundra	Va. Moist Sedge, Dwarf Shrub Tundra	Moist *Carex bigelowii, Eriophorum angustifolium, Dryas integrifolia, Salix reticulata, Tomenthypnum nitens, Thamnolia subuliformis* Sedge, Dwarf Shrub Tundra (moist alkaline tundra) Moist *Luzula arctica, Poa arctica, Saxifraga cernua, Salix planifolia, Dicranum elongatum, Ochrolechia frigida* Graminoid, Dwarf Shrub, Crustose Lichen Tundra (moist acidic tundra)

Table 6. Continued

LEVEL A Small-Scale Units	LEVEL B Landsat-Scale Units	LEVEL C Photo-Interpreted Map Units	LEVEL D Typical Plant Communities
C. Moist Tundra (continued)	V. Moist or Dry Tundra (continued)	Va. Moist Sedge, Dwarf Shrub Tundra (continued)	Moist *Carex aquatilis, Eriophorum angustifolium, Salix planifolia, Campylium stellatum* Sedge, Dwarf Shrub Tundra (moist acidic tundra, wetter facies)
		Vc. Dry, Dwarf Shrub, Crustose Lichen Tundra (*Dryas* tundra, pingos, river bars)	Dry *Dryas integrifolia, Carex rupestris, Oxytropis nigrescens, Salix reticulata, Ditrichum flexicaule, Lecanora epibyron* Dwarf Shrub, Forb, Crustose Lichen Tundra (*Dryas* tundra, pingos) Dry *Dryas integrifolia, Astragalus alpinus, Oxytropis borealis, Salix reticulata, Distichium capillaceum, Lecanora epibyron* Dwarf Shrub, Forb, Crustose Lichen Tundra (*Dryas* tundra, river bars)
		Vd. Dry, Dwarf Shrub, Fruticose Lichen Tundra (dry acidic tundra)	Dry *Salix rotundifolia, Pedicularis kanei, Luzula arctica, Ploytichum* sp., *Alectoria nigricans, Cetraria islandica* Dwarf Shrub, Fruticose Lichen Tundra (dry acidic tundra near coast)
		Ve. Moist Graminoid, Dwarf Shrub Tundra/Barren Complex (frost-scar tundra complex)	Typical communities listed in Va plus either completely barren frost scars or communities such as: Dry *Saxifraga oppositifolia, Dryas integrifolia, Chrysanthemum integrifolium, Juncus biglumis, Arctagrostis latifolia, Ochrolechia frigida* Barren (alkaline frost scars)
E. Partially Vegetated and Barren	IX. Partially Vegetated	IXb. Dry Barren/Dwarf Shrub, Forb Grass Complex (forb rich river bars)	Typical communities listed in Vc, and mixed forb, grass and dwarf shrub communities such as: Dry *Bromus pumpellianus, Festuca rubra, Astragalus alpinus, Androsace chamaejasme, Salix ovalifolia* Grass, Forb, Dwarf Shrub Tundra (forb rich river bars) Dry *Dryas integrifolia, Artemisia borealis, A. glomerata, Salix ovalifolia, Androsace chamaejasme* Dwarf Shrub, Forb Tundra (*Dryas* river bars near arctic coast)
		IXe. Dry Barren/Grass Complex (coastal sand dune grassland)	Dry *Elymus arenarius* Grass Tundra (coastal sand dune grassland)
		IXf. Dry Barren/Dwarf Shrub Grass complex (sand dune steppe)	Dry *Artemisia borealis, A. glomerata, Deschampsia caespitosa, Trisetum spicatum* Dwarf Shrub, Grass Tundra (sand dune steppe)
		IXh. Wet Barren/Wet Sedge Tundra Complex (barren/saline tundra complex, saltmarsh)	Typical communities listed in IIIb

Table 6. Continued

LEVEL A Small-Scale Units	LEVEL B Landsat-Scale Units	LEVEL C Photo-Interpreted Map Units	LEVEL D Typical Plant Communities
E. Partially Vegetated and Barren (continued)	IX. Partially Vegetated (continued)	IXi. Dry Barren/Forb, Graminoid Complex (coastal barrens)	Dry *Cochlearia officinalis, Stellaria humifusa, Puccinellia phryganodes, P. andersonii, Salix ovalifolia, Potentilla pulchella* Forb, Graminoid Tundra (coastal saline barrens)
	X. Light- colored Barrens (ground cover <30%)	Xa. River Gravels	Completely barren or with communities listed under IXb and IXc.
		Xc. Barren Gravel Outcrops	Typical communities listed under Vd or IXe or the following among many others; Dry *Dryas octopetala, Lupinus arcticus, Potentilla biflora, Smelowski calycina,Saxifraga tricusoidata, Salix phlebophylla, Silene acaulis* Dwarf Shrub Barren (gravel outcrops)
		Xe. Gravel Roads and Pads	Completely barren or partially vegetated with communities similar to IXb and IXc.
	XI. Dark-colored Barrens (ground cover <30%)	XIa. Wet Mud (drained lakes and ponds)	Completely barren or occasionally wtih colonizing species such as *Deschampsia caespitosa* and *Senecio congestus.*
		XIc. Bare Peat (mostly barren coastal areas caused by storm surges)	Completely barren or with sparse communities similar to IIIa, Va, and IXi.

Table 7. Caribou numbers within the coastal 1- to 4-km interval and the inland 5- to 8-km interval from the Beaufort Sea coast for the Badami and Bullen Point to Staines River study areas, Alaska, based on aerial survey data, summer 1999. No appropriate paired Bullen to Staines River flight was available for the 20 June 1999 Badami area survey.

	Badami						Bullen to Staines				
	1- to 4-km[a]		5- to 8-km		Total		1- to 4-km[a]		5- to 8-km		Total
Flight 1 (15 June)	4	7%	56	93%	60	Flight 1 (14 June)	41	24%	128	76%	169
Flight 3 (26 June)	347	23%	1142	77%	1489	Flight 3 (25 June)	156	42%	215	58%	371
Flight 4 (1 July)	1271	39%	1969	61%	3240	Flight 4 (29 June)	525	40%	772	60%	1297
Flight 5 (8 July)	1251	46%	1445	54%	2696	Flight 5 (9 July)	0	0%	0	0%	0
Flight 6 (17 July)	10	100%	0	0%	10	Flight 6 (15 July)	76	60%	51	40%	127
Flight 7 (19 July)	79	31%	176	69%	255	Flight 7 (18 July)	0	0%	3	100%	3

[a]Wilcoxon Signed Rank Test--paired non-parametric (Normal approx. = 0.839, Sum negative = -6.00, Sum positive = 15.00, $n = 6$, $P = 0.4017$)
Mann-Whitney U--rank sum test (U = 21.00, $n = 12$, $P = 0.6889$)

Table 8. Caribou density 1 km north of the Badami pipeline by pipeline segment, before and after winter 1997-1998 construction of the Badami pipeline, based on 1994 to 1999 aerial survey data, Badami study area, Alaska.

Pipe Segment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Segment Area (km^2)	2.90	2.07	1.73	1.78	1.74	2.09	1.89	1.78	1.56	1.86	1.81	1.68	1.62	1.68	1.64	1.63	1.62	1.62	1.61	1.72	1.58	1.74
Water Area (km^2)	0.34	0.85	0.19	0.20	0.76	0.32	0.25	0.37	0.18	0.19	0.25	0.53	0.65	0.30	0.78	0.59	0.32	0.18	0.19	0.03	0.15	0.07
Land Area (km^2)	2.56	1.22	1.55	1.59	0.97	1.78	1.64	1.41	1.38	1.67	1.56	1.15	0.97	1.39	0.86	1.05	1.30	1.44	1.42	1.69	1.42	1.67
Pre-Construction																						
1994 Survey Data (10 Flights)																						
Mean Caribou	1.7	0.1	0.1	0	0.3	0.2	0.1	0.1	0	0.5	0	0	4.4	0	0	0	0	0.3	0	0	0	0
Mean Density (No/km^2)	0.66	0.08	0.06	0.00	0.31	0.11	0.06	0.07	0.00	0.30	0.00	0.00	4.52	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00
Total Caribou	17	1	1	0	3	2	1	1	0	5	0	0	44	0	0	0	0	3	0	0	0	0
Number of Groups	3	1	1	0	2	1	1	1	0	3	0	0	1	0	0	0	0	1	0	0	0	0
1995 Survey Data (6 Flights)																						
Mean Caribou	0	0	0	0	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.66	65.83	0
Mean Density (No/km^2)	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.94	46.21	0.00
Total Caribou	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	395	0
Number of Groups	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
1997 Survey Data (3 Flights)																						
Mean Caribou	0	0	0	0	0	0	1.66	0	0.33	0	0	0	0	0.66	1	0	0	0	0	0.33	0	0
Mean Density (No/km^2)	0.00	0.00	0.00	0.00	0.00	0.00	1.01	0.00	0.24	0.00	0.00	0.00	0.00	0.48	1.16	0.00	0.00	0.00	0.00	0.20	0.00	0.00
Total Caribou	0	0	0	0	0	0	5	0	1	0	0	0	0	2	3	0	0	0	0	1	0	0
Number of Groups	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	1	0	0
Post-Construction																						
1998 Survey Data (7 Flights)																						
Mean Caribou	26.28	6	0	0.14	0.14	0	0	0.14	0	0	0	0	0.29	0	0	0	0	0	0	0	0	0
Mean Density (No/km^2)	10.26	4.91	0.00	0.09	0.14	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Caribou	184	42	0	1	1	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Number of Groups	5	2	0	1	1	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0
1999 Survey Data (7 Flights)																						
Mean Caribou	0.14	42.14	0	3.86	0.14	1.14	1.86	4.14	0	0	0.71	0	0	0	0	2.43	0.14	3	0.14	0	0	0
Mean Density (No/km^2)	0.05	34.50	0.00	2.43	0.14	0.64	1.13	2.93	0.00	0.00	0.46	0.00	0.00	0.00	0.00	2.32	0.11	2.08	0.10	0.00	0.00	0.00
Total Caribou	1	295	0	27	1	8	13	29	0	0	5	0	0	0	0	17	1	21	1	0	0	0
Number of Groups	1	1	0	2	1	1	1	3	0	0	3	0	0	0	0	2	1	1	1	0	0	0

Table 9. Caribou density 1 km south of the Badami pipeline by pipeline interval, before and after winter 1997-1998 construction of the Badami pipeline, based on 1994 to 1999 aerial survey data, Badami study area, Alaska.

Pipe Segment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Segment Area (km^2)	2.90	1.70	1.74	1.77	1.75	2.21	1.80	1.74	1.59	1.85	1.82	1.63	1.62	1.72	1.61	1.63	1.62	1.62	1.61	1.72	1.58	1.86
Water Area (km^2)	0.60	0.63	0.48	0.18	0.48	0.80	0.20	0.09	0.13	0.15	0.12	0.32	0.21	0.48	0.16	0.17	0.00	0.08	0.30	0.16	0.31	0.30
Land Area (km^2)	2.30	1.06	1.26	1.59	1.26	1.41	1.61	1.66	1.47	1.70	1.69	1.31	1.41	1.24	1.45	1.46	1.62	1.54	1.31	1.56	1.28	1.56
Pre-Construction																						
1994 Survey Data (10 Flights)																						
Mean Caribou	1.20	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.20	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.10	0.00	5.50
Mean Density (No/km^2)	0.52	2.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.06	0.00	3.52
Total Caribou	12	24	0	0	0	0	0	0	0	0	32	0	0	0	0	0	0	8	0	1	0	55
Number of Groups	2	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	1	0	1
1995 Survey Data (6 Flights)																						
Mean Caribou	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean Density (No/km^2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Caribou	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Groups	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997 Survey Data (3 Flights)																						
Mean Caribou	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00
Mean Density (No/km^2)	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.40
Total Caribou	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
Number of Groups	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Post-Construction																						
1998 Survey Data (7 Flights)																						
Mean Caribou	0.57	0.00	0.00	3.10	0.00	102.80	0.29	0.00	0.14	308.60	0.14	0.00	0.29	0.00	0.00	0.00	0.00	0.29	0.71	0.00	0.00	0.00
Mean Density (No/km^2)	0.25	0.00	0.00	1.95	0.00	72.89	0.18	0.00	0.10	181.98	0.08	0.00	0.21	0.00	0.00	0.00	0.00	0.19	0.54	0.00	0.00	0.00
Total Caribou	4	0	0	22	0	720	2	0	1	2160	1	0	2	0	0	0	0	2	5	0	0	0
Number of Groups	1	0	0	1	0	1	1	0	1	1	1	0	2	0	0	0	0	1	1	0	0	0
1999 Survey Data (7 Flights)																						
Mean Caribou	0.29	4.28	0.29	0.00	0.43	0.00	0.57	0.00	0.00	0.29	0.29	0.00	0.43	0.29	0.00	5.28	1.00	4.71	0.00	0.29	7.14	0.00
Mean Density (No/km^2)	0.13	4.02	0.23	0.00	0.34	0.00	0.35	0.00	0.00	0.17	0.17	0.00	0.30	0.23	0.00	3.61	0.62	3.06	0.00	0.19	5.60	0.00
Total Caribou	2	30	2	0	3	0	4	0	0	2	2	0	3	2	0	37	7	33	0	2	50	0
Number of Groups	1	1	1	0	2	0	2	0	0	1	1	0	1	1	0	3	2	3	0	2	1	0

Table 10. Habitat by pipeline segment within 500 m north and south of the Badami pipeline based on LandSat habitat mapping (Walker and Acevedo 1987).

	I. Water		II. Wet Herbaceous Tundra		III. Moist or Dry Herbaceous Tundra		IV. Moist Herbaceous, Mixed-Shrub Tundra		V. Shrubland		VI. Sparse Vegetation		VII. Barren		Total Area
Segment	(km^2)	%Area	(km^2)	%Area	(km^2)	%Area	(km^2)	%Area	(km^2)	%Area	(km^2)	%Area	(km^2)	%Area	(km^2)
1	0.86	28.8%	1.41	47.2%	0.48	15.9%		0.00		0.0%	0.19	6.5%	0.05	1.7%	3.00
2	0.44	23.8%	0.44	23.8%	0.12	6.6%		0.00		0.0%	0.18	9.6%	0.67	36.3%	1.84
3	0.50	28.6%	0.52	30.0%	0.66	37.6%		0.00		0.0%	0.02	1.0%	0.05	2.8%	1.74
4	0.24	13.5%	0.91	51.3%	0.63	35.2%		0.00		0.0%		0.0%		0.0%	1.78
5	0.53	30.7%	0.94	54.1%	0.26	15.2%		0.00		0.0%		0.0%		0.0%	1.74
6	0.60	27.3%	1.09	50.2%	0.49	22.5%		0.00		0.0%		0.0%		0.0%	2.18
7	0.35	19.2%	0.68	37.4%	0.78	43.3%	0.00	0.00		0.0%		0.0%		0.0%	1.81
8	0.19	10.7%	0.36	20.6%	1.12	63.6%	0.09	0.05		0.0%	0.00	0.1%		0.0%	1.77
9	0.28	17.8%	0.45	28.5%	0.82	52.3%	0.02	0.01		0.0%	0.00	0.1%	0.00	0.0%	1.57
10	0.25	13.4%	0.61	32.7%	0.65	34.7%	0.03	0.02		0.0%	0.07	3.7%	0.26	13.9%	1.87
11	0.15	8.5%	0.64	35.6%	0.93	51.2%	0.08	0.05		0.0%		0.0%		0.0%	1.81
12	0.37	22.1%	0.96	58.1%	0.33	19.7%	0.00	0.00		0.0%		0.0%		0.0%	1.66
13	0.36	22.1%	0.75	46.3%	0.51	31.4%	0.00	0.00		0.0%		0.0%		0.0%	1.62
14	0.49	29.0%	1.00	58.4%	0.21	12.5%		0.00		0.0%		0.0%		0.0%	1.70
15	0.54	33.0%	0.74	45.4%	0.35	21.6%		0.00		0.0%		0.0%		0.0%	1.63
16	0.23	13.9%	1.10	67.5%	0.30	18.6%	0.00	0.00		0.0%		0.0%		0.0%	1.63
17	0.32	19.7%	0.29	18.2%	0.90	55.2%	0.09	0.06	0.01	0.5%	0.01	0.8%		0.0%	1.62
18	0.07	4.6%	0.37	22.5%	1.01	62.4%	0.03	0.02		0.0%	0.03	1.9%	0.11	7.1%	1.62
19	0.21	13.2%	0.45	28.0%	0.55	34.2%	0.01	0.01		0.0%	0.11	6.6%	0.28	17.1%	1.62
20	0.07	4.1%	0.74	43.0%	0.71	41.2%	0.02	0.01		0.0%	0.05	2.9%	0.13	7.8%	1.73
21	0.34	21.7%	0.81	51.3%	0.40	25.1%	0.01	0.01		0.0%	0.01	0.6%	0.01	0.5%	1.58
22	0.22	11.6%	0.67	35.5%	1.00	52.7%	0.00	0.00		0.0%		0.0%	0.00	0.0%	1.89
Total	7.61	19.3%	15.95	40.5%	13.21	33.5%	0.40	1.0%	0.01	0.0%	0.67	1.7%	1.56	4.0%	39.41

