FINAL REPORT
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Large Mammal Distribution in the Badami Study Area, Summer 1998

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ABSTRACT

Large mammal distribution was documented between the Sagavanirktok River delta on the west to Bullen Point on the east and inland up to 24 km from the coast within the Badami development area on the North Slope, Alaska, during seven systematic strip-transect surveys from 10 June to 11 August 1998. Caribou (*Rangifer tarandus*) numbers within the study area ranged from 26 on 11 August to 6980 on 22 July. Mean caribou group size ranged from 1.4 caribou per group on 11 August to 120.3 caribou per group on 22 July. During the 10 and 15 June calving period surveys, a total of 416 caribou including 132 calves in 94 groups, and 1002 caribou including 318 calves in 108 groups were observed, respectively. Sex-age composition of classified caribou for the combined calving period surveys was 1% bulls, 66% cows, and 33% calves. During the post-calving period; sex-age composition of classified caribou varied between surveys, but for the combined post–calving surveys, 15% were bulls, 62% were cows, and 23% were calves. During the calving period, 20 or fewer caribou were north of the Badami pipeline; which was consistent with previous calving period distributions showing few caribou within approximately 5 km of the coastline. A minimum of 4382 caribou including 891 calves, crossed the Badami pipeline corridor during the study period. The proportion of caribou within the study area that occurred north of the pipeline ranged from 0% on 9 July to 73% on 30 June 1998. During six of seven surveys 18 to 36 muskoxen (*Ovibos moschatus*) were observed within the study area, including 0 to 8 calves. A minimum of 25 muskoxen including 7 calves, crossed the Badami pipeline corridor at least twice during the study period. Other species observed included two grizzly bears (*Ursus arctos*) on 10 June and a moose (*Alces alces*) on 9 July.

Key words: Alaska, caribou, *Rangifer tarandus,* Central Arctic Herd, oil field, muskoxen, *Ovibos moschatus*, Arctic coastal plane

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 caribou distribution information (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 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, if any, 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 oil fields), and one east of the Sagavanirktok River. These are thought to reflect east and west segments of the CAH. 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 use 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. 1996a). 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. 1996a; Noel 1998). Caribou also may use gravel roads and pads and oil field facilities as insect-relief habitat (Pollard et al. 1996a,b; Noel et al. 1998).

By the late 1800s, muskoxen 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 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 oil field (Pollard and Noel 1994, 1995; Noel 1998). 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.

Coastal areas are used seasonally by grizzly bears. 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 when caribou are on the coastal plain. In late July, they gradually return south to the foothills after caribou have left the coastal plain (Clough et al. 1987). Riparian areas are used as travel corridors and contain abundant prey and preferred vegetation. Moose are uncommon on the North Slope, but they were observed in the area during 1994 and 1995 surveys (Pollard and Noel 1994, 1995).

ISSUES

Potential impacts to caribou from oil development in the Badami study area include: (a) blockage of northward movements to the Beaufort Sea coast by roads, pipelines, or other facilities and oil field activities; and (b) 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 1998, 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 distribution within the study area during 1998. 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 crossing areas along the Badami pipeline corridor.

STUDY AREA

The 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 70°00' north latitude (Fig. 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, with moist and dry tundra vegetation types being common on high-centered ice wedge polygon terrain. However, drainage is poor away from fluvial gradients and high-centered ice-wedge polygons; strangmoor,

thaw-lakes and ponds, and drained lake basins predominate in these areas. The approximately 40-km Badami pipeline extends across the northernmost section of the study area, about 2 to 5-km inland between the Endicott pipeline and the Badami facility (Fig. 1).

METHODS

AERIAL SURVEYS

During summer 1998, seven systematic strip-transect aerial surveys (Caughley 1977) were conducted from a Cessna 206 fixed-wing aircraft. Transect centerlines were spaced at 1.6-km intervals providing for 100% study area coverage (Fig. 1). All transects were oriented north–south and centered on township and section lines mapped on 1:63,360 scale U.S. Geological Survey (USGS) topographic maps. Twenty-seven transects (numbers 21 to 47, Fig. 1) were flown during each survey. Surveys were flown 90 m above ground level at 115 km/hr airspeed. Two observers recorded mammal sightings. Each observer was responsible for searching an 800-m wide swath 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. Animal behavior and habitat descriptions were recorded when possible.