APPENDIX A

1999 DATA

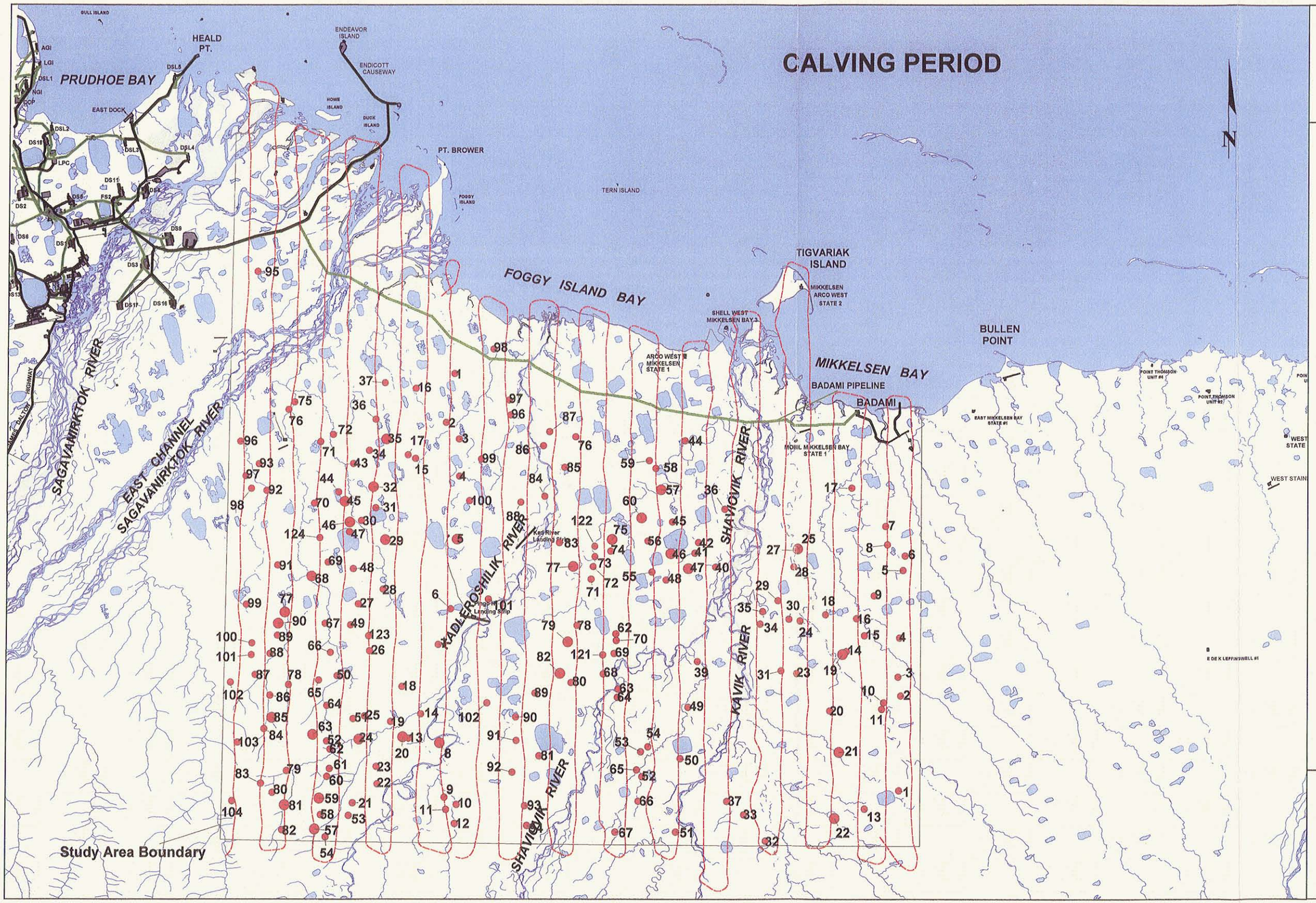


Figure A-1

Distribution of caribou observed in the Badami study area, Alaska, on 15 June 1999.

Caribou Group Size

15 June 1999	Groups
Less than 10	164
10 to 100	29
101 to 250	0
Greater than 250	0

22 — Group Attribute Number (see Table A-1)

Survey Flight Line

Pipelines

Roads

Oil Production and Service Facilities

Miles 1 0 1 2 3 4 5

Kilometers 1 0 1 2 3 4 5

Map Projection: UTM Zone 6
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View Scale: 1:253,000
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Prepared by: LGL Alaska Research Associates
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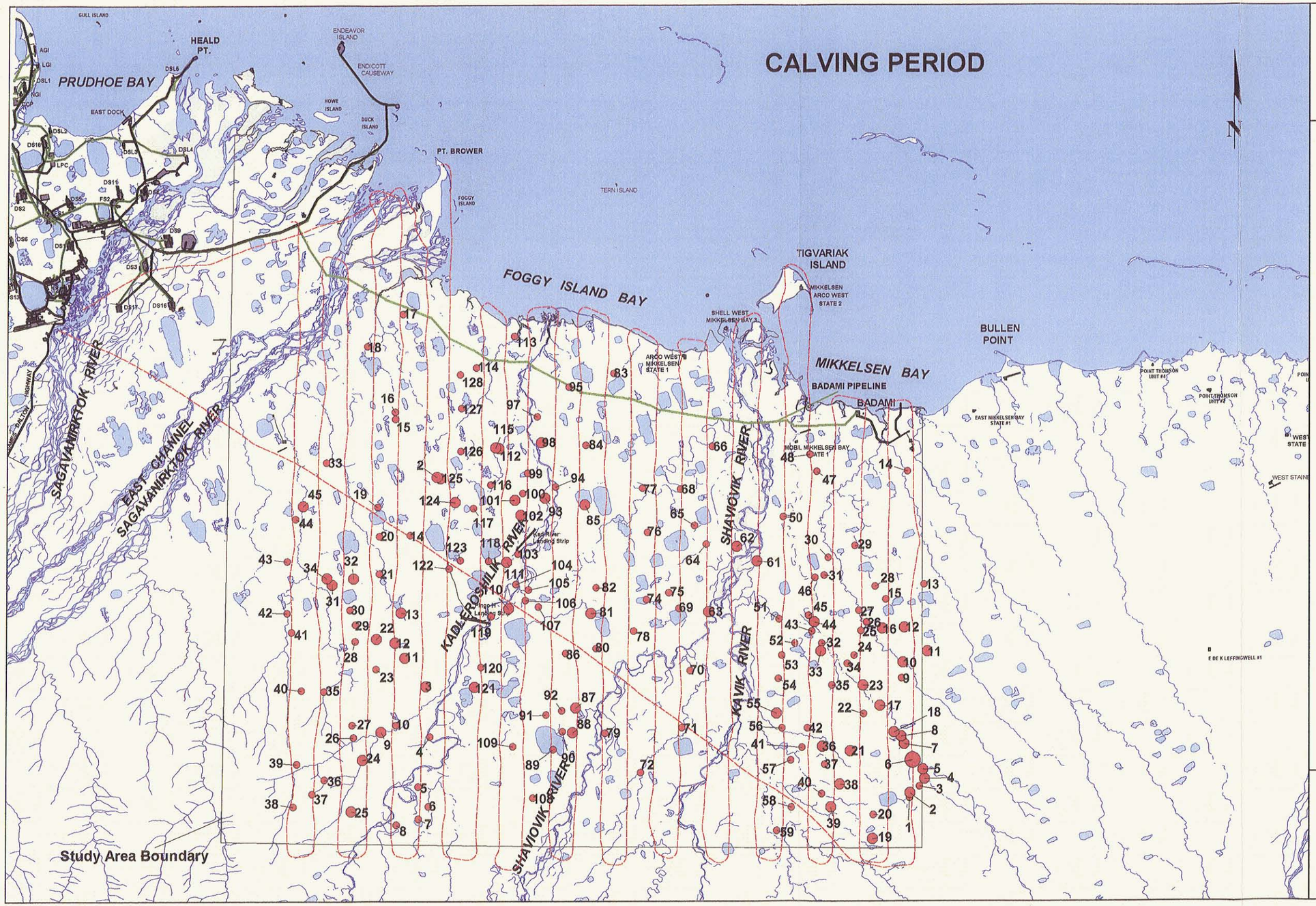

Figure A-2

Distribution of caribou observed in the Badami study area, Alaska, on 20 June 1999.

Caribou Group Size

20 June	Groups
Less than 10	115
10 to 100	51
101 to 250	1
Greater than 250	0

22 — Group Attribute Number (see Table A-1)

Survey Flight Line

Pipelines

Roads

Oil Production and Service Facilities

Miles
1 0 1 2 3 4 5
Kilometers
1 0 1 2 3 4 5

Map Projection: UTM Zone 6
Datum: NAD 27
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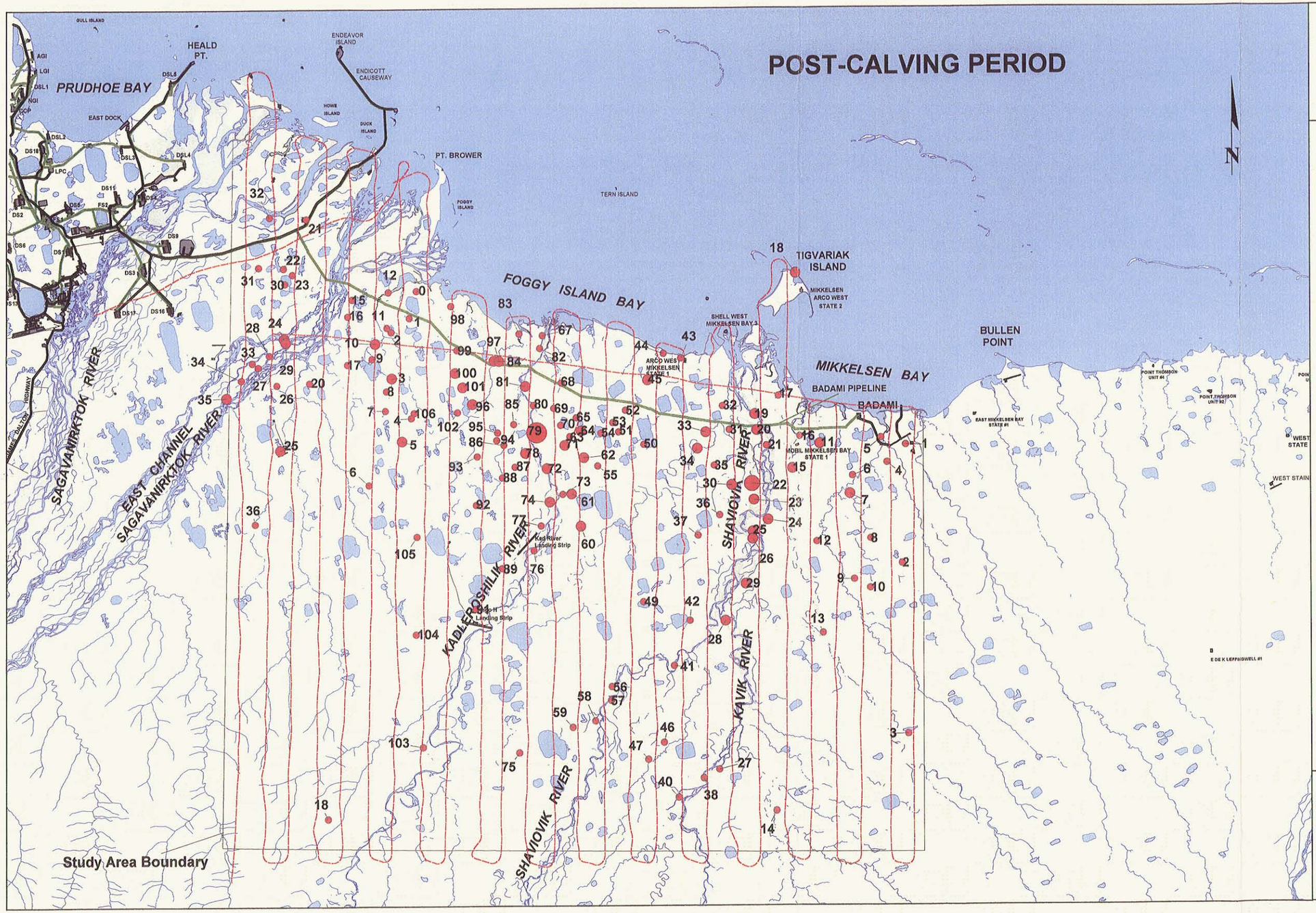

Figure A-3

Distribution of caribou observed in the Badami study area, Alaska, on 26 June 1999.

Caribou Group Size

25 June	Groups
Less than 10	97
10 to 100	37
101 to 250	1
Greater than 250	1

22 — Group Attribute Number (see Table A-1)

Survey Flight Line

Pipelines

Roads

Oil Production and Service Facilities

Miles
1 0 1 2 3 4 5
1 0 1 2 3 4 5
Kilometers

Map Projection: UTM Zone 6
Datum: NAD 27
View Scale: 1:253,000
Mapping Scale: 1:63,360
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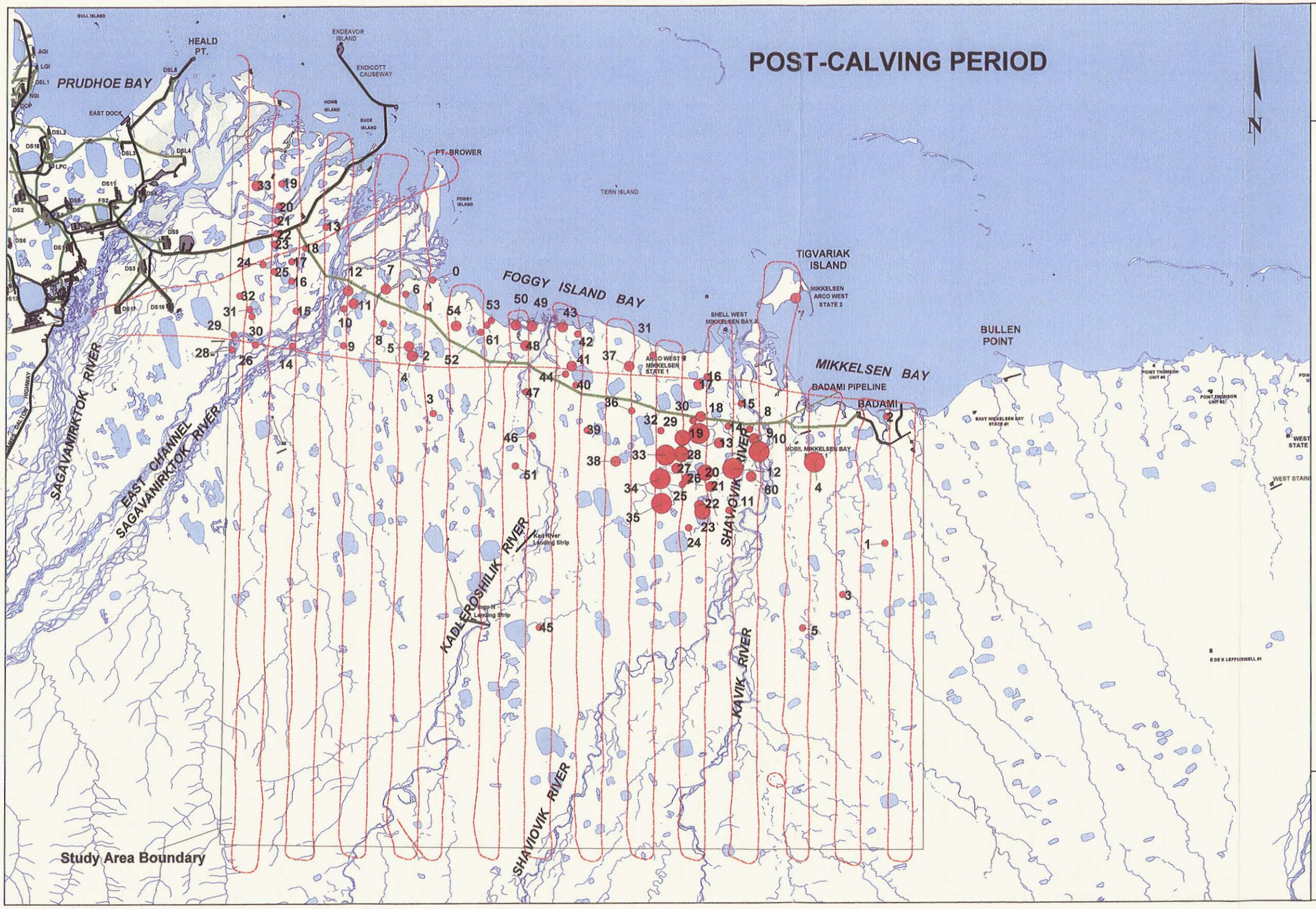

Figure A-4

Distribution of caribou observed in the Badami study area, Alaska, on 1 July 1999.

Caribou Group Size

1 July	Groups
Less than 10	52
10 to 100	25
101 to 250	4
Greater than 250	7

22 — Group Attribute Number (see Table A-1)

Survey Flight Line

Pipelines

Roads

Oil Production and Service Facilities

Miles
1 0 1 2 3 4 5
1 0 1 2 3 4 5
Kilometers

Map Projection: UTM Zone 6
Datum: NAD 27
View Scale: 1:253,000
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
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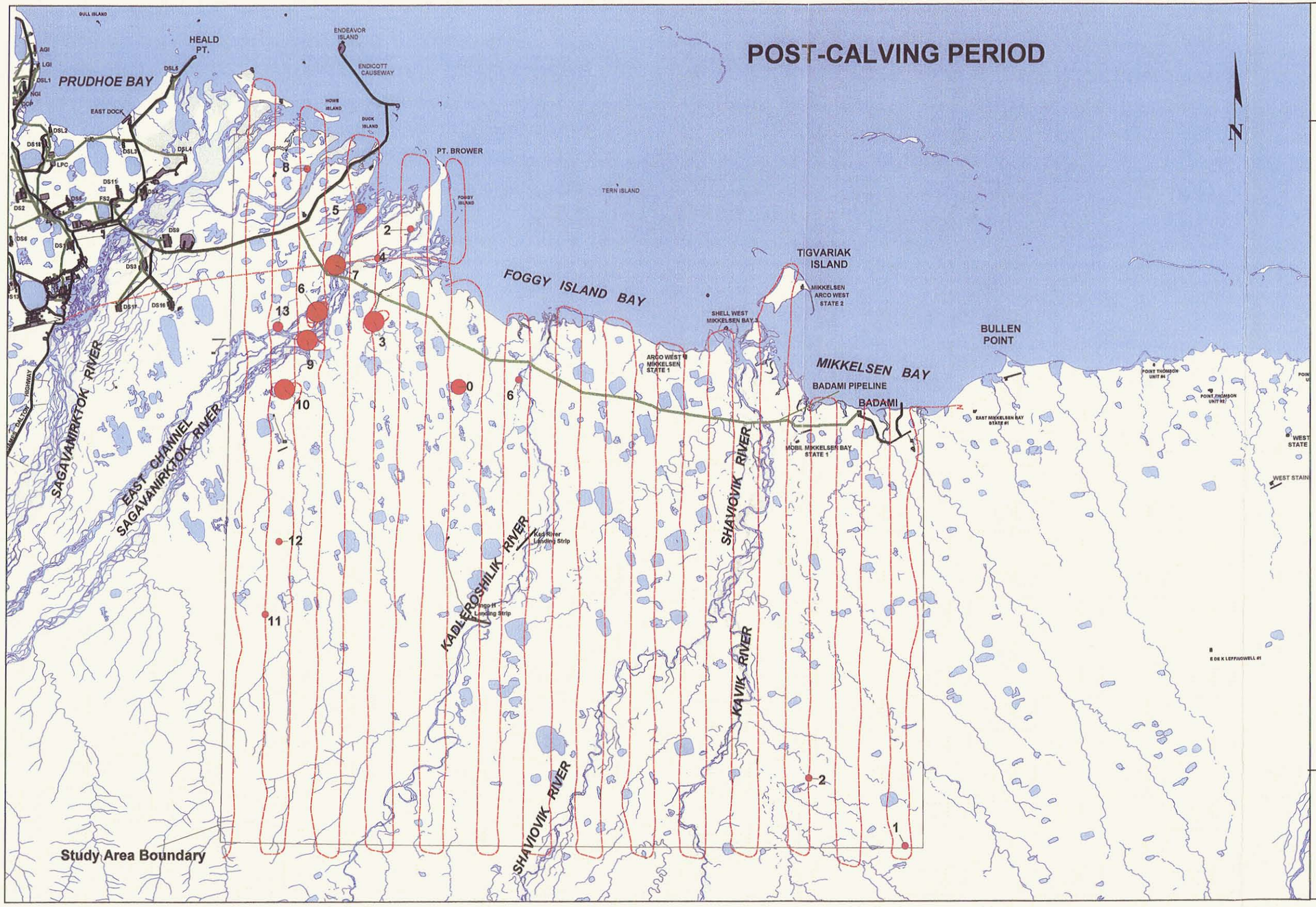

Figure A-5

Distribution of caribou observed in the Badami study area, Alaska, on 8 July 1999.

Caribou Group Size

8 July	Groups
Less than 10	8
10 to 100	2
101 to 250	1
Greater than 250	5

22 — Group Attribute Number (see Table A-1)

Survey Flight Line

Pipelines

Roads

Oil Production and Service Facilities

Miles
1 0 1 2 3 4 5
1 0 1 2 3 4 5
Kilometers

Map Projection: UTM Zone 6
Datum: NAD 27
View Scale: 1:253,000
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
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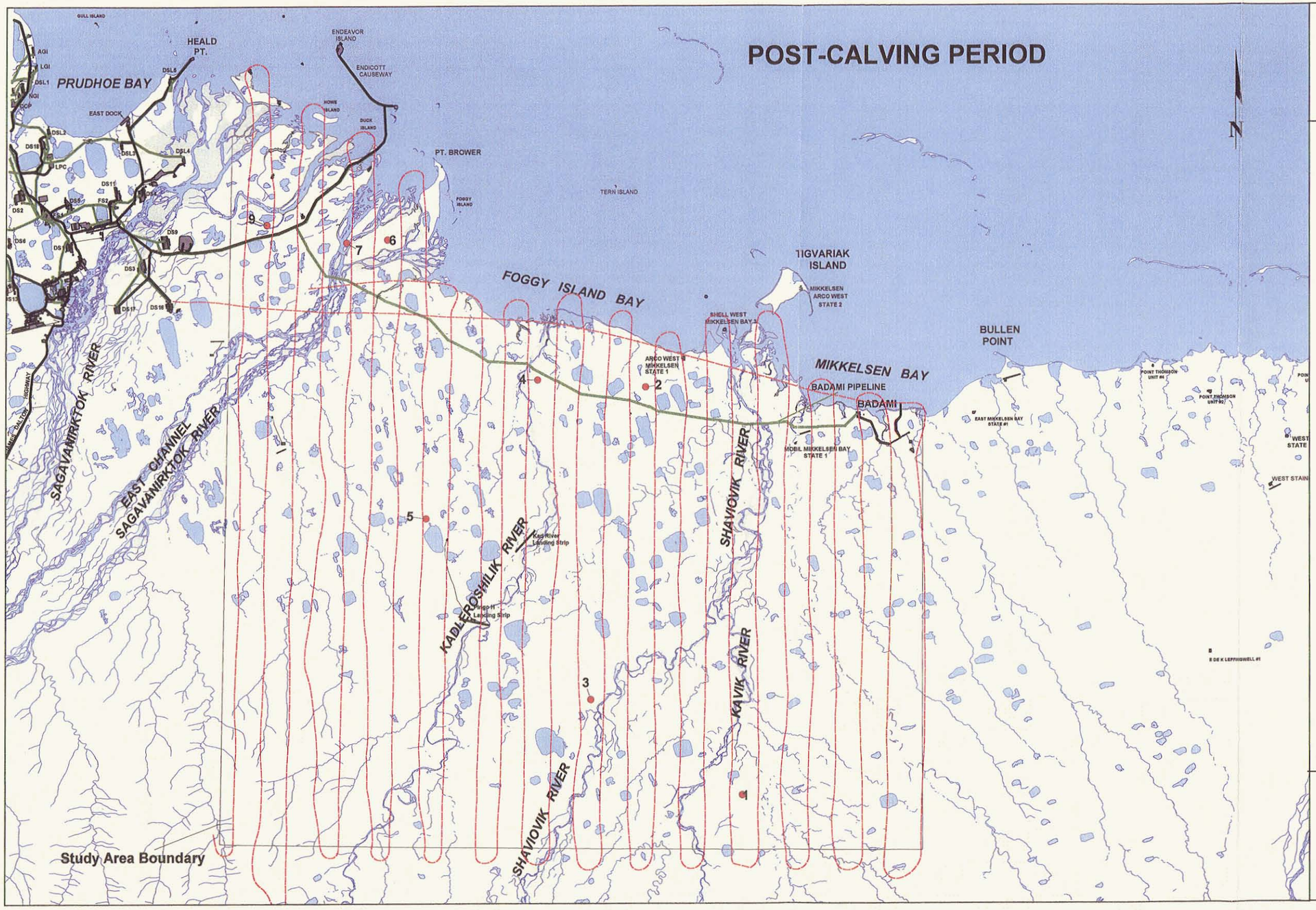

Figure A-6

Distribution of caribou observed in the Badami study area, Alaska, on 17 July 1999.

Caribou Group Size

17 July	Groups
Less than 10	8
10 to 100	0
101 to 250	0
Greater than 250	0

22 — Group Attribute Number (see Table A-1)

Survey Flight Line

Pipelines

Roads

Oil Production and Service Facilities

Miles
1 0 1 2 3 4 5
Kilometers
1 0 1 2 3 4 5

Map Projection: UTM Zone 6
Datum: NAD 27
View Scale: 1:253,000
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
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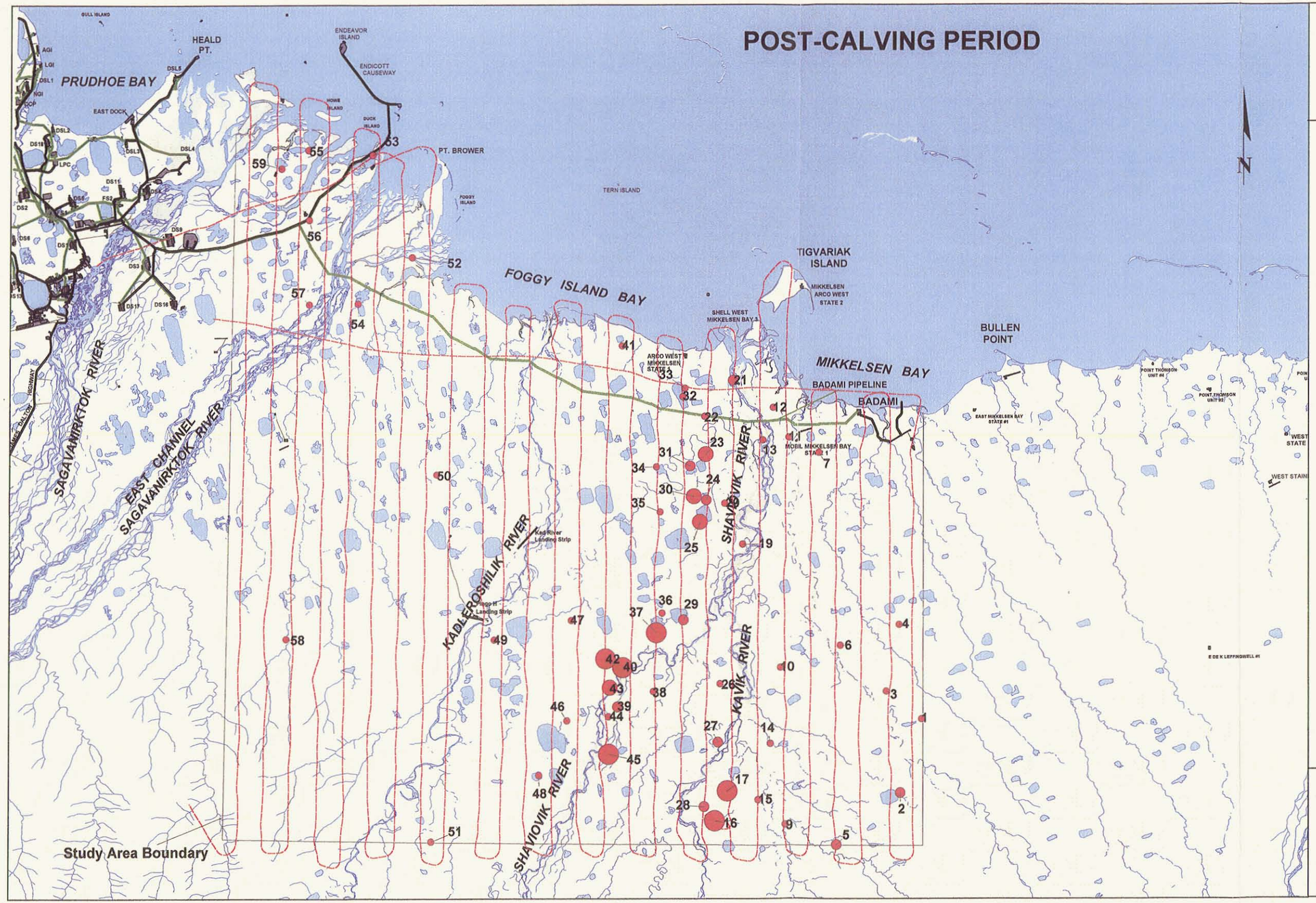

Figure A-7

Distribution of caribou observed in the Badami study area, Alaska, on 19 July 1999.

Caribou Group Size

19 July	Groups
Less than 10	38
10 to 100	9
101 to 250	4
Greater than 250	6

22 — Group Attribute Number (see Table A-1)

Survey Flight Line

Pipelines

Roads

Oil Production and Service Facilities

Miles
1 0 1 2 3 4 5
1 0 1 2 3 4 5
Kilometers

Map Projection: UTM Zone 6
Datum: NAD 27
View Scale: 1:253,000
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 99BDca_7.wor

Figure A-8

Distribution of large mammals, other than caribou, observed in the Badami study area, Alaska, between 15 June and 19 July 1999.

Species	Groups
Muskoxen	6
Grizzly Bear	6
Wolf	2
Moose	2

07/08/1999 — Date of Sightings (see Table A-2)

Survey Flight Line

Pipelines

Roads

Oil Production and Service Facilities

Miles
1 0 1 2 3 4 5
1 0 1 2 3 4 5
Kilometers

Map Projection: UTM Zone 6
Datum: NAD 27
View Scale: 1:253,000
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 99BDot_8.wor

Table A-1. Caribou (ca) sightings in the Badami study area, Alaska, summer 1999. Coordinates are longitude, latitude, and datum is WGS 1984. Time is Alaska Daylight Savings Time. See Table 6 for habitat code definitions.

Longitude°W	Latitude°N	Date	Time ADST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total	Behavior	Habitat	Direction
147.026109	69.938640	15-Jun-99	10:14:55	1	1	ca	0	0	0	3	3	move	Va	N
147.023921	69.991530	15-Jun-99	10:16:59	1	2	ca	0	2	1	0	3	rest	Va	
147.028249	70.002070	15-Jun-99	10:17:23	1	3	ca	0	0	0	6	6	rest	Va	
147.026160	70.024020	15-Jun-99	10:18:11	1	4	ca	0	0	0	4	4	feed	IIIa	
147.020773	70.062070	15-Jun-99	10:19:36	1	5	ca	0	1	1	0	2	rest	Vb	
147.017544	70.070210	15-Jun-99	10:19:55	1	6	ca	0	0	0	1	1	feed	Ve	
147.049889	70.086870	15-Jun-99	10:26:20	1	7	ca	0	1	0	0	1			
147.046620	70.076540	15-Jun-99	10:26:42	1	8	ca	0	5	1	0	6	feed	IIIa	
147.068299	70.047750	15-Jun-99	10:27:43	1	9	ca	0	2	0	0	2	feed	IIIa	
147.051887	69.987650	15-Jun-99	10:29:51	1	10	ca	0	0	0	2	2			
147.054866	69.983990	15-Jun-99	10:29:59	1	11	ca	0	0	0	4	4	feed	IIIa	
147.092870	69.903490	15-Jun-99	10:33:43	1	12	ca	0	2	0	0	2			
147.082306	69.928390	15-Jun-99	10:34:40	1	13	ca	0	0	0	2	2	feed	Ve	
147.113449	70.016310	15-Jun-99	10:38:02	1	14	ca	0	2	2	0	4	feed	Vb	
147.083926	70.025280	15-Jun-99	10:38:23	1	15	ca	0	9	0	0	9	rest	Va	
147.097149	70.034820	15-Jun-99	10:38:45	1	16	ca	0	1	1	1	3	rest	Vc	
147.106031	70.108440	15-Jun-99	10:41:36	1	17	ca	0	1	0	0	1			
147.148483	70.036940	15-Jun-99	10:48:40	1	18	ca	0	2	1	0	3			
147.119649	70.014720	15-Jun-99	10:49:26	1	19	ca	0	0	0	25	25	rest	Vb	
147.140447	69.982950	15-Jun-99	10:50:33	1	20	ca	0	3	0	0	3			
147.124777	69.959910	15-Jun-99	10:51:21	1	21	ca	0	12	4	0	16	feed	Vb	
147.131493	69.923170	15-Jun-99	10:52:39	1	22	ca	3	0	0	7	10	rest	Va	
147.196090	70.003740	15-Jun-99	10:57:23	1	23	ca	0	0	0	6	6	rest	Vc	
147.190713	70.033290	15-Jun-99	10:58:34	1	24	ca	1	0	0	2	3	feed	Va	
147.195191	70.073960	15-Jun-99	11:00:11	1	25	ca	2	0	0	11	13	feed	Va	
147.197930	70.073240	15-Jun-99	11:12:37	1	27	ca	0	3	0	1	4	feed	Va	
147.202120	70.063780	15-Jun-99	11:12:57	1	28	ca	0	1	0	2	3	feed	Va	
147.227997	70.044680	15-Jun-99	11:13:36	1	29	ca	0	4	3	0	7	stan	Va	
147.209696	70.034290	15-Jun-99	11:13:57	1	30	ca	0	4	2	0	6			
147.222019	70.005270	15-Jun-99	11:14:57	1	31	ca	0	0	0	2	2			
147.245629	69.910420	15-Jun-99	11:18:15	1	32	ca	0	1	1	0	2			
147.281831	69.924980	15-Jun-99	11:19:37	1	33	ca	2	0	0	1	3			
147.257553	70.031560	15-Jun-99	11:23:55	1	34	ca	0	3	0	0	3			
147.253306	70.038500	15-Jun-99	11:24:11	1	35	ca	0	0	0	4	4			
147.317384	70.096230	15-Jun-99	11:35:10	1	36	ca	1	0	0	4	5			
147.310037	69.932310	15-Jun-99	11:40:49	1	37	ca	0	1	0	0	1			
147.359623	70.010200	15-Jun-99	11:47:55	1	39	ca	0	1	1	0	2	feed	Vb	
147.331689	70.063440	15-Jun-99	11:50:02	1	40	ca	0	1	0	0	1	rest	Vc	
147.365330	70.071230	15-Jun-99	11:50:20	1	41	ca	0	0	0	1	1			
147.359573	70.077320	15-Jun-99	11:50:34	1	42	ca	0	1	0	0	1			
147.383293	70.134870	15-Jun-99	11:57:27	1	44	ca	0	3	3	1	7	rest	Va	
147.402701	70.088840	15-Jun-99	11:59:02	1	45	ca	0	0	0	3	3	rest	Vc	
147.404483	70.070850	15-Jun-99	11:59:39	1	46	ca	0	12	4	0	16			
147.375569	70.062540	15-Jun-99	11:59:56	1	47	ca	0	12	2	0	14	rest	Vb	
147.411889	70.055990	15-Jun-99	12:00:09	1	48	ca	0	0	0	1	1			
147.373887	69.984580	15-Jun-99	12:02:35	1	49	ca	0	3	3	1	7	rest	Vb	
147.385841	69.955880	15-Jun-99	12:03:36	1	50	ca	0	1	1	0	2			
147.391927	69.915170	15-Jun-99	12:05:01	1	51	ca	0	2	0	0	2			
147.447660	69.945690	15-Jun-99	12:07:37	1	52	ca	0	0	0	8	8	rest	Vb	
147.450159	69.959520	15-Jun-99	12:08:09	1	53	ca	0	0	0	4	4			
147.438586	69.962300	15-Jun-99	12:08:16	1	54	ca	4	0	0	0	4			
147.435279	70.060430	15-Jun-99	12:12:09	1	55	ca	0	0	0	3	3	rest	Va	
147.442361	70.077980	15-Jun-99	12:12:50	1	56	ca	0	0	0	3	3	walk	Va	
147.421564	70.107030	15-Jun-99	12:13:59	1	57	ca	0	7	4	0	11			
147.430790	70.119110	15-Jun-99	12:14:28	1	58	ca	0	1	1	0	2			
147.441724	70.123520	15-Jun-99	12:14:38	1	59	ca	0	0	0	1	1	trot	Va	S