As with previous aerial surveys conducted by LGL in the Prudhoe Bay oil field and adjacent areas (Pollard et al. 1992a,b and others), Global Positioning System (GPS) receivers were used to navigate the aircraft during surveys and to identify the location of the aircraft when animals were observed. Coordinates of animal sightings were calculated using the GPS aircraft position offset by the visual estimate of distance from the aircraft. At the time of sighting, all data were entered directly into a notebook computer with a Trimble Mobile™ GPS PC card receiver using Geolink® software. For each sighting, a real-time 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 an observer 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 are adults (or yearlings), that could not be classified with confidence; caribou near the outer margin of transect strips were most difficult to classify. When large groups of caribou were encountered, the survey aircraft left the transect line and circled the group to facilitate counting and classification. For large groups, classifications were generalizations based on the apparent proportions of sex-age categories within the group. The GPS allowed the aircraft to return to the point of departure

from the transect line, and no survey coverage was lost as a consequence of transect departures. Muskoxen were classified as adult (unclassified) or juvenile (calves), and grizzly bears were classified as single or female with dependent young. Fox den locations were also noted during surveys. Opportunistic information was collected during over-flights of the Badami study area in transit to study areas to the east.

GEOGRAPHIC ANALYSIS

After the field season, sighting attributes were combined with base–map data in MapInfo® Geographic Information System (GIS). Distribution maps for each survey were produced from spatial data. Data summaries and analyses were based on individual caribou rather than groups. Individual caribou were used for the following reasons: (1) during aerial surveys, groups were sometimes difficult to distinguish; (2) groups were sometimes disparate in size, ranging from 1 to 2000 individuals; and (3) groups were not of fixed membership. However, location data were collected for groups; therefore individual caribou locations were not independent.

To identify potential caribou crossing areas along the Badami pipeline, we constructed a buffer that extended 1 km north of the pipeline. We assumed that by limiting the buffer to the north side of the pipeline, caribou within the buffer had crossed the pipeline somewhere near their position. We subdivided the buffer into 1.6-km segments that corresponded with north-south township and section lines. Caribou observations were then summarized by pipeline segment. Mean caribou densities within the buffer were calculated as the total number of caribou divided by the number of surveys and the total land area for each segment, excluding area of lakes (1:63,360-scale).

MODELED PARASITIC INSECT ACTIVITY

Predictive models for mosquito and oestrid fly activity, developed by Russell et al. (1993), were used to classify days as either insect or non-insect days (Appendix B). Index values were calculated for each hour that temperature and wind data were recorded at the Deadhorse Weather Station (ASCC 1998). Insect days were defined as days when the value of either the mosquito index or the oestrid index was ≥ 0.5 for ≥ 4 hours (after Cameron et al. 1995). Non-insect days were then days with <4 hours of ≥ 0.5 mosquito and oestrid activity indices. The models and syntax used to calculate the indices are presented in Appendix B.

RESULTS

Seven systematic surveys of the study area were completed (Appendix A). Coastal fog prevented surveying the entire study area on 15 June (94% coverage, Fig. A-2). A total of 15568 caribou in 374 groups was recorded for the seven surveys (Table 1). During the calving period (prior to 20 June), cows and calves were 99% of classified caribou (2 surveys: 66% cows, 33% calves). During the post-calving period, cows and calves were 85% of classified caribou (5 surveys: 62% cows, 23% calves). For individual surveys, cows and calves ranged from 81% to 99% of classified caribou. Bulls were 1% of classified caribou during the calving period, and 15% of classified caribou for combined surveys (range for individual surveys: 1% – 19%).

A total of 158 muskoxen in 14 groups were observed during systematic surveys (Table 1, Table A-2, Fig. A-5). A group of 37 muskoxen was observed just south of the study area on 10 June (Table A-3). Two grizzly bears were observed (10 June) during our systematic surveys (Table A-2, Fig. A-5). While en route to the eastern edge of the study area on 22 July, a grizzly bear was sighted, but was not observed within the study area during the strip-transect survey (Table A-3). Two moose were observed on 9 July, one within the study area and one just south of the study area (Table A-2, Table A-3, Fig. A-5). Four fox dens were recorded during the 11 August survey (Table A-2, Fig. A-5).