Table A-1. Continued

Longitude°W	Latitude°N	Date	Time ADST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total	Behavior	Habitat	Direction
147.453000	70.091030	15-Jun-99	12:21:46	1	60	ca	0	0	0	13	13	feed	Va	
147.492599	70.025420	15-Jun-99	12:24:02	1	62	ca	0	0	0	1	1			
147.487651	69.994460	15-Jun-99	12:25:06	1	63	ca	1	0	0	0	1			
147.488791	69.989780	15-Jun-99	12:25:16	1	64	ca	0	0	0	4	4			
147.456389	69.949440	15-Jun-99	12:26:39	1	65	ca	0	0	0	7	7	rest	Vb	
147.453310	69.932050	15-Jun-99	12:27:15	1	66	ca	0	2	1	1	4	rest	Vb	
147.489869	69.914850	15-Jun-99	12:29:07	1	67	ca	0	0	0	3	3			
147.513300	70.013600	15-Jun-99	12:33:00	1	121	ca	1	0	0	1	2	feed	Va	
147.512220	70.002860	15-Jun-99	12:32:36	1	68	ca	1	0	0	5	6	feed	Va	
147.494970	70.014370	15-Jun-99	12:33:03	1	69	ca	0	0	0	2	2	feed	Vb	
147.491841	70.021760	15-Jun-99	12:33:20	1	70	ca	0	0	0	6	6			
147.534419	70.056110	15-Jun-99	12:34:41	1	71	ca	0	0	0	9	9			
147.531260	70.063220	15-Jun-99	12:34:58	1	72	ca	0	0	0	5	5			
147.528461	70.068890	15-Jun-99	12:35:11	1	73	ca	1	0	0	0	1			
147.502476	70.072080	15-Jun-99	12:35:19	1	74	ca	1	4	0	0	5			
147.529011	70.074770	15-Jun-99	12:35:26	1	122	ca	1	0	0	0	1	feed	Va	
147.500587	70.078710	15-Jun-99	12:35:34	1	75	ca	0	11	4	0	15			
147.562726	70.136550	15-Jun-99	12:43:38	1	76	ca	0	2	0	0	2			
147.564184	70.063240	15-Jun-99	12:46:09	1	77	ca	0	13	6	0	19			
147.556611	70.030100	15-Jun-99	12:47:17	1	78	ca	0	1	0	0	1	feed	Vb	
147.571371	70.020680	15-Jun-99	12:47:37	1	79	ca	0	23	6	0	30			
147.565126	69.997890	15-Jun-99	12:48:24	1	80	ca	0	7	2	0	9			
147.616270	69.956760	15-Jun-99	12:54:09	1	81	ca	1	0	0	0	1	feed	Va	
147.583476	70.003000	15-Jun-99	12:55:58	1	82	ca	0	12	12	38	62			
147.587267	70.076580	15-Jun-99	12:58:52	1	83	ca	0	0	0	4	4			
147.612461	70.102740	15-Jun-99	12:59:53	1	84	ca	0	1	1	0	2	feed		
147.580391	70.119290	15-Jun-99	13:00:32	1	85	ca	0	0	0	2	2			
147.616070	70.131280	15-Jun-99	13:01:01	1	86	ca	0	0	0	1	1	walk	IVa	
147.606044	70.139280	15-Jun-99	13:01:20	1	87	ca	0	5	1	0	6	feed	Va	
147.652294	70.099230	15-Jun-99	13:08:39	1	88	ca	1	4	0	0	5	rest	Vb	
147.624280	69.991810	15-Jun-99	13:12:17	1	89	ca	0	7	2	0	9			
147.655454	69.978420	15-Jun-99	13:12:45	1	90	ca	0	5	1	0	6			
147.653904	69.965210	15-Jun-99	13:13:13	1	91	ca	2	0	0	5	7	rest	Vb	
147.659739	69.947480	15-Jun-99	13:13:50	1	92	ca	0	0	0	6	6	rest		
147.638501	69.928960	15-Jun-99	13:14:27	1	93	ca	2	0	0	0	2			
147.634544	69.918000	15-Jun-99	13:14:50	1	94	ca	2	0	0	4	6		Vb	
147.670973	70.148510	15-Jun-99	13:25:36	1	96	ca	0	1	0	1	2	rest	Vb	
147.673823	70.156940	15-Jun-99	13:25:56	1	97	ca	0	1	1	0	2			
147.700750	70.185660	15-Jun-99	13:27:03	1	98	ca	0	0	0	1	1	feed	Va	
147.718370	70.123360	15-Jun-99	13:31:42	1	99	ca	0	0	0	7	8			
147.736319	70.099750	15-Jun-99	13:32:30	1	100	ca	0	0	0	1	1			
147.703027	70.044320	15-Jun-99	13:34:22	1	101	ca	0	2	0	0	2	rest	Va	
147.702697	69.986030	15-Jun-99	13:36:22	1	102	ca	1	0	0	0	1	rest	IVa	
147.764574	70.171510	15-Jun-99	14:28:14	1	1	ca	0	1	1	0	2	rest	Va	
147.777167	70.143800	15-Jun-99	14:29:12	1	2	ca	0	3	0	0	3	rest	IIIa	
147.755449	70.134540	15-Jun-99	14:29:31	1	3	ca	0	5	0	0	5	rest	Va	
147.753769	70.113560	15-Jun-99	14:30:15	1	4	ca	0	2	1	0	3	feed	Vb	
147.756019	70.077900	15-Jun-99	14:31:30	1	5	ca	5	9	0	0	14	feed	Vb	
147.764573	70.038570	15-Jun-99	14:32:50	1	6	ca	0	0	0	1	1			
147.784103	70.018460	15-Jun-99	14:33:31	1	7	ca	0	0	0	1	1	walk	IVa	
147.779007	69.963480	15-Jun-99	14:35:19	1	8	ca	0	15	0	0	15	feed	IVa	
147.769730	69.933230	15-Jun-99	14:36:20	1	9	ca	0	1	0	0	1	feed	IVa	
147.749810	69.929220	15-Jun-99	14:36:28	1	10	ca	0	1	1	0	2	feed	Vb	
147.766720	69.926350	15-Jun-99	14:36:34	1	11	ca	0	1	1	0	2	feed	IIIe	
147.752146	69.918680	15-Jun-99	14:36:50	1	12	ca	0	3	1	0	4	rest	Va	
147.829310	69.965780	15-Jun-99	14:40:17	1	13	ca	0	0	0	4	4	feed	IIIe	
147.810331	69.979440	15-Jun-99	14:40:49	1	14	ca	1	0	0	0	1			
147.826823	70.123270	15-Jun-99	14:46:17	1	15	ca	0	3	0	0	3	rest	Vb	
147.827951	70.162960	15-Jun-99	14:47:50	1	16	ca	0	1	1	1	3	feed	Vb	
147.839031	70.125270	15-Jun-99	14:58:21	1	17	ca	0	0	0	7	7	rest	Vc	

Table A-1. Continued

Longitude°W	Latitude°N	Date	Time ADST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total	Behavior	Habitat	Direction
147.841759	69.994660	15-Jun-99	15:02:39	1	18	ca	0	1	0	0	1	stan	IIIa	
147.858987	69.974890	15-Jun-99	15:03:19	1	19	ca	0	4	2	0	6			
147.838939	69.966470	15-Jun-99	15:03:36	1	20	ca	2	12	2	0	16	rest	Va	
147.918309	69.929450	15-Jun-99	15:07:02	1	21	ca	0	0	0	3	3	feed	Vb	
147.879100	69.940050	15-Jun-99	15:07:28	1	22	ca	0	0	0	2	1	rest	Va	
147.881009	69.949760	15-Jun-99	15:07:52	1	23	ca	0	0	0	5	5			
147.910083	69.964870	15-Jun-99	15:08:26	1	24	ca	0	11	1	0	12	rest	Vb	
147.901747	69.977920	15-Jun-99	15:08:55	1	25	ca	1	0	0	1	2	walk	Va	W
147.895560	70.014350	15-Jun-99	15:10:15	1	26	ca	1	5	0	0	6			
147.897600	70.022800	15-Jun-99	15:10:35	1	123	ca	0	2	0	0	2	walk	Va	
147.915630	70.040660	15-Jun-99	15:11:16	1	27	ca	0	0	0	2	2	rest	Ve	
147.875851	70.049110	15-Jun-99	15:11:36	1	28	ca	0	0	0	1	1			
147.873601	70.077110	15-Jun-99	15:12:39	1	29	ca	0	0	0	15	15			
147.913261	70.087720	15-Jun-99	15:13:02	1	30	ca	0	8	1	0	9	rest	Vb	
147.890434	70.095010	15-Jun-99	15:13:19	1	31	ca	0	0	0	1	1			
147.894910	70.106910	15-Jun-99	15:13:46	1	32	ca	0	2	12	31	45			
147.902741	70.127420	15-Jun-99	15:14:33	1	34	ca	0	1	1	1	3	feed	Vb	
147.875247	70.133960	15-Jun-99	15:14:48	1	35	ca	0	13	4	0	17			
147.893219	70.145150	15-Jun-99	15:15:13	1	36	ca	0	1	1	0	2	rest	Va	
147.878899	70.165850	15-Jun-99	15:16:00	1	37	ca	0	0	0	1	1			
147.928176	70.119880	15-Jun-99	15:27:44	1	43	ca	0	1	0	0	1	rest	Va	
147.951314	70.103610	15-Jun-99	15:28:16	1	44	ca	0	0	0	6	6			
147.941080	70.098460	15-Jun-99	15:28:26	1	45	ca	0	21	10	0	31	rest	Ve	
147.932176	70.086780	15-Jun-99	15:28:50	1	46	ca	0	7	4	0	11	rest	Vb	
147.932436	70.081320	15-Jun-99	15:29:00	1	47	ca	0	4	4	0	8	feed	Vb	
147.925037	70.060540	15-Jun-99	15:29:41	1	48	ca	0	8	1	0	9	feed	Vb	
147.927369	70.028820	15-Jun-99	15:30:43	1	49	ca	1	0	0	2	3	feed	Va	
147.947514	70.000170	15-Jun-99	15:31:40	1	50	ca	1	0	0	4	5			
147.920191	69.976280	15-Jun-99	15:32:28	1	51	ca	0	0	1	3	4	feed	Va	
147.962259	69.963540	15-Jun-99	15:32:55	1	52	ca	0	0	0	5	5			
147.924369	69.922370	15-Jun-99	15:34:16	1	53	ca	0	4	1	0	5	feed	Vb	
147.961370	69.910260	15-Jun-99	15:34:39	1	54	ca	0	0	0	1	1			
147.926750	69.902870	15-Jun-99	15:34:54	1	55	ca	5	0	0	6	11	feed	Vb	
147.965919	69.902450	15-Jun-99	15:35:35	1	56	ca	1	14	0	0	15			
147.979250	69.914540	15-Jun-99	15:36:03	1	57	ca	0	14	3	0	17			
147.970067	69.922510	15-Jun-99	15:36:22	1	58	ca	1	0	0	0	1			
147.972916	69.931660	15-Jun-99	15:36:44	1	59	ca	5	17	4	0	26			
147.960750	69.943800	15-Jun-99	15:37:12	1	60	ca	0	0	0	4	4			
147.957001	69.948240	15-Jun-99	15:37:22	1	61	ca	0	0	0	3	3			
147.956391	69.958990	15-Jun-99	15:37:48	1	62	ca	0	0	0	6	6			
147.985736	69.967020	15-Jun-99	15:38:06	1	63	ca	0	10	1	0	11	feed	Vb	
147.963180	69.983450	15-Jun-99	15:38:44	1	64	ca	1	0	0	6	7			
147.977654	69.997580	15-Jun-99	15:39:16	1	65	ca	1	0	0	1	2			
147.959341	70.013190	15-Jun-99	15:39:52	1	66	ca	0	0	0	1	1			
147.969139	70.029500	15-Jun-99	15:40:28	1	67	ca	0	4	2	0	6			
147.993083	70.055890	15-Jun-99	15:41:28	1	68	ca	0	14	10	0	24	rest	Vb	
147.966477	70.063970	15-Jun-99	15:41:46	1	69	ca	0	0	0	3	3	feed	Va	
147.980867	70.077670	15-Jun-99	15:42:16	1	124	ca	0	6	2	0	8	rest	Va	
147.991017	70.097130	15-Jun-99	15:43:01	1	70	ca	0	21	6	0	7	feed	Vb	
147.982910	70.131950	15-Jun-99	15:44:19	1	71	ca	0	0	0	5	5			
147.962121	70.136170	15-Jun-99	15:44:29	1	72	ca	0	0	0	1	1			
148.027483	70.154200	15-Jun-99	15:56:32	1	75	ca	0	0	0	2	2	play	Va	
148.036869	70.149940	15-Jun-99	15:56:41	1	76	ca	0	2	1	0	3			
148.035684	70.035400	15-Jun-99	16:00:30	1	77	ca	0	24	8	0	32			
148.027009	69.994810	15-Jun-99	16:01:52	1	78	ca	0	2	0	1	3			
148.027277	69.946630	15-Jun-99	16:03:29	1	79	ca	0	0	0	4	4			
148.049599	69.934440	15-Jun-99	16:03:54	1	80	ca	0	0	0	2	2		Ve	
148.029380	69.927700	15-Jun-99	16:04:07	1	81	ca	0	5	2	6	13	rest		
148.032657	69.913790	15-Jun-99	16:04:34	1	82	ca	0	2	0	0	2			
148.068670	69.939470	15-Jun-99	16:06:43	1	83	ca	1	1	1	1	4			

Table A-1. Continued

Longitude°W	Latitude°N	Date	Time ADST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total	Behavior	Habitat	Direction
148.065330	69.969900	15-Jun-99	16:07:52	1	84	ca	0	1	1	1	3	trot	Vb	N
148.053037	69.976140	15-Jun-99	16:08:06	1	85	ca	0	15	7	0	22			
148.056916	69.988670	15-Jun-99	16:08:33	1	86	ca	0	0	0	2	2			
148.081731	70.000060	15-Jun-99	16:08:58	1	87	ca	0	6	1	0	7	rest	Vb	
148.058274	70.012040	15-Jun-99	16:09:25	1	88	ca	1	0	0	3	4			
148.046611	70.022440	15-Jun-99	16:09:48	1	89	ca	0	0	0	6	6			
148.045981	70.029080	15-Jun-99	16:10:03	1	90	ca	0	0	0	15	15			
148.048947	70.061940	15-Jun-99	16:11:16	1	91	ca	0	0	0	2	2			
148.069629	70.103990	15-Jun-99	16:12:52	1	92	ca	0	3	0	0	3	rest	Va	
148.083240	70.118970	15-Jun-99	16:13:26	1	93	ca	1	0	0	2	3	feed	Vc	
148.092749	70.227580	15-Jun-99	16:25:23	1	95	ca	0	0	0	2	2			
148.114967	70.131550	15-Jun-99	16:28:32	1	96	ca	0	1	0	1	2			
148.104771	70.111990	15-Jun-99	16:29:10	1	97	ca	0	2	0	2	4	trot	Va	S
148.094747	70.104980	15-Jun-99	16:29:24	1	98	ca	0	1	1	0	2	feed	Vb	
148.098987	70.039500	15-Jun-99	16:31:35	1	99	ca	0	1	0	1	2	feed	Va	
148.088330	70.017810	15-Jun-99	16:32:18	1	100	ca	0	3	1	0	4	feed	Vb	
148.088830	70.011240	15-Jun-99	16:32:31	1	101	ca	0	0	0	1	1	feed	Vb	
148.122003	69.995620	15-Jun-99	16:33:02	1	102	ca	1	0	0	0	1			
148.107963	69.962130	15-Jun-99	16:34:09	1	103	ca	0	1	0	0	1			
148.115007	69.929480	15-Jun-99	16:35:15	1	104	ca	2	0	0	7	9			
147.012197	69.935470	20-Jun-99	11:26:59	2	1	ca	0	2	1	0	3			
147.011657	69.938230	20-Jun-99	11:27:06	2	2	ca	0	7	4	0	11			
146.995636	69.941870	20-Jun-99	11:27:14	2	3	ca	0	5	2	0	7			
146.987480	69.946030	20-Jun-99	11:27:23	2	4	ca	0	15	15	0	30			
146.990369	69.951270	20-Jun-99	11:27:35	2	5	ca	0	25	12	0	37			
147.007070	69.956370	20-Jun-99	11:27:47	2	6	ca	0	80	47	0	127	feed	Vb	
147.021183	69.965390	20-Jun-99	11:28:08	2	7	ca	0	32	10	0	42			
147.026060	69.969750	20-Jun-99	11:28:18	2	8	ca	0	14	6	0	20	feed	IVa	
147.025669	70.002060	20-Jun-99	11:29:33	2	9	ca	0	0	0	2	2	stan	Vc	
147.023090	70.011030	20-Jun-99	11:29:53	2	10	ca	0	15	4	0	19			
146.982981	70.017030	20-Jun-99	11:30:07	2	11	ca	0	8	6	0	14			
147.021341	70.030460	20-Jun-99	11:30:38	2	12	ca	0	12	10	0	22	feed	Va	
146.988580	70.054660	20-Jun-99	11:31:36	2	13	ca	0	1	1	0	2	bed	Vb	
147.016194	70.118420	20-Jun-99	11:34:03	2	14	ca	0	1	0	0	1	feed	Va	
147.051517	70.046260	20-Jun-99	11:39:38	2	15	ca	0	2	0	0	2	bed	Vb	
147.056874	70.029880	20-Jun-99	11:40:12	2	16	ca	0	10	8	0	18	feed	Vb	
147.061063	69.986840	20-Jun-99	11:41:37	2	17	ca	0	45	25	0	70	feed	Vb	
147.037596	69.971940	20-Jun-99	11:42:07	2	18	ca	0	12	4	0	16		Vb	
147.072181	69.912890	20-Jun-99	11:45:21	2	19	ca	0	6	4	0	10	feed	Vb	
147.071391	69.926100	20-Jun-99	11:45:51	2	20	ca	0	3	0	0	3	feed	Vb	
147.108701	69.961320	20-Jun-99	11:47:12	2	21	ca	0	20	4	0	24	feed	Va	
147.086963	69.982050	20-Jun-99	11:47:59	2	22	ca	0	1	0	0	1	run	Vb	S
147.088393	69.998100	20-Jun-99	11:48:37	2	23	ca	0	24	18	0	42	bed	Vc	
147.103084	70.014800	20-Jun-99	11:49:16	2	24	ca	0	6	3	0	9	feed	Va	
147.091640	70.028570	20-Jun-99	11:49:48	2	25	ca	0	7	0	0	7			
147.082764	70.033390	20-Jun-99	11:49:59	2	26	ca	0	5	4	0	9	feed	Vb	
147.095037	70.039950	20-Jun-99	11:50:15	2	27	ca	0	1	1	0	2			
147.069061	70.053540	20-Jun-99	11:50:46	2	28	ca	0	2	1	0	3	feed	Vb	
147.102404	70.076430	20-Jun-99	11:51:38	2	29	ca	0	4	2	0	6	feed	Va	
147.145856	70.069630	20-Jun-99	11:58:22	2	30	ca	0	4	4	0	8	bed	IVa	
147.152601	70.059570	20-Jun-99	11:58:42	2	31	ca	0	1	0	0	1	feed	Vb	
147.156160	70.021480	20-Jun-99	11:59:58	2	32	ca	0	3	0	0	3			
147.157779	70.017090	20-Jun-99	12:00:07	2	33	ca	0	15	0	0	15	bed	Vb	
147.114451	70.010120	20-Jun-99	12:00:21	2	34	ca	0	0	0	2	2			
147.139149	69.998120	20-Jun-99	12:00:45	2	35	ca	0	3	2	0	5	walk	IVa	W
147.155130	69.963800	20-Jun-99	12:01:53	2	36	ca	0	6	4	0	10	feed	Vb	
147.151031	69.953810	20-Jun-99	12:02:13	2	37	ca	0	2	1	0	3	bed	Vb	
147.126394	69.943010	20-Jun-99	12:02:34	2	38	ca	0	14	6	0	20	bed	Va	
147.140797	69.930350	20-Jun-99	12:02:59	2	39	ca	0	10	4	0	14	feed	Vb	
147.156011	69.937590	20-Jun-99	12:05:44	2	40	ca	0	0	0	1	1	bed	Vb	

Table A-1. Continued

Longitude°W	Latitude°N	Date	Time ADST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total	Behavior	Habitat	Direction
147.188614	69.963240	20-Jun-99	12:06:44	2	41	ca	0	6	0	0	6			
147.179767	69.974010	20-Jun-99	12:07:08	2	42	ca	0	1	1	0	2	feed	Va	
147.172670	70.028150	20-Jun-99	12:09:12	2	43	ca	0	2	0	0	2			
147.168641	70.033280	20-Jun-99	12:09:24	2	44	ca	0	15	10	0	25	bed	Xa	
147.178526	70.036940	20-Jun-99	12:09:32	2	45	ca	0	6	2	0	8		Vc	
147.168063	70.058280	20-Jun-99	12:10:21	2	46	ca	0	1	0	1	2	walk	Vb	
147.165844	70.118190	20-Jun-99	12:12:39	2	47	ca	0	1	0	0	1	walk	IVa	S
147.176860	70.127780	20-Jun-99	12:13:01	2	48	ca	0	1	0	0	1	feed	Vb	
147.221489	70.092620	20-Jun-99	12:22:09	2	50	ca	0	1	0	0	1	feed	Vc	
147.228017	70.034920	20-Jun-99	12:24:02	2	51	ca	0	1	0	0	1	bed	Vb	
147.201111	70.021320	20-Jun-99	12:24:28	2	52	ca	0	0	0	1	1			
147.223219	70.014590	20-Jun-99	12:24:41	2	53	ca	0	1	0	0	1			
147.228824	70.001540	20-Jun-99	12:25:07	2	54	ca	0	2	0	0	2	feed	Vb	
147.230934	69.982240	20-Jun-99	12:25:45	2	55	ca	0	8	6	0	14			
147.222159	69.973870	20-Jun-99	12:26:02	2	56	ca	0	2	0	0	2	bed	Vb	
147.207516	69.956090	20-Jun-99	12:26:37	2	57	ca	0	1	0	0	1	feed	Va	
147.206027	69.930110	20-Jun-99	12:27:28	2	58	ca	0	2	0	0	2	rest	Va	
147.230084	69.917100	20-Jun-99	12:27:53	2	59	ca	0	3	0	0	3	run	Vb	S
147.224359	69.906930	20-Jun-99	12:28:14	2	60	ca	0	1	0	0	1			
147.265007	70.067650	20-Jun-99	12:35:06	2	61	ca	0	10	2	0	12	run	Vc	E
147.298114	70.075840	20-Jun-99	12:45:05	2	62	ca	0	12	10	0	22	feed	Vb	
147.343371	70.039070	20-Jun-99	12:56:27	2	63	ca	0	10	8	0	18	feed	Vb	
147.347889	70.076960	20-Jun-99	12:57:56	2	64	ca	0	1	0	0	1	bed	Va	
147.366719	70.087660	20-Jun-99	12:58:22	2	65	ca	0	2	1	0	3	run	IVa	W
147.339094	70.132250	20-Jun-99	13:00:07	2	66	ca	0	1	1	0	2	bed	Vb	
147.390519	70.107990	20-Jun-99	13:05:39	2	68	ca	0	1	1	0	2	feed	Vb	
147.391199	70.040930	20-Jun-99	13:07:51	2	69	ca	0	3	2	0	5	feed	Vb	
147.372029	70.006000	20-Jun-99	13:09:00	2	70	ca	0	2	1	0	3	feed	Va	
147.385043	69.974160	20-Jun-99	13:10:02	2	71	ca	0	2	0	0	2	feed	Va	
147.451259	69.949010	20-Jun-99	13:14:25	2	72	ca	0	4	1	0	5	feed	Vb	
147.444151	70.045820	20-Jun-99	13:18:10	2	74	ca	0	0	0	1	1			
147.407791	70.049610	20-Jun-99	13:18:19	2	75	ca	0	4	2	0	6	feed	Vb	
147.443323	70.083610	20-Jun-99	13:19:39	2	76	ca	0	3	3	0	6	feed	Va	
147.452389	70.108510	20-Jun-99	13:20:37	2	77	ca	0	1	2	0	3			
147.464604	70.028060	20-Jun-99	13:29:59	2	78	ca	0	2	0	0	2	feed	Vb	
147.509203	69.970730	20-Jun-99	13:37:17	2	79	ca	0	0	0	4	4			
147.525944	70.018130	20-Jun-99	13:39:08	2	80	ca	0	4	2	0	6	feed	Va	
147.534659	70.037880	20-Jun-99	13:39:55	2	81	ca	0	0	0	10	10		Va	
147.526871	70.052260	20-Jun-99	13:40:29	2	82	ca	0	6	0	0	6	feed	Vb	
147.500876	70.173100	20-Jun-99	13:45:07	2	83	ca	0	2	0	0	2			
147.545756	70.132350	20-Jun-99	13:49:28	2	84	ca	0	1	0	0	1	bed	IVa	
147.546246	70.098860	20-Jun-99	13:50:34	2	85	ca	0	10	4	0	14	bed	Vb	
147.575651	70.015150	20-Jun-99	13:53:16	2	86	ca	0	5	0	0	5	feed	Vb	
147.558007	69.984760	20-Jun-99	13:54:16	2	87	ca	0	8	4	0	12	feed	Vb	
147.562556	69.970810	20-Jun-99	13:54:43	2	88	ca	0	15	10	0	25	feed	Vb	
147.594491	69.961310	20-Jun-99	13:59:34	2	89	ca	1	7	0	0	8	run		S
147.579350	69.971390	20-Jun-99	13:59:57	2	90	ca	0	2	0	0	2	feed	Vc	
147.606756	69.980660	20-Jun-99	14:00:19	2	91	ca	0	1	1	0	2	feed	Va	
147.580860	69.983180	20-Jun-99	14:00:24	2	92	ca	0	3	2	0	5	feed	Vb	
147.612263	70.102450	20-Jun-99	14:04:55	2	93	ca	0	14	6	0	20	feed	Vb	
147.594933	70.108800	20-Jun-99	14:05:09	2	94	ca	0	4	0	0	4	bed	Xa	
147.574521	70.165090	20-Jun-99	14:07:17	2	95	ca	0	2	0	0	2	walk	Vb	E
147.626749	70.148210	20-Jun-99	14:11:25	2	97	ca	0	0	0	1	1			
147.619721	70.133680	20-Jun-99	14:11:53	2	98	ca	0	0	0	10	10		Vc	
147.641420	70.116280	20-Jun-99	14:12:26	2	99	ca	0	1	0	0	1			
147.649186	70.104960	20-Jun-99	14:12:48	2	100	ca	0	1	0	0	1			
147.662109	70.101120	20-Jun-99	14:12:55	2	101	ca	0	12	0	0	12		Vb	
147.652104	70.092660	20-Jun-99	14:13:11	2	102	ca	0	17	12	0	29	bed	Vb	
147.655753	70.070730	20-Jun-99	14:13:53	2	103	ca	0	2	0	0	2	stan	Xe	
147.659041	70.053730	20-Jun-99	14:14:25	2	104	ca	0	2	2	0	4	feed	Vc	

Table A-1. Continued

Longitude°W	Latitude°N	Date	Time ADST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total	Behavior	Habitat	Direction
147.637743	70.050800	20-Jun-99	14:14:31	2	105	ca	0	1	0	0	1	stan	Xa	
147.642550	70.044810	20-Jun-99	14:14:42	2	106	ca	0	1	0	0	1			
147.621501	70.041210	20-Jun-99	14:14:50	2	107	ca	0	0	0	5	5			
147.626577	69.934330	20-Jun-99	14:18:18	2	108	ca	0	2	0	0	2	feed	Va	
147.660531	69.962860	20-Jun-99	14:22:26	2	109	ca	0	7	0	0	7	feed	Vb	
147.670336	70.039940	20-Jun-99	14:25:24	2	110	ca	0	19	12	0	31	bed	Xa	
147.674413	70.066110	20-Jun-99	14:26:23	2	111	ca	0	7	4	0	11	feed	Vb	
147.689181	70.130140	20-Jun-99	14:28:52	2	112	ca	0	22	14	0	36			
147.666167	70.193470	20-Jun-99	14:31:16	2	113	ca	0	1	1	0	2	feed	Vc	
147.728953	70.175500	20-Jun-99	14:33:23	2	114	ca	0	1	0	0	1	bed	Vb	
147.695201	70.130570	20-Jun-99	14:34:49	2	115	ca	0	0	0	20	20		Vb	
147.702189	70.109590	20-Jun-99	14:35:30	2	116	ca	0	3	0	0	3		Va	
147.730653	70.096320	20-Jun-99	14:35:55	2	117	ca	0	1	0	0	1	feed	Vb	
147.704487	70.066620	20-Jun-99	14:36:52	2	118	ca	0	4	3	0	7	feed	Vb	
147.698540	70.035460	20-Jun-99	14:37:52	2	119	ca	0	0	0	4	4		Ia	
147.714720	70.006950	20-Jun-99	14:38:46	2	120	ca	0	1	1	0	2	feed	Va	
147.725013	69.995780	20-Jun-99	14:39:07	2	121	ca	0	14	8	0	22	feed	Vb	
147.768871	70.062050	20-Jun-99	14:48:49	2	122	ca	0	4	0	0	4	bed	Vb	
147.750851	70.066710	20-Jun-99	14:49:00	2	123	ca	0	3	0	0	3	bed	Vb	
147.760724	70.099540	20-Jun-99	14:50:16	2	124	ca	0	25	18	0	43	bed	IVa	
147.785223	70.112830	20-Jun-99	14:50:47	2	125	ca	0	7	4	0	11	feed	Vb	W
147.752801	70.128440	20-Jun-99	14:51:24	2	126	ca	0	5	0	0	5	feed	IVa	
147.752221	70.152650	20-Jun-99	14:52:20	2	127	ca	0	3	2	0	5	bed	IVa	
147.755150	70.171530	20-Jun-99	14:53:04	2	128	ca	0	2	1	0	3	feed	Va	
147.791150	70.113640	20-Jun-99	15:47:45	2	2	ca	0	6	4	0	10	stan	Vc	
147.804024	69.995940	20-Jun-99	15:51:39	2	3	ca	0	10	4	0	14	bed	Vc	
147.796057	69.967810	20-Jun-99	15:52:36	2	4	ca	0	0	0	1	1	stan	Vc	
147.814337	69.940060	20-Jun-99	15:53:32	2	5	ca	0	4	0	1	5	feed	Vb	
147.796817	69.929030	20-Jun-99	15:53:54	2	6	ca	0	1	0	0	1	feed	Va	
147.812949	69.922100	20-Jun-99	15:54:08	2	7	ca	0	3	0	0	3	bed	Vb	
147.847694	69.918620	20-Jun-99	15:55:51	2	8	ca	0	4	0	0	4	bed	Xa	
147.875440	69.969940	20-Jun-99	15:57:54	2	9	ca	0	45	23	0	68	bed	Vc	
147.851033	69.974010	20-Jun-99	15:58:04	2	10	ca	0	1	0	0	1	feed	Vc	
147.838919	70.011760	20-Jun-99	15:59:34	2	11	ca	0	11	3	0	14	feed	Vc	
147.854710	70.020020	20-Jun-99	15:59:54	2	12	ca	0	55	32	0	87	feed	Vc	
147.845907	70.037030	20-Jun-99	16:00:34	2	13	ca	0	15	7	0	22	feed	Vc	
147.833261	70.080530	20-Jun-99	16:02:20	2	14	ca	0	1	0	0	1	bed	IVa	
147.860227	70.146090	20-Jun-99	16:04:58	2	15	ca	0	2	0	0	2	bed	Vc	
147.860587	70.150220	20-Jun-99	16:05:08	2	16	ca	0	2	0	0	2			
147.850593	70.205380	20-Jun-99	16:07:20	2	17	ca	0	1	1	0	2	bed	IVa	
147.908254	70.186940	20-Jun-99	16:13:26	2	18	ca	0	4	0	0	4	bed	IVa	
147.886834	70.096350	20-Jun-99	16:16:28	2	19	ca	0	2	0	0	2	walk	Vc	E
147.883387	70.079840	20-Jun-99	16:17:01	2	20	ca	0	7	2	0	9	bed	Vc	
147.882467	70.058770	20-Jun-99	16:17:44	2	21	ca	0	0	0	4	4	feed	Vc	
147.885487	70.022070	20-Jun-99	16:18:56	2	22	ca	0	25	12	0	37	feed	Va	
147.885137	70.005170	20-Jun-99	16:19:30	2	23	ca	0	0	0	2	2	feed	Va	
147.904726	69.954320	20-Jun-99	16:21:12	2	24	ca	0	6	4	0	10	bed	Vb	
147.921610	69.925790	20-Jun-99	16:24:19	2	25	ca	0	8	2	0	10			
147.919921	69.966820	20-Jun-99	16:25:56	2	26	ca	0	2	0	0	2			
147.922270	69.973540	20-Jun-99	16:26:12	2	27	ca	0	1	1	0	2			
147.919760	70.020510	20-Jun-99	16:28:02	2	28	ca	0	5	3	0	8			
147.919871	70.029930	20-Jun-99	16:28:25	2	29	ca	0	2	0	0	2			
147.929337	70.038040	20-Jun-99	16:28:44	2	30	ca	0	4	3	0	7			
147.958970	70.052160	20-Jun-99	16:29:17	2	31	ca	0	28	12	0	40	feed	Vc	
147.924379	70.055860	20-Jun-99	16:29:26	2	32	ca	0	36	20	0	56			
147.971537	70.120930	20-Jun-99	16:40:50	2	33	ca	0	4	2	0	6	bed	Va	
147.967559	70.055830	20-Jun-99	16:42:58	2	34	ca	0	25	14	0	39			
147.969223	69.992180	20-Jun-99	16:45:08	2	35	ca	0	0	0	1	1	feed	Va	
147.965979	69.943040	20-Jun-99	16:46:46	2	36	ca	0	0	0	7	7	feed	Va	
147.985399	69.935080	20-Jun-99	16:47:02	2	37	ca	0	3	0	0	3			