CARIBOU

Calving Period

Survey 1—10 June 1998

Survey weather conditions were good with overcast skies, winds at 3.6 to 4.6 meters per second (mps) from the east-northeast (40° to 110°), and temperature 1 to 3 °C from 1600 to 2100 Alaska Standard Time (AST) (ASCC 1998). A total of 416 caribou in 94 groups was recorded within the study area, including 132 cow-calf pairs (Fig. A-1, Table 1, Table A-1). Most caribou groups (91% [86 of 94]) consisted of less than 10 animals. Mean and 95% confidence interval (95CI) of group size was 4.4 ± 1.25 caribou. Most caribou (95% of total [396 of 416]; 96% of calves [127 of 132]) were south of the Badami pipeline; with 44% of caribou (173 of 396 total; 39% of calves [50 of 127]) between the Sagavanirktok River and the Kadleroshilik River, 31% (123 of 396 total; 37% of calves [47 of 127]) between the Kadleroshilik River and the Shaviovik River, and 25% (100 of 396 total; 24% of calves [30 of 127]) east of the Shaviovik River (Fig. A-1).

Survey 2—15 June 1998

Survey conditions were marginal with a 150-m ceiling, winds at 5.1 to 7.2 mps from the east northeast (50° to 70°), and temperature 5 to 9 °C from 1500 to 1900 AST. Fog prevented surveying the coastal portions of transects in the Sagavanirktok River delta, resulting in approximately 94% coverage of the study area (Fig. A-1). A total of 1002 caribou in 108 groups was recorded within the survey area (Fig. A-1, Table 1, Table A-1). Most caribou groups (80% [86 of 108]) consisted of less than 10 animals; however, two groups of more than 120 animals were observed east of the Shaviovik River. Mean and 95CI of group size was 9.3 ± 4.33 caribou. Most caribou (99% of total [993 of 1002]; 99% of calves [314 of 318]) were south of the Badami pipeline, where 34% (337 of 993 total; 35% of calves [110 of 314]) of caribou were between the Sagavanirktok River and the Kadleroshilik River, 23% (228 of 993 total; 20% of calves [63 of 314]) were between the Kadleroshilik River and the Shaviovik River, and 43% (428 of 993 total; 45% of calves [141 of 314]) were east of the Shaviovik River (Fig. A-1).

Post-Calving Period

Survey 3—30 June 1998

Survey conditions were good with scattered clouds, winds at 3.6 to 6.2 mps from the east-northeast (30° to 60°) and temperatures 15 to 18 °C from 1200 to 1700 AST. A total of 436 caribou in seven groups was recorded within the study area (Fig. A-2, Table 1, Table A-1). Sixty-four percent (274 of 436) of all caribou observed were in a single cow-dominated group approximately 2 km west of the mouth of the Kadleroshilik River. All caribou observed during the survey were along the coast and north of the Badami pipeline. Mean and 95CI of group size was 62.3 ± 91.8 caribou.

Daily mean temperature was 14.3 °C and daily mean wind speed was 4.6 mps (Table B-1). Parasitic insect activity indices showed conditions favorable for mosquito activity during one hour of the day, and favorable conditions for oestrid activity during three hours of the day (Fig. 2, Table B-1). On 29 June, indices showed conditions were favorable for mosquito activity during one hour of the day, and favorable for oestrid activity during six hours of the day. The clumped coastal distribution of caribou on 30 June suggests that caribou were responding to parasitic insects, perhaps to conditions on 29 June.

Survey 4—9 July 1998

Survey conditions were fair with scattered clouds, winds at 10.8 to 11.8 mps from the east (80°), gusting to 14.4 mps, and temperatures 9 to 12 °C from 1600 to 2100 AST. A total of 2651 caribou in 48 groups was recorded within the study area (Fig. A-2, Table 1, Table A-1).

Mean and 95CI of group size was 55.2 ± 34.3 caribou. East of the Shaviovik River, 82% of caribou were at least 3.2 km inland; 76% (1665 of 2185) of these animals were in four cow-calf dominated groups of between 325 and 500 individuals. West of the Shaviovik River, caribou were distributed at least 4 km inland in groups that largely consisted of less than 10 total animals (65% [20 of 31] of groups), with the exception of one group of 160 animals observed resting about 200 m west of the Kadleroshilik River, and about 10.5 km inland.

Daily mean temperature was 9.1 °C and daily mean wind speed was 10.7 mps (Table B-1). Mosquito and oestrid activity indices showed that conditions were too cool and windy for insect activity on 9 July (Fig. 2, Table B-1).