Table A-1. Continued

Longitude°W	Latitude°N	Date	Time ADST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total	Behavior	Habitat	Direction
148.016113	69.927890	20-Jun-99	16:49:35	2	38	ca	0	4	0	0	4			
148.011764	69.951410	20-Jun-99	16:50:33	2	39	ca	0	2	0	0	2			
148.005980	69.992580	20-Jun-99	16:52:11	2	40	ca	0	0	0	1	1			
148.023850	70.025110	20-Jun-99	16:53:28	2	41	ca	0	5	0	0	5			
148.031936	70.035860	20-Jun-99	16:53:53	2	42	ca	0	1	0	0	1	feed	Vc	
148.033066	70.064960	20-Jun-99	16:55:02	2	43	ca	0	5	3	1	9	feed	Vc	
148.021133	70.088790	20-Jun-99	16:56:01	2	44	ca	0	3	1	0	4			
148.008860	70.096260	20-Jun-99	16:56:19	2	45	ca	0	8	3	0	11	feed	Vc	
147.020753	70.135270	26-Jun-99	9:51:35	3	1	ca	0	2	2	0	4	feed	Va	
147.026970	70.068580	26-Jun-99	9:53:59	3	2	ca	0	1	1	0	2	feed	Va	
147.017716	69.973090	26-Jun-99	9:57:27	3	3	ca	0	1	0	0	1	rest	Va	
147.051887	70.125310	26-Jun-99	10:08:47	3	4	ca	0	1	0	0	1	rest	Vc	
147.061723	70.139170	26-Jun-99	10:09:19	3	5	ca	0	0	0	3	3	rest	Vc	
147.108033	70.117870	26-Jun-99	10:11:53	3	6	ca	0	1	0	0	1	move	Va	E
147.112520	70.107800	26-Jun-99	10:12:15	3	7	ca	0	12	8	0	20	feed	Va	
147.078569	70.082600	26-Jun-99	10:13:09	3	8	ca	0	0	0	1	1	trot	Ve	S
147.105134	70.059620	26-Jun-99	10:13:58	3	9	ca	0	2	1	0	3	feed	Va	
147.079139	70.054740	26-Jun-99	10:14:09	3	10	ca	0	1	0	0	1	feed	Vc	
147.162249	70.135960	26-Jun-99	10:30:59	3	11	ca	0	20	10	20	50	feed	Vc	
147.167256	70.080730	26-Jun-99	10:32:56	3	12	ca	0	2	0	0	2	rest	Va	
147.156721	70.029410	26-Jun-99	10:34:44	3	13	ca	0	0	0	4	4	feed	Vc	
147.233803	69.930400	26-Jun-99	10:40:34	3	14	ca	0	1	0	0	1	rest	Vc	
147.208296	70.122110	26-Jun-99	10:47:46	3	15	ca	0	25	14	0	39	feed	Vc	
147.195971	70.140130	26-Jun-99	10:48:28	3	16	ca	0	1	0	0	1	feed	Vc	
147.231623	70.162960	26-Jun-99	10:49:21	3	17	ca	2	0	0	0	2	feed	Vc	
147.203907	70.231870	26-Jun-99	10:52:02	3	18	ca	15	4	4	5	28	feed	Vc	N
147.270624	70.152490	26-Jun-99	10:55:31	3	19	ca	0	15	0	6	21			
147.266936	70.143520	26-Jun-99	10:55:50	3	20	ca	0	15	4	0	19			
147.251384	70.134910	26-Jun-99	10:56:08	3	21	ca	5	0	0	0	5			
147.274923	70.113340	26-Jun-99	10:56:54	3	22	ca	0	60	30	50	140			
147.271734	70.104380	26-Jun-99	10:57:13	3	23	ca	0	34	6	0	40			
147.248787	70.093110	26-Jun-99	10:57:37	3	24	ca	30	20	6	0	56			
147.273004	70.086480	26-Jun-99	10:57:51	3	25	ca	7	60	30	0	97			
147.273524	70.082240	26-Jun-99	10:58:00	3	26	ca	0	45	20	0	65	rest	Vc	
147.327049	69.953180	26-Jun-99	11:06:45	3	27	ca	0	0	0	1	1	walk	Vc	W
147.317584	70.036180	26-Jun-99	11:09:54	3	28	ca	10	0	0	8	18	feed	Vc	
147.284391	70.057020	26-Jun-99	11:10:42	3	29	ca	1	0	0	12	13	run	Vc	N
147.308157	70.112610	26-Jun-99	11:12:50	3	30	ca	2	0	0	8	10	feed	Vc	
147.312126	70.143680	26-Jun-99	11:14:02	3	31	ca	0	2	0	0	2	rest	Vc	
147.323730	70.157180	26-Jun-99	11:14:33	3	32	ca	0	0	0	1	1	run	Va	W
147.350936	70.142410	26-Jun-99	11:18:41	3	33	ca	0	20	8	0	28	feed	Va	
147.364700	70.133130	26-Jun-99	11:19:00	3	34	ca	0	10	4	10	24	feed	Va	
147.336857	70.123600	26-Jun-99	11:19:20	3	35	ca	0	0	0	2	2	walk	Va	N
147.327791	70.095580	26-Jun-99	11:20:18	3	36	ca	0	0	0	1	1	walk	IVa	N
147.362961	70.084100	26-Jun-99	11:20:42	3	37	ca	0	3	0	0	3	feed	Va	
147.352007	69.948320	26-Jun-99	11:25:26	3	38	ca	1	1	0	0	2	walk	Ia	
147.392257	69.937570	26-Jun-99	11:28:45	3	40	ca	1	0	0	0	1			
147.400543	70.010940	26-Jun-99	11:31:35	3	41	ca	0	2	0	0	2	rest	Xa	
147.375626	70.036210	26-Jun-99	11:32:32	3	42	ca	1	3	0	0	4			
147.391767	70.184070	26-Jun-99	11:38:16	3	43	ca	0	4	2	0	6	feed	Vc	
147.420336	70.186680	26-Jun-99	11:39:11	3	44	ca	0	2	0	0	2	rest	Vc	
147.446351	70.171780	26-Jun-99	11:39:42	3	45	ca	0	7	3	0	10	feed	Va	
147.416167	69.968100	26-Jun-99	11:46:43	3	46	ca	0	1	0	0	1	rest	Va	
147.441894	69.958570	26-Jun-99	11:47:03	3	47	ca	0	1	0	0	1			
147.451421	70.046560	26-Jun-99	11:54:53	3	49	ca	0	0	0	1	1	rest	Va	
147.451741	70.135350	26-Jun-99	11:58:18	3	50	ca	0	0	0	5	5	rest	IVa	
147.493329	70.142370	26-Jun-99	11:58:34	3	51	ca	0	0	0	1	1	feed	Vc	
147.482453	70.154570	26-Jun-99	11:59:03	3	52	ca	0	2	1	0	3	feed	Va	
147.503166	70.147630	26-Jun-99	12:03:19	3	53	ca	0	1	0	0	1	feed	Vc	
147.522506	70.141640	26-Jun-99	12:03:31	3	54	ca	0	2	0	0	2		IVa	

Table A-1. Continued

Longitude°W	Latitude°N	Date	Time ADST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total	Behavior	Habitat	Direction
147.527603	70.123070	26-Jun-99	12:04:09	3	55	ca	0	4	2	0	6	feed	IIIa	
147.502087	69.999040	26-Jun-99	12:08:22	3	56	ca	4	0	0	1	5	feed	Vc	
147.503157	69.991360	26-Jun-99	12:08:37	3	57	ca	1	0	0	0	1	walk	Xa	N
147.528891	69.979870	26-Jun-99	12:09:01	3	58	ca	0	1	0	0	1	walk	Vc	N
147.565856	69.976190	26-Jun-99	12:15:02	3	59	ca	0	1	0	0	1	rest	Vc	
147.554661	70.088980	26-Jun-99	12:19:22	3	60	ca	0	6	4	0	10			
147.570363	70.107200	26-Jun-99	12:20:04	3	61	ca	15	20	12	10	57	feed	Vc	
147.550554	70.127710	26-Jun-99	12:20:51	3	62	ca	2	6	2	3	13		IVa	
147.574006	70.139530	26-Jun-99	12:21:19	3	63	ca	0	5	2	0	7			
147.555706	70.142730	26-Jun-99	12:21:26	3	64	ca	0	30	20	20	70	feed	Va	
147.563817	70.150250	26-Jun-99	12:21:45	3	65	ca	0	4	0	0	4			
147.621349	70.196360	26-Jun-99	12:24:59	3	67	ca	0	0	0	1	1	feed	Vc	
147.588806	70.169810	26-Jun-99	12:25:53	3	68	ca	0	2	0	0	2	rest	Vc	
147.601200	70.155460	26-Jun-99	12:26:23	3	69	ca	0	2	0	1	3			
147.589446	70.145870	26-Jun-99	12:26:42	3	70	ca	0	6	0	0	6	rest	Vb	
147.582359	70.134570	26-Jun-99	12:27:05	3	71	ca	0	4	1	8	13	rest	Vb	
147.611743	70.121480	26-Jun-99	12:27:32	3	72	ca	0	31	18	0	49		Vc	
147.585046	70.107000	26-Jun-99	12:28:01	3	73	ca	0	3	0	0	3			
147.606704	70.102560	26-Jun-99	12:28:10	3	74	ca	0	12	4	0	16			
147.653303	69.961930	26-Jun-99	12:37:56	3	75	ca	0	1	0	0	1	walk	Vc	E
147.632106	70.075120	26-Jun-99	12:42:17	3	76	ca	0	2	1	0	3	walk	Vc	N
147.620531	70.089120	26-Jun-99	12:42:49	3	77	ca	0	0	0	6	6			
147.647476	70.129980	26-Jun-99	12:44:24	3	78	ca	0	17	10	0	27	rest	Xa	
147.629247	70.141680	26-Jun-99	12:44:50	3	79	ca	0	100	70	125	295			
147.635124	70.157010	26-Jun-99	12:45:25	3	80	ca	1	0	0	3	4	feed	Vc	
147.648666	70.167750	26-Jun-99	12:45:50	3	81	ca	0	11	6	0	17	walk	Xa	N
147.625189	70.189170	26-Jun-99	12:46:40	3	82	ca	0	2	1	0	3	feed	Vc	
147.659801	70.197220	26-Jun-99	12:48:04	3	83	ca	0	0	0	2	2	feed	Va	
147.700820	70.181890	26-Jun-99	12:48:36	3	84	ca	0	8	3	0	11	feed	Va	
147.667139	70.146220	26-Jun-99	12:49:49	3	85	ca	0	4	2	0	6	feed	Vc	
147.683120	70.134480	26-Jun-99	12:50:14	3	86	ca	0	1	0	1	2	rest	Vc	
147.664450	70.122100	26-Jun-99	12:50:39	3	87	ca	0	2	0	0	2	rest	Vc	
147.685139	70.116000	26-Jun-99	12:50:52	3	88	ca	0	4	2	0	6	feed	Va	
147.684049	70.064920	26-Jun-99	12:52:36	3	89	ca	0	1	0	0	1	feed	Va	
147.726056	70.041990	26-Jun-99	13:04:07	3	91	ca	0	0	0	1	1	rest	Va	
147.727114	70.100470	26-Jun-99	13:06:22	3	92	ca	0	2	0	0	2	feed	Vc	
147.726336	70.127840	26-Jun-99	13:07:25	3	93	ca	0	1	0	0	1	trot		SE
147.694921	70.137050	26-Jun-99	13:07:46	3	94	ca	0	0	0	2	2			
147.693611	70.141390	26-Jun-99	13:07:56	3	95	ca	0	0	0	1	1	rest	Va	
147.735030	70.157350	26-Jun-99	13:08:32	3	96	ca	0	51	5	20	76	feed	Va	N
147.692561	70.181770	26-Jun-99	13:09:28	3	97	ca	0	2	2	13	17			
147.771959	70.212420	26-Jun-99	13:11:44	3	98	ca	0	2	0	0	2			
147.761346	70.187690	26-Jun-99	13:12:36	3	99	ca	0	3	0	0	3			
147.763614	70.174880	26-Jun-99	13:13:02	3	100	ca	0	15	8	0	23			
147.751191	70.166770	26-Jun-99	13:13:19	3	101	ca	0	0	0	25	25			
147.759117	70.152690	26-Jun-99	13:13:48	3	102	ca	0	3	0	0	3	feed	Va	
147.809031	69.964720	26-Jun-99	13:25:15	3	103	ca	0	1	0	0	1	run	Va	
147.822443	70.027540	26-Jun-99	13:27:38	3	104	ca	0	1	0	0	1	feed	Vc	
147.822723	70.082360	26-Jun-99	13:29:44	3	105	ca	0	0	0	1	1	stand	Vc	
147.829649	70.152110	26-Jun-99	13:32:23	3	106	ca	0	0	0	1	1	feed	Va	
147.828601	70.220750	26-Jun-99	14:21:48	3	0	ca	0	0	0	1	1	walk	Va	E
147.839650	70.205570	26-Jun-99	14:22:20	3	1	ca	0	1	0	0	1	rest	Vc	
147.869053	70.197550	26-Jun-99	14:22:37	3	2	ca	0	2	0	0	2	rest	Va	
147.866973	70.171620	26-Jun-99	14:23:30	3	3	ca	0	20	10	15	45	feed	Va	
147.834211	70.149290	26-Jun-99	14:24:16	3	4	ca	0	0	0	1	1	rest	Vc	
147.848983	70.136090	26-Jun-99	14:24:44	3	5	ca	0	15	7	0	22	walk	Vb	
147.902747	70.111210	26-Jun-99	14:41:00	3	6	ca	1	0	0	0	1	rest	Ve	
147.877170	70.153320	26-Jun-99	14:42:37	3	7	ca	0	5	1	0	6	feed	Va	
147.875721	70.164290	26-Jun-99	14:43:02	3	8	ca	0	0	0	1	1			
147.900407	70.182410	26-Jun-99	14:43:43	3	9	ca	0	2	1	0	3	feed	Va	

Table A-1. Continued

Longitude°W	Latitude°N	Date	Time ADST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total	Behavior	Habitat	Direction
147.895310	70.191020	26-Jun-99	14:44:02	3	10	ca	0	22	11	0	33	walk	Va	
147.876261	70.200050	26-Jun-99	14:44:23	3	11	ca	0	0	0	4	4			
147.874751	70.219980	26-Jun-99	14:45:08	3	12	ca	0	1	0	0	1	feed	Vc	
147.934983	70.215700	26-Jun-99	14:51:25	3	15	ca	1	0	0	1	2			
147.941689	70.206100	26-Jun-99	14:51:45	3	16	ca	0	1	0	0	1	rest	Va	
147.940939	70.179050	26-Jun-99	14:52:40	3	17	ca	0	2	0	0	2	feed	Va	
147.962071	69.924260	26-Jun-99	15:03:20	3	18	ca	0	0	0	1	1		Vc	
148.002719	70.168400	26-Jun-99	15:12:41	3	20	ca	0	0	0	6	6	feed	Va	
148.012347	70.260400	26-Jun-99	15:19:55	3	21	ca	0	1	0	0	1	rest	Vc	
148.048679	70.232620	26-Jun-99	15:20:52	3	22	ca	0	0	0	2	2			
148.033717	70.229190	26-Jun-99	15:20:59	3	23	ca	2	2	0	0	4	rest	Va	
148.045670	70.193060	26-Jun-99	15:22:14	3	24	ca	0	0	0	12	12	rest	Vc	
148.049449	70.130310	26-Jun-99	15:24:20	3	25	ca	0	2	2	9	13		Xe	
148.056566	70.166970	26-Jun-99	15:42:37	3	26	ca	0	2	0	0	2	feed	Va	
148.087739	70.176880	26-Jun-99	15:43:00	3	27	ca	0	0	0	8	8	rest	Vc	
148.069797	70.183670	26-Jun-99	15:43:15	3	28	ca	3	0	0	5	8	rest	Vc	
148.042961	70.191090	26-Jun-99	15:43:32	3	29	ca	0	0	0	26	26	feed	Vc	
148.045871	70.224000	26-Jun-99	15:44:48	3	30	ca	0	0	0	2	2	rest	Va	
148.089829	70.232950	26-Jun-99	15:45:08	3	31	ca	0	0	0	3	3	feed	Va	
148.072986	70.261110	26-Jun-99	15:46:13	3	32	ca	1	1	0	0	2	feed	Vc	
148.097447	70.179180	26-Jun-99	15:55:03	3	33	ca	0	0	0	3	3			
148.114590	70.169470	26-Jun-99	15:55:23	3	34	ca	0	1	0	0	1	feed	Va	
148.138249	70.159470	26-Jun-99	15:55:43	3	35	ca	0	0	0	10	10	feed	Vc	
148.088491	70.088490	26-Jun-99	15:58:07	3	36	ca	0	0	0	1	1	feed	Vb	
147.054633	70.078430	1-Jul-99	10:29:43	4	1	ca	0	1	0	0	1	walk	Va	S
147.051347	70.149840	1-Jul-99	10:32:16	4	2	ca	2	2	0	0	4	rest	Va	
147.123166	70.049630	1-Jul-99	10:47:57	4	3	ca	0	1	1	0	2		Ve	
147.169824	70.124010	1-Jul-99	10:54:11	4	4	ca	0	150	80	50	280	feed	Va	
147.188924	70.030600	1-Jul-99	10:57:29	4	5	ca	0	1	0	0	1	feed	Va	
147.202807	70.216340	1-Jul-99	11:14:48	4	7	ca	0	7	3	0	10			
147.277521	70.142630	1-Jul-99	11:19:18	4	8	ca	0	1	1	0	2		Vc	
147.270046	70.137390	1-Jul-99	11:19:29	4	9	ca	3	8	1	0	12			
147.261930	70.129970	1-Jul-99	11:19:45	4	10	ca	60	150	52	100	362	feed	Vc	
147.274511	70.115910	1-Jul-99	11:20:16	4	60	ca	0	0	0	30	30	feed	Xa	
147.310657	70.096900	1-Jul-99	11:35:16	4	11	ca	0	1	0	0	1	feed	Va	
147.304740	70.120380	1-Jul-99	11:36:07	4	12	ca	7	150	50	70	277	feed	Vc	
147.327229	70.134850	1-Jul-99	11:36:38	4	13	ca	0	0	0	12	12	feed	Va	
147.312796	70.144340	1-Jul-99	11:36:58	4	14	ca	0	4	1	0	5	rest	Va	
147.291537	70.157120	1-Jul-99	11:37:25	4	15	ca	0	1	0	0	1	feed	Va	
147.347180	70.172240	1-Jul-99	11:40:27	4	16	ca	0	1	1	0	2	feed		
147.360943	70.167660	1-Jul-99	11:40:37	4	17	ca	0	7	6	0	13	feed	Va	
147.357514	70.149760	1-Jul-99	11:41:15	4	18	ca	0	10	5	0	15			
147.360203	70.140190	1-Jul-99	11:41:36	4	19	ca	7	225	70	10	312	feed	Va	
147.349540	70.118090	1-Jul-99	11:42:23	4	20	ca	0	70	30	20	120	feed	Va	
147.340144	70.110240	1-Jul-99	11:42:40	4	21	ca	0	40	20	10	70	feed	Va	
147.358601	70.099720	1-Jul-99	11:43:04	4	22	ca	0	25	6	0	31	feed	Va	
147.353684	70.096130	1-Jul-99	11:43:11	4	23	ca	2	70	20	30	122	feed	Va	
147.375799	70.086950	1-Jul-99	11:56:51	4	24	ca	1	0	0	0	1	rest	Va	
147.386520	70.111640	1-Jul-99	11:57:45	4	25	ca	0	6	3	0	9			
147.379114	70.114540	1-Jul-99	11:57:51	4	26	ca	0	20	10	0	30	feed	Va	
147.396196	70.120550	1-Jul-99	11:58:04	4	27	ca	0	40	20	10	70	feed		
147.388660	70.128570	1-Jul-99	11:58:21	4	28	ca	0	100	50	20	170			
147.386910	70.137710	1-Jul-99	11:58:41	4	29	ca	0	60	30	50	140	feed	Va	
147.369999	70.147460	1-Jul-99	11:59:02	4	30	ca	0	4	3	0	7	rest	Va	
147.437037	70.184340	1-Jul-99	12:01:17	4	31	ca	0	3	0	0	3	feed	Va	
147.422664	70.141770	1-Jul-99	12:02:49	4	32	ca	3	0	0	0	3	feed	Vb	
147.414499	70.127960	1-Jul-99	12:03:19	4	33	ca	0	300	150	200	650	feed	Vb	
147.423114	70.114640	1-Jul-99	12:03:47	4	34	ca	0	250	100	50	400	feed	Vb	
147.420686	70.100730	1-Jul-99	12:04:16	4	35	ca	0	150	100	150	400	feed	Vb	
147.471040	70.152970	1-Jul-99	12:20:21	4	36	ca	2	0	0	0	2			

Table A-1. Continued

Longitude°W	Latitude°N	Date	Time ADST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total	Behavior	Habitat	Direction
147.476057	70.178110	1-Jul-99	12:21:13	4	37	ca	0	30	13	0	43	feed	Va	
147.496700	70.124260	1-Jul-99	12:25:21	4	38	ca	0	5	3	20	28	feed	Vb	
147.543887	70.141740	1-Jul-99	12:42:04	4	39	ca	0	0	0	1	1			
147.563294	70.167190	1-Jul-99	12:43:00	4	40	ca	0	0	0	1	1	feed	Va	
147.570660	70.177950	1-Jul-99	12:43:23	4	41	ca	0	10	5	15	30	feed	Va	
147.561197	70.195990	1-Jul-99	12:44:02	4	42	ca	0	5	0	0	5	feed	Va	
147.586666	70.199890	1-Jul-99	12:45:29	4	43	ca	5	20	7	10	42	feed	Vb	
147.580789	70.173410	1-Jul-99	12:46:28	4	44	ca	0	1	1	0	2	run	Va	N
147.619759	70.030550	1-Jul-99	12:51:36	4	45	ca	0	0	0	1	1	walk	Va	N
147.634254	70.138320	1-Jul-99	13:05:20	4	46	ca	0	1	0	0	1	walk	Xa	
147.645627	70.163050	1-Jul-99	13:06:15	4	47	ca	2	1	0	0	3	feed	Vb	
147.647297	70.189220	1-Jul-99	13:07:12	4	48	ca	14	22	11	10	57	feed	Va	
147.637013	70.200050	1-Jul-99	13:07:36	4	49	ca	0	12	6	0	18	rest	Va	
147.663656	70.200610	1-Jul-99	13:08:31	4	50	ca	10	26	10	10	56	rest	Va	
147.661711	70.121320	1-Jul-99	13:11:27	4	51	ca	0	0	0	4	4	feed	Vb	
147.720897	70.196430	1-Jul-99	13:30:37	4	52	ca	0	1	1	0	2	rest	Va	
147.711163	70.200500	1-Jul-99	13:30:46	4	61	ca	0	1	0	0	1	feed		
147.703547	70.203100	1-Jul-99	13:30:52	4	53	ca	0	7	0	0	7			
147.761587	70.199840	1-Jul-99	13:32:52	4	54	ca	5	0	0	8	13	feed	Vc	N
147.800754	70.225490	1-Jul-99	14:45:33	4	0	ca	4	0	0	3	7	rest	Va	
147.810421	70.210540	1-Jul-99	14:46:06	4	1	ca	0	8	0	0	8	walk		S
147.831670	70.182660	1-Jul-99	14:47:06	4	2	ca	0	31	10	20	61	feed	Va	S
147.796606	70.150470	1-Jul-99	14:48:17	4	3	ca	0	1	1	0	2	rest	XIIb	
147.833271	70.182840	1-Jul-99	15:07:39	4	4	ca	0	0	0	45	45			
147.838259	70.188080	1-Jul-99	15:07:50	4	5	ca	0	10	3	0	13	feed	Va	
147.845096	70.217350	1-Jul-99	15:08:53	4	6	ca	0	1	0	0	1	rest	IVa	
147.877790	70.220160	1-Jul-99	15:14:54	4	7	ca	0	16	0	10	26	feed	Va	
147.880849	70.200720	1-Jul-99	15:15:36	4	8	ca	0	0	0	3	3	feed	Vc	
147.946757	70.188130	1-Jul-99	15:36:54	4	9	ca	0	1	0	0	1	feed	Va	N
147.947257	70.208910	1-Jul-99	15:37:39	4	10	ca	0	0	0	3	3			
147.931176	70.211840	1-Jul-99	15:37:45	4	11	ca	0	20	15	0	35			
147.940610	70.218880	1-Jul-99	15:38:01	4	12	ca	0	21	5	4	30	feed	Vc	NW
147.978371	70.254520	1-Jul-99	15:43:24	4	13	ca	0	0	0	1	1	walk	Va	NE
148.030627	70.187480	1-Jul-99	16:06:44	4	14	ca	0	0	0	4	4	stand	Ia	
148.025649	70.207280	1-Jul-99	16:07:27	4	15	ca	0	6	1	0	7	rest	Va	
148.033426	70.224080	1-Jul-99	16:08:02	4	16	ca	5	0	0	2	7	feed	Va	
148.034124	70.235020	1-Jul-99	16:08:26	4	17	ca	0	7	2	0	9	feed	Vc	
148.011886	70.242740	1-Jul-99	16:08:42	4	18	ca	0	2	0	0	2	walk	IVa	N
148.052517	70.278320	1-Jul-99	16:14:01	4	19	ca	1	0	0	0	1	feed	Va	
148.056036	70.265930	1-Jul-99	16:14:28	4	20	ca	0	0	0	4	4	feed	Vc	
148.059504	70.257800	1-Jul-99	16:14:46	4	21	ca	0	1	0	0	1	feed	Vc	
148.059484	70.250560	1-Jul-99	16:15:02	4	22	ca	0	1	0	0	1	walk	Xe	
148.061963	70.244510	1-Jul-99	16:15:15	4	23	ca	0	1	0	0	1	feed	Va	
148.080933	70.233140	1-Jul-99	16:15:40	4	24	ca	0	0	0	3	3	rest	IVa	
148.062693	70.229280	1-Jul-99	16:15:48	4	25	ca	0	1	0	0	1	feed	IIIa	
148.090889	70.187890	1-Jul-99	16:17:17	4	26	ca	1	0	0	0	1			
148.129330	70.185110	1-Jul-99	16:38:36	4	28	ca	0	1	0	0	1	feed	Va	
148.126371	70.193410	1-Jul-99	16:38:54	4	29	ca	1	0	0	0	1	feed	Vc	
148.097626	70.203890	1-Jul-99	16:39:17	4	30	ca	1	8	0	0	9			
148.101703	70.207790	1-Jul-99	16:39:26	4	31	ca	0	1	0	0	1			
148.117874	70.215400	1-Jul-99	16:39:42	4	32	ca	0	1	0	0	1	trot	Vb	E
148.093847	70.277090	1-Jul-99	16:41:54	4	33	ca	2	21	10	0	33	feed	Va	
147.020974	69.908930	8-Jul-99	11:33:37	5	1	ca	0	1	0	0	1			
147.178130	69.946340	8-Jul-99	12:10:43	5	2	ca	1	0	0	0	1	feed	Va	
147.659010	70.169050	8-Jul-99	14:13:50	5	6	ca	0	1	0	0	1	feed	Xa	
147.757159	70.164800	8-Jul-99	15:45:47	5	0	ca	30	60	20	20	130	feed	Va	
147.841309	70.253080	8-Jul-99	16:11:17	5	2	ca	0	1	1	0	2	feed	Xa	
147.898702	70.201101	8-Jul-99	16:34:28	5	3	ca	100	150	55	50	355			
147.894490	70.236610	8-Jul-99	16:37:21	5	4	ca	2	0	0	0	2	rest	Xa	
147.923446	70.264040	8-Jul-99	16:41:42	5	5	ca	10	0	0	40	50	run	Xa	SE

Table A-1. Continued

Longitude°W	Latitude°N	Date	Time ADST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total	Behavior	Habitat	Direction
147.993245	70.206054	8-Jul-99	17:05:43	5	6	ca	120	250	100	75	545	feed	Xa	
147.964005	70.232472	8-Jul-99	17:10:40	5	7	ca	55	120	70	50	295	feed	Xa	
148.013786	70.285940	8-Jul-99	17:15:21	5	8	ca	1	0	0	0	1	move	Ia	E
148.008337	70.190030	8-Jul-99	17:18:46	5	9	ca	250	300	125	140	815	move	Ia	E
148.043928	70.162135	8-Jul-99	17:21:11	5	10	ca	100	200	100	50	450	rest	Va	
148.067800	70.035190	8-Jul-99	17:36:58	5	11	ca	1	0	0	0	1	move	Va	NW
148.047731	70.076190	8-Jul-99	17:38:26	5	12	ca	1	0	0	0	1			
148.056829	70.197410	8-Jul-99	17:42:48	5	13	ca	0	0	0	50	50	rest	Vc	
147.285641	69.938030	17-Jul-99	10:09:48	6	1	ca	1	0	0	0	1	feed	Vb	
147.447621	70.166560	17-Jul-99	10:44:29	6	2	ca	0	1	0	0	1	feed	Va	
147.533560	69.990410	17-Jul-99	11:20:57	6	3	ca	0	1	0	0	1	feed	Vb	
147.625839	70.169990	17-Jul-99	11:51:58	6	4	ca	0	1	0	1	2	run	Va	E
147.805843	70.091130	17-Jul-99	14:30:26	6	5	ca	0	1	0	0	1	feed	Va	
147.876271	70.247680	17-Jul-99	15:06:22	6	6	ca	0	3	0	0	3	feed	Va	
147.943696	70.245710	17-Jul-99	15:11:16	6	7	ca	1	0	0	0	1	feed	Xa	
148.075104	70.255080	17-Jul-99	16:11:46	6	9	ca	0	2	1	0	3	move	XIa	SE
146.993809	69.978210	19-Jul-99	13:24:49	7	1	ca	1	0	0	3	4	rest	Va	
147.028959	69.937060	19-Jul-99	13:29:15	7	2	ca	14	0	0	0	14			
147.052407	69.993680	19-Jul-99	13:31:18	7	3	ca	1	0	0	0	1			
147.031329	70.031160	19-Jul-99	13:32:40	7	4	ca	0	2	0	0	2			
147.132680	69.908230	19-Jul-99	13:47:50	7	5	ca	10	35	8	0	53	feed	Va	
147.127224	70.019270	19-Jul-99	13:51:51	7	6	ca	0	2	0	0	2	feed	Va	
147.163287	70.128170	19-Jul-99	13:58:56	7	7	ca	0	0	0	2	2	rest	XIa	
147.213860	69.905940	19-Jul-99	14:07:25	7	8	ca	2	4	4	0	10			
147.216491	69.919430	19-Jul-99	14:07:55	7	9	ca	1	0	0	0	1			
147.225496	70.006940	19-Jul-99	14:11:07	7	10	ca	0	1	0	0	1	rest		
147.213231	70.136860	19-Jul-99	14:15:58	7	11	ca	0	1	0	0	1			
147.239539	70.153590	19-Jul-99	14:16:36	7	12	ca	1	0	0	0	1			
147.256103	70.135130	19-Jul-99	14:23:32	7	13	ca	1	0	0	0	1	feed		
147.241431	69.964300	19-Jul-99	14:29:32	7	14	ca	0	0	0	1	1			
147.261250	69.932930	19-Jul-99	14:30:40	7	15	ca	0	1	0	0	1			
147.332101	69.921084	19-Jul-99	14:33:43	7	16	ca	45	150	30	100	325	feed	Xa	
147.311866	69.937720	19-Jul-99	14:34:58	7	17	ca	55	150	25	100	330	feed	Xa	
147.288969	70.076150	19-Jul-99	14:40:09	7	19	ca	0	1	0	0	1		Va	
147.318883	70.099290	19-Jul-99	14:41:01	7	20	ca	1	2	0	0	3	move	IIId	NW
147.306430	70.169020	19-Jul-99	14:43:39	7	21	ca	15	25	6	0	46	feed	Va	
147.352947	70.148540	19-Jul-99	14:46:55	7	22	ca	0	1	1	0	2	rest		
147.351037	70.127040	19-Jul-99	14:47:39	7	23	ca	10	55	30	20	115			
147.349489	70.101170	19-Jul-99	14:48:34	7	24	ca	8	45	8	20	81			
147.359574	70.088760	19-Jul-99	14:48:59	7	25	ca	10	75	30	20	135			
147.324991	69.997500	19-Jul-99	14:52:08	7	26	ca	0	0	0	8	8	move	Va	N
147.327710	69.964870	19-Jul-99	14:53:17	7	27	ca	4	5	2	0	11	move	Va	N
147.349520	69.928970	19-Jul-99	14:54:33	7	28	ca	0	20	0	0	20			
147.385371	70.033340	19-Jul-99	15:00:57	7	29	ca	0	50	0	0	50			
147.369689	70.103210	19-Jul-99	15:03:33	7	30	ca	50	25	10	50	135			
147.376306	70.120410	19-Jul-99	15:04:12	7	31	ca	6	45	4	0	55			
147.389030	70.159640	19-Jul-99	15:05:41	7	32	ca	0	1	1	0	2			
147.385513	70.164430	19-Jul-99	15:05:52	7	33	ca	0	6	2	0	8			
147.431739	70.119810	19-Jul-99	15:09:53	7	34	ca	1	0	0	0	1			
147.425121	70.094260	19-Jul-99	15:10:46	7	35	ca	0	1	0	0	1	rest	Va	
147.420336	70.037100	19-Jul-99	15:12:48	7	36	ca	1	0	0	0	1	stand	Va	
147.429450	70.026040	19-Jul-99	15:13:11	7	37	ca	100	250	75	200	625	rest		
147.433549	69.992960	19-Jul-99	15:14:20	7	38	ca	0	1	0	0	1			
147.492479	69.984270	19-Jul-99	15:20:59	7	39	ca	20	0	0	25	45	feed		
147.484653	70.006260	19-Jul-99	15:21:49	7	40	ca	75	150	30	150	405	rest	Vc	
147.490730	70.188120	19-Jul-99	15:28:41	7	41	ca	1	0	0	0	1	feed		
147.512910	70.011070	19-Jul-99	15:36:19	7	42	ca	70	170	40	200	480	feed	Vc	
147.505286	69.994950	19-Jul-99	15:36:52	7	43	ca	20	50	10	50	130	feed	Va	
147.506863	69.978650	19-Jul-99	15:37:26	7	44	ca	0	1	0	0	1			
147.506086	69.957760	19-Jul-99	15:38:10	7	45	ca	75	175	40	100	390			

Table A-1. Continued

Longitude°W	Latitude°N	Date	Time ADST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total	Behavior	Habitat	Direction
147.575050	69.976290	19-Jul-99	15:43:13	7	46	ca	3	0	0	2	5		Va	
147.569463	70.032610	19-Jul-99	15:45:20	7	47	ca	0	1	1	0	2	feed	Va	
147.620081	69.945670	19-Jul-99	16:05:22	7	48	ca	0	1	0	0	1			
147.695461	70.021360	19-Jul-99	16:30:54	7	49	ca	1	0	0	0	1			
147.793889	70.114090	19-Jul-99	16:42:27	7	50	ca	0	1	0	0	1	move	IVA	
147.794209	69.908280	19-Jul-99	16:49:16	7	51	ca	0	1	0	0	1			
147.840167	70.236540	19-Jul-99	18:20:19	7	52	ca	2	5	0	2	9		Va	
147.908444	70.293590	19-Jul-99	18:47:44	7	53	ca	0	1	0	0	1	stand	Xe	
147.928246	70.210140	19-Jul-99	18:52:04	7	54	ca	2	0	0	0	2			
148.014057	70.295980	19-Jul-99	19:21:29	7	55	ca	2	0	0	0	2	feed	IIId	
148.010449	70.256950	19-Jul-99	19:22:51	7	56	ca	1	0	0	0	1	feed	XIa	
148.007650	70.209320	19-Jul-99	19:24:32	7	57	ca	0	0	0	1	1	feed	XIa	
148.035304	70.020190	19-Jul-99	19:31:05	7	58	ca	0	1	1	0	2			
148.057604	70.285480	19-Jul-99	19:50:23	7	59	ca	1	0	0	0	1		IVa	

Table A-2. Muskoxen (mx), grizzly bear (bb), moose (ms), and wolf (wo) sightings in the Badami study area, Alaska, summer 1999. Coordinates are longitude, latitude, and datum is WGS 1984. Time is Alaska Daylight Savings Time. See Table 6 for habitat code definitions.