Survey 5—16 July 1998

Survey conditions were fair with overcast skies, winds at 7.2 to 9.3 mps from the northeast (50° to 60°), and temperatures 10 to 14 °C from 1700 to 2200 AST. A total of 4057 caribou in 40 groups was recorded within the study area (Fig. A-3, Table A-1). Mean group size was 101.4 ± 71.2 95CI. Forty-one percent (1680 of 4057) of caribou were in three cow-calf dominated groups of between 260 and 1110 animals along the eastern coast of Foggy Island Bay. An additional 35% (1409 of 4057) of caribou were in three cow-calf dominated groups of between 259 and 720 animals west of the Kadleroshilik River, and within 2.5 km south of the Badami pipeline. A cow-calf-dominated group of 340 animals was approximately 4.5 km south of the Badami pipeline along the Sagavanirktok River.

Daily mean temperature was 11.0 °C and daily mean wind speed was 7.2 mps (Table B-1). Mosquito and oestrid activity indices showed that conditions were too cool and windy for insect activity on 16 July (Fig. 2, Table B-1). However, hourly weather data were unavailable between 1120 and 1650 AST, which presumably included the warmest part of the day, and conditions had been favorable for at least two hours on 15 July. The coastal and riparian distributions of caribou on 16 July suggest that caribou were responding to parasitic insects.

Survey 6—22 July 1998

Survey conditions were fair with hazy visibility, winds at 10.3 to 11.3 mps from the east (80°), gusting to 13.9 mps, and temperatures 11 to 13 °C from 1300 to 1800 AST. A total of 6980 caribou in 58 groups was recorded within the study area (Fig. A-3, Table A-1). Mean and 95CI of group size was 120 ± 96.7 caribou. Seventy-eight percent (5462 of 6980) of caribou were north of the Badami pipeline; 87% (4745 of 5462) of these animals were in three cow-calf dominated groups of 1100 to 2160 individuals. Two of these groups were within 1.5 km of the Kadleroshilik River (one on each side of the river), and one group was about 4 km east of the

river. Most of the remaining caribou (82% [1251 of 1518]) were southwest of the Badami pipeline in or between the east and west channels of the Sagavanirktok River.

Daily mean temperature was 10.1 °C and daily mean wind speed was 8.0 mps (Table B-1). Mosquito and oestrid activity indices indicated that conditions were too cool and windy for insect activity on 22 July; however, three days prior to the survey (19 July) more than four hours were favorable for parasitic insect activity (Fig. 2, Table B-1). The clumped, coastal, and riparian distributions of caribou on 16 July suggests that caribou were responding to parasitic insects.

Survey 7—11 August 1998

Survey conditions were good with overcast skies, winds at 4.1 to 6.2 mps from the west-southwest (230° to 250°), and temperatures 13 to 16 °C from 1200 to 1600 AST. A total of 26 caribou in 19 groups was recorded within the study area (Fig. A-3, Table A-1). Four animals were east of the Kadleroshilik River; five animals were north of the Badami Pipeline. Daily mean temperature was 12.7 °C and daily mean wind speed was 3.7 mps (Table B-1). Based on parasitic insect indices, conditions were favorable for mosquito and oestrid activity during three hours of the day. Weather conditions during the previous week were too cool for insect activity (Fig.2, Table B-1).

Badami Pipeline Corridor

During the calving period, few caribou were north of the Badami pipeline corridor (Table 2, Fig. A-1). This is not unexpected and does not constitute a blockage of movement as calving caribou distribution is generally inland of the pipeline corridor (Pollard and Noel 1994, 1995; Noel 1998). Both the proportion and number of caribou in the study area that were north of the pipeline during the post-calving period varied considerably from 0% (11 of 2651) on 9 July to 73% (320 of 436) on 30 June 1998 (Table 2). The largest number of caribou (6980 total) was recorded on 22 July with 63% (4382 of 6980) of these north of the pipeline corridor. This represents a minimum of 4382 caribou including 891 cow-calf pairs that crossed the pipeline corridor at least twice during the study period (once northbound and once southbound).

Twelve caribou groups were recorded within a 1-km buffer area north of the pipeline during systematic surveys from 10 June to 11 August 1998. One large group of 2160 animals, was spread both north and south of the pipeline, approximately 1.4 km east of the Kadleroshilik River, but the point location for this group falls south of the pipeline (Pipeline Segment 10, Fig. A-4). The majority of animals in that group were standing or feeding. Seven groups within 1-km north of the pipeline contained one or two caribou. A cluster of five groups of between 13 and

70 animals were recorded southeast of the Endicott pipeline (Pipeline Segment 1 and 2, Fig. A-4). The pipeline segments with the highest crossing frequency, as density of caribou, were Segments 1 and 2 (Fig. A-4), however, Segment 10 may have had the highest number of caribou.