Longitude °W	Latitude °N	Date	Time	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total	Behavior	Habitat	Direction
147.341003	69.933750	15-Jun-99	11:44:53	1	38	bb	2	0	0	0	2			
147.671964	70.040430	15-Jun-99	13:21:18	1	95	mx	0	0	0	16	16			
148.081303	70.169410	15-Jun-99	16:15:22	1	94	mx	0	4	4	10	18	feed	Va	
147.443703	70.013740	20-Jun-99	13:16:54	2	73	bb	0	0	0	1	1	feed	Va	
148.047547	70.167170	20-Jun-99	16:59:09	2	46	mx	0	0	0	16	16			
147.389839	69.927740	26-Jun-99	11:28:23	3	39	ms	2	0	0	0	2	feed	Vc	
147.420046	69.908980	26-Jun-99	11:48:47	3	48	bb	0	0	0	2	2		Vb	
147.826021	70.229200	26-Jun-99	13:35:23	3	107	mx	0	4	4	10	18	stand	Xe	
147.232597	69.946523	1-Jul-99	11:04:05	4	6	wo	0	0	0	1	1	run	Va	W
147.768223	69.997410	1-Jul-99	13:40:03	4	55	bb	0	0	0	1	1	feed	Vb	
147.749300	69.960730	1-Jul-99	13:41:22	4	56	mx	0	0	0	2	2	stand	Vc	
148.070200	69.900280	1-Jul-99	16:27:27	4	27	mx	0	0	3	14	17	feed	Va	
147.283699	70.027480	8-Jul-99	12:32:05	5	3	bb	0	0	0	1	1	move		W
147.482576	69.921760	8-Jul-99	13:20:15	5	5	ms	0	2	0	0	2	rest	Va	
148.094811	70.040670	8-Jul-99	17:58:26	5	14	bb	0	0	0	1	1	run	Va	E
147.304270	70.038890	19-Jul-99	14:38:45	7	18	wo	0	0	0	2	2	move	Xa	W

Table A-3. Opportunistic caribou (ca) sightings outside the Badami study area, Alaska, summer 1999. Coordinates are longitude, latitude, and datum is WGS 1984. Time is Alaska Daylight Savings Time. See Table 6 for habitat code definitions.

Longitude °W	Latitude °N	Date	Time	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total	Behavior	Habitat	Direction
147.092870	69.903490	15-Jun-99	10:33:43	1	12	ca	0	2	0	0	2			
147.926750	69.902870	15-Jun-99	15:34:54	1	55	ca	5	0	0	6	11	feed	Vb	
147.965919	69.902450	15-Jun-99	15:35:35	1	56	ca	1	14	0	0	15			
147.224359	69.906930	20-Jun-99	12:28:14	2	60	ca	0	1	0	0	1			
147.213860	69.905940	19-Jul-99	14:07:25	7	8	ca	2	4	4	0	10			

APPENDIX B

MOSQUITO AND OESTRID ACTIVITY INDICES

Appendix B. Mosquito and Oestrid Activity Indices

Mosquito Activity Index (Russell et al. 1993)

IF temperature >18 °C THEN $TI_m = 1$
IF temperature <6 °C THEN $TI_m = 0$
$TI_m = 1-((18-\text{temperature})/13)$
IF wind >6 mps then $WI_m = 0$
$WI_m = (6-\text{wind})/6$
then $I_m = TI_m \times WI_m$

where:

TI_m = Temperature Index for Mosquitoes
WI_m = Wind Index for Mosquitoes
then I_m = Mosquito Activity Index

These parameters were translated into IF statements for TI_m and WI_m with inputs as follows:

$TI_m = IF\ (T_h < 6, 0, IF(T_h > 18, 1, (1-((18-T_h)/13))))$
$WI_m = IF\ (V_h > 6, 0, ((6-V_h)/6))$
then $I_m = TI_m \times Wi_m$

where:

T_h = Temperature in °C recorded hourly at Deadhorse Weather Station
V_h = Wind velocity in mps recorded hourly at Deadhorse Weather Station

Syntax is: IF (logical test, value if true, value if false)

Oestrid Fly Activity Index (after Mörschel 1999):

$$y = \frac{e^{(-2.9646+0.166xTemp-0.1951xWind)}}{1+e^{(-2.9646+0.166xTemp-0.1951xWind)}}$$

where:

y = Estimated probability of oestrid fly presence (between 0 and 1)
Temp = Temperature in °C recorded hourly at Deadhorse Weather Station
Wind = Wind speed in mps recorded hourly at Deadhorse Weather Station

The oestrid fly activity index (y) predicts presence/absence of oestrid flies with 83% reliability. Oestrid flies were considered present when y was ≥ 0.4

Table B-1. Daily average temperature and wind velocity recorded at the Deadhorse Weather Station (ASCC 1999), with tabulations of hourly mosquito (Russel et al. 1993) and oestrid activity indices (Mörschel 1999) and mean number of mosquitoes collected during sweep net sampling.

					Mosquito Index			Oestrid Index	
Date	Mean Temperature (°C)	*n*	Mean Wind Speed (mps)	*n*	Number of Records <0.5	Number of Records ≥0.5	Mosq. No.	Number of Records <0.4	Number of Records ≥0.4
1-May-99	-7.56	27	4.05	34	27	0	N/A	27	0
2-May-99	-8.75	12	9.12	12	12	0	N/A	12	0
3-May-99	-12.69	26	9.88	26	26	0	N/A	26	0
4-May-99	-14.29	24	7.88	24	24	0	N/A	24	0
5-May-99	-10.73	30	4.83	32	30	0	N/A	30	0
6-May-99	-9.13	30	2.86	32	30	0	N/A	30	0
7-May-99	-7.75	28	3.60	28	28	0	N/A	28	0
8-May-99	-6.14	29	3.30	31	29	0	N/A	29	0
9-May-99	-5.56	25	3.15	30	25	0	N/A	25	0
10-May-99	-5.91	35	8.03	37	35	0	N/A	35	0
11-May 99	-2.48	27	7.75	27	27	0	N/A	27	0
12-May-99	-2.07	29	9.98	29	29	0	N/A	29	0
13-May-99	-2.93	29	4.71	29	29	0	N/A	29	0
14-May-99	-0.81	21	3.66	23	21	0	N/A	21	0
15-May-99	-1.04	24	3.24	24	24	0	N/A	24	0
16-May-99	-2.04	24	3.81	24	24	0	N/A	24	0
17-May 99	-7.00	27	5.65	29	27	0	N/A	27	0
18-May-99	-7.73	26	9.23	26	26	0	N/A	26	0
19-May-99	-6.42	26	10.81	26	26	0	N/A	26	0
20-May-99	-5.74	27	9.52	27	27	0	N/A	27	0
21-May-99	-5.52	25	6.70	25	25	0	N/A	25	0
22-May-99	-4.23	21	4.13	26	20	0	N/A	20	0
23-May-99	-4.12	25	2.61	29	25	0	N/A	25	0
24-May-99	-3.52	27	8.57	27	27	0	N/A	27	0
25-May-99	-4.36	25	9.52	25	25	0	N/A	25	0
26-May-99	-4.23	26	11.01	26	26	0	N/A	26	0
27-May-99	-2.00	29	7.67	29	29	0	N/A	29	0
28-May-99	-0.36	25	3.56	29	25	0	N/A	25	0
29-May-99	-1.34	29	5.11	30	29	0	N/A	29	0
30-May-99	-2.08	24	7.73	24	24	0	N/A	24	0
31-May-99	-0.61	31	2.77	34	31	0	N/A	31	0

Table B-1. Continued.

Date	Mean Temperature (°C)	*n*	Mean Wind Speed (mps)	*n*	Mosquito Index: Number of Records <0.5	Mosquito Index: Number of Records ≥0.5	Mosq. No.	Oestrid Index: Number of Records <0.4	Oestrid Index: Number of Records ≥0.4
1-Jun-99	-0.58	31	7.56	32	31	0	N/A	31	0
2-Jun-99	-0.53	17	6.29	27	17	0	N/A	17	0
3-Jun-99	0.06	33	3.59	34	33	0	N/A	33	0
4-Jun-99	-0.07	29	5.84	29	29	0	N/A	29	0
5-Jun-99	-0.32	28	4.98	28	28	0	N/A	28	0
6-Jun-99	-0.07	27	4.69	29	27	0	N/A	27	0
7-Jun-99	-2.07	30	7.29	30	28	0	N/A	28	0
8-Jun-99	-0.52	25	8.30	25	25	0	N/A	25	0
9-Jun-99	1.63	35	6.83	35	35	0	N/A	35	0
10-Jun-99	1.32	37	7.47	37	37	0	N/A	37	0
11-Jun-99	2.37	41	3.89	41	41	0	N/A	41	0
12-Jun-99	5.84	25	5.39	25	25	0	N/A	25	0
13-Jun-99	7.54	26	4.12	26	26	0	N/A	26	0
14-Jun-99	4.66	29	3.62	29	29	0	N/A	29	0
15-Jun-99	5.04	26	5.05	26	26	0	N/A	26	0
16-Jun-99	4.25	28	10.17	28	28	0	N/A	28	0
17-Jun-99	3.58	36	4.15	36	36	0	N/A	36	0
18-Jun-99	1.82	38	3.91	38	38	0	N/A	38	0
19-Jun-99	2.09	33	3.79	33	33	0	N/A	33	0
20-Jun-99	1.18	34	6.48	34	34	0	N/A	34	0
21-Jun-99	0.47	36	12.67	36	36	0	N/A	36	0
22-Jun-99	2.22	37	8.36	37	37	0	N/A	37	0
23-Jun-99	3.53	32	3.88	32	32	0	N/A	32	0
24-Jun-99	2.00	38	5.42	38	38	0	N/A	38	0
25-Jun-99	5.25	24	5.04	24	24	0	N/A	24	0
26-Jun-99	6.92	24	3.77	24	24	0	N/A	24	0
27-Jun-99	1.14	35	3.83	36	35	0	N/A	35	0
28-Jun-99	3.59	29	3.21	29	29	0	N/A	29	0
29-Jun-99	4.83	24	6.35	24	24	0	0	24	0
30-Jun-99	6.38	24	4.53	24	24	0	0.5	24	0

Table B-1. Continued.

Date	Mean Temperature (°C)	*n*	Mean Wind Speed (mps)	*n*	Mosquito Index: Number of Records <0.5	Mosquito Index: Number of Records ≥0.5	Mosq. No.	Oestrid Index: Number of Records <0.4	Oestrid Index: Number of Records ≥0.4
1-Jul-99	10.79	24	4.31	24	23	1	1.5	24	0
2-Jul-99	15.91	23	3.80	23	20	3	103.3	20	3
3-Jul-99	14.21	24	3.97	24	24	0	38.5	24	0
4-Jul-99	14.63	24	5.23	24	24	0	5.62	24	0
5-Jul-99	15.17	24	4.46	24	23	1	92.9	24	0
6-Jul-99	8.83	42	5.11	42	42	0	40.0	42	0
7-Jul-99	8.30	37	2.40	38	37	0	17.6	37	0
8-Jul-99	9.16	32	2.38	32	32	0	26.9	32	0
9-Jul-99	12.00	26	3.04	26	23	3	83.1	25	1
10-Jul-99	9.20	30	4.29	30	30	0	26.5	30	0
11-Jul-99	6.92	24	3.75	24	24	0	22.1	24	0
12-Jul-99	6.91	23	4.29	24	23	0	20	23	0
13-Jul-99	8.65	23	5.55	23	23	0	8.5	23	0
14-Jul-99	8.63	24	7.21	24	24	0	5	24	0
15-Jul-99	10.21	24	4.76	24	21	3	7.3	24	0
16-Jul-99	10.17	29	3.09	29	28	1	29.5	29	0
17-Jul-99	5.97	36	4.71	36	36	0	3.4	36	0
18-Jul-99	4.26	27	5.70	27	27	0	1.9	27	0
19-Jul-99	3.88	34	3.42	34	34	0	0	34	0
20-Jul-99	2.54	26	8.99	26	26	0	0	26	0
21-Jul-99	1.83	36	6.31	36	36	0	0	36	0
22-Jul-99	2.97	34	5.01	34	34	0	26.3	34	0
23-Jul-99	2.50	34	1.89	34	34	0	2.2	34	0
24-Jul-99	3.0	38	2.94	38	38	0	0	38	0
25-Jul-99	1.52	42	5.85	42	42	0	N/A	42	0
26-Jul-99	1.71	35	8.95	36	35	0	N/A	35	0
27-Jul-99	2.03	36	7.52	36	36	0	N/A	36	0
28-Jul-99	2.03	30	3.04	30	30	0	N/A	30	0
29-Jul-99	2.46	41	6.25	42	41	0	N/A	41	0
30-Jul-99	7.92	24	3.62	24	24	0	N/A	24	0
31-Jul-99	12.00	24	4.63	24	23	1	N/A	23	1

Table B-1. Continued.

Date	Mean Temperature (°C)	*n*	Mean Wind Speed (mps)	*n*	Mosquito Index: Number of Records <0.5	Mosquito Index: Number of Records ≥0.5	Mosq. No.	Oestrid Index: Number of Records <0.4	Oestrid Index: Number of Records ≥0.4
1-Aug-99	12.86	21	4.01	21	19	2	N/A	21	0
2-Aug-99	11.00	21	3.45	21	21	0	N/A	21	0
3-Aug-99	7.63	32	8.05	32	32	0	N/A	32	0
4-Aug-99	9.97	29	5.76	29	29	0	N/A	29	0
5-Aug-99	17.42	24	4.07	24	20	4	N/A	14	10
6-Aug-99	15.73	30	3.07	32	28	2	N/A	20	10
7-Aug-99	9.52	27	5.79	27	27	0	N/A	27	0
8-Aug-99	7.10	41	5.30	41	41	0	N/A	41	0
9-Aug-99	9.72	43	1.91	45	43	0	N/A	43	0
10-Aug-99	7.22	37	3.26	39	37	0	N/A	37	0
11-Aug-99	12.63	24	3.02	24	18	6	N/A	22	2
12-Aug-99	7.24	34	4.04	43	34	0	N/A	34	0
13-Aug-99	7.13	39	2.93	39	39	0	N/A	39	0
14-Aug-99	9.41	29	3.48	30	29	0	N/A	29	0
15-Aug-99	7.18	39	2.00	39	39	0	N/A	39	0
16-Aug-99	10.38	26	3.06	26	26	0	N/A	26	0
17-Aug-99	10.98	40	6.72	41	40	0	N/A	40	0
18-Aug-99	5.11	57	3.00	57	57	0	N/A	57	0
19-Aug-99	3.32	34	11.91	34	34	0	N/A	34	0
20-Aug-99	4.10	29	10.85	29	29	0	N/A	29	0
21-Aug-99	3.18	39	8.84	44	39	0	N/A	39	0
22-Aug-99	3.07	46	3.50	54	46	0	N/A	46	0
23-Aug-99	3.02	44	9.74	44	44	0	N/A	44	0
24-Aug-99	2.83	36	9.52	36	36	0	N/A	36	0
25-Aug-99	2.55	31	4.59	31	31	0	N/A	31	0
26-Aug-99	5.92	24	5.23	24	24	0	N/A	24	0
27-Aug-99	2.34	41	5.58	41	41	0	N/A	41	0
28-Aug-99	-0.19	31	3.73	31	31	0	N/A	31	0
29-Aug-99	0.69	35	8.39	35	35	0	N/A	35	0
30-Aug-99	2.25	40	6.94	40	40	0	N/A	40	0
31-Aug-99	1.16	19	3.22	27	19	0	N/A	19	0