MUSKOXEN

Muskoxen were observed within the study area on all seven systematic surveys. During six of the seven surveys, a group of less than 15 muskoxen was observed (Fig. A-5, Table A-2). Seven or eight calves were noted as part of this group during three surveys (30 June, 9 July, and 11 August). During the 22 July survey, three calves were observed. Groups of more than 15 muskoxen were primarily observed within 800 m of the Kadleroshilik or the Shaviovik rivers (5 of 6 observations). Additionally, on 10 June a group of 37 muskoxen, including 6 calves, were observed just east of the Shaviovik River, south of the study area. A group of 15 muskoxen, including 3 calves were observed along the coast of Foggy Island Bay approximately 1.5 km east of the Kadleroshilik River, during a non-systematic over-flight on 9 August.

Two muskoxen groups, possibly containing many of the same individuals, were recorded north of the Badami pipeline corridor on 30 June and 11 August 1998. One group of 25 muskoxen (69% [25 of 36] of muskoxen in the study area) was north of the pipeline on 30 June, and 1 group of 20 muskoxen (100% [20 of 20]) was north of the pipeline on 11 August. Because no muskoxen were recorded on the three surveys between 30 June and 11 August, this represents a minimum of 25 muskoxen, including 7 calves, that crossed the pipeline corridor at least twice during the study period.

GRIZZLY BEARS

Two grizzly bears were observed within the study area on 10 June (Fig. A-5, Table A-2). No other grizzly bears were sighted during subsequent surveys.

DISCUSSION

During the seven systematic strip–transect surveys conducted in the Badami study area from 26 to 6980 caribou were observed (Table 1). The most recent estimate of population size for the CAH (1997) was 20,000 (1997 count: 19,730), with an estimated 8000 (1997 count: 7733) in the eastern segment of the CAH (E. Lenart, ADF&G, personal communication). Caribou that calve between Bullen Point and the Canning River are 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 and the estimated 43.9% cow composition of the CAH during October 1996 (Hicks 1997), 3% to 7% of CAH cows

and 7% to 18% of cows from the eastern segment of the CAH used the Badami study area during calving. During post-calving, these percentages were 0% to 44% of CAH cows and 0% to 100% of cows in the eastern segment of the CAH.

Based on previous years of caribou calving-period distribution within the Badami study area, calving caribou were not expected to occur north of the Badami pipeline corridor. Blockage of movements during the calving period has not been considered an issue, because generally 20 or fewer caribou have been recorded north of the pipeline corridor during calving period surveys prior to pipeline construction (Pollard and Noel 1994, 1995; Noel 1998).

Sex and age composition of classified caribou varied between surveys. For the combined post–calving survey period, 15% were bulls, 62% were cows, and 23% were calves. The proportion of bulls was less than half that reported by Noel (1998) for surveys conducted in 1997. It is possible that some unclassified caribou were small bulls, contributing to an underestimate of bulls within the study area in 1998; also, it is possible that some cows were miss-classified in 1997. It is possible that segregation between bull groups and cow-calf groups and differential movements of these groups in and out of the study area in 1997 and 1998 account for these differences.

During the post-calving period, weather-moderated insect activity influence caribou distribution, movement, and behavior more than any other environmental factor (White et al. 1975; Roby 1978; Dau 1986; Johnson and Lawhead 1989; Pollard et al. 1996a). 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. 1996b). From the patterns of caribou distributions in the study area between 30 June and 11 August 1998, it appears that caribou shifted back and forth between coastal insect-relief and inland foraging habitats. Observations of caribou north of the Badami pipeline between the Endicott pipeline and the Badami facility indicate that a minimum of 4382 caribou crossed the Endicott/Badami pipeline corridor during the insect season in 1998. The proportion of caribou within the Badami study area that were north of the pipeline varied from 0% to 73% during the post-calving period, again demonstrating that caribou moved across the pipeline corridor.

Although caribou group size generally begins to increase after peak calving, insect harassment apparently is a major factor causing large aggregations (Roby 1978; Johnson and Lawhead 1989, Pollard et al. 1996a,b). During 1998, mean caribou group size increased from 62 on 30 June to 120 on 22 July.

The models for mosquito and oestrid activity do not appear to explain the shift in caribou distribution between 9 and 22 July 1998. According to these models, insects were inactive during both the 16 July and 22 July surveys (Fig. A-3). Yet, the formation of large caribou groups and their coastal distribution suggests that caribou were responding to mosquito harassment (Dau 1986, Johnson and Lawhead 1989, White et al. 1975, Pollard et al. 1996a,b) on these survey days. There are three plausible explanations for the lack of agreement between the modeled insect activity and caribou distributions: 1) the indices may be conservative for conditions when mosquitoes and oestrids are active; 2) the Deadhorse weather data may not accurately represent conditions within the study area; and 3) caribou distributions may reflect conditions prior to the actual survey day.

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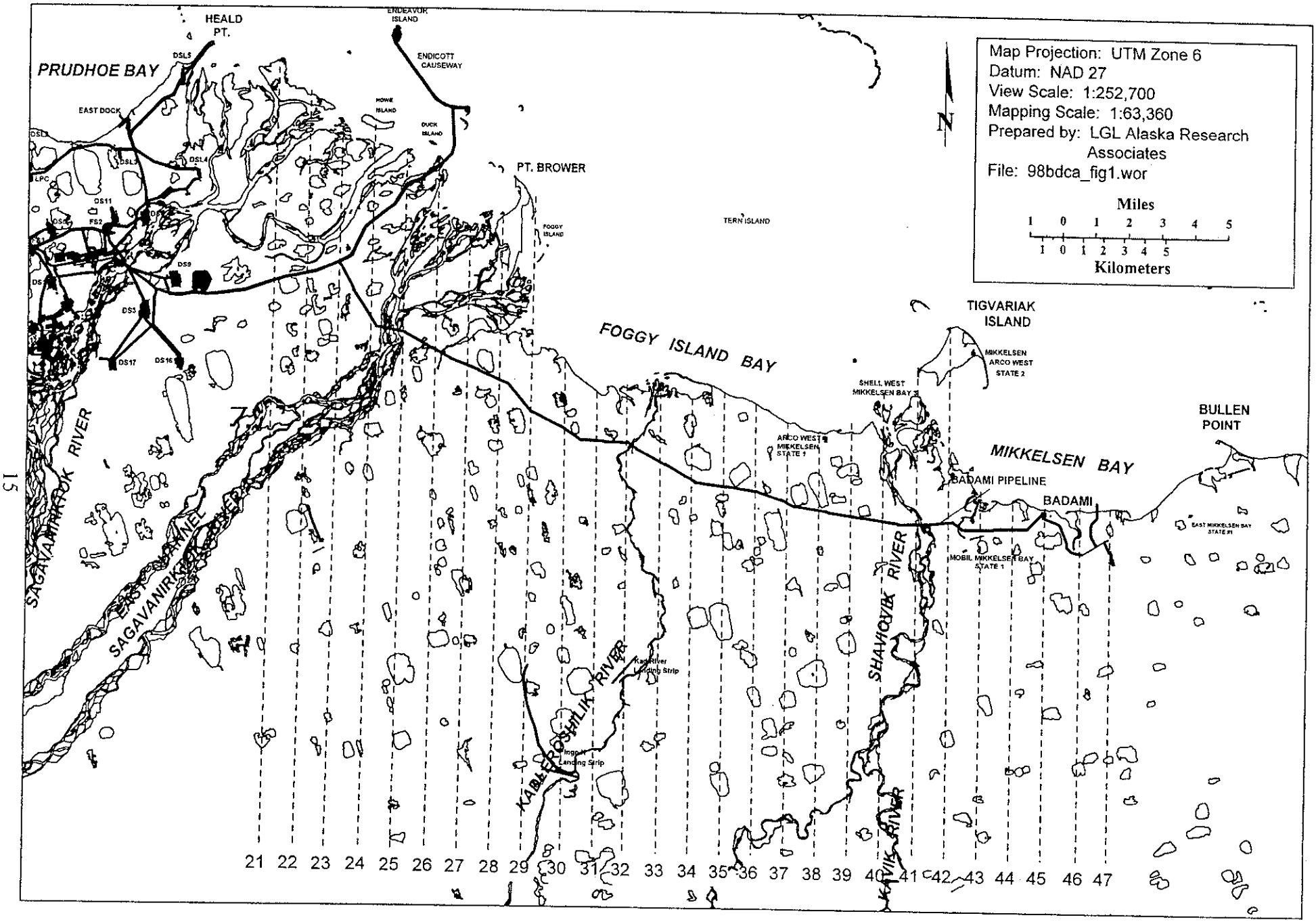

Figure 1. Survey transects in the Badami study area, Alaska, 1998.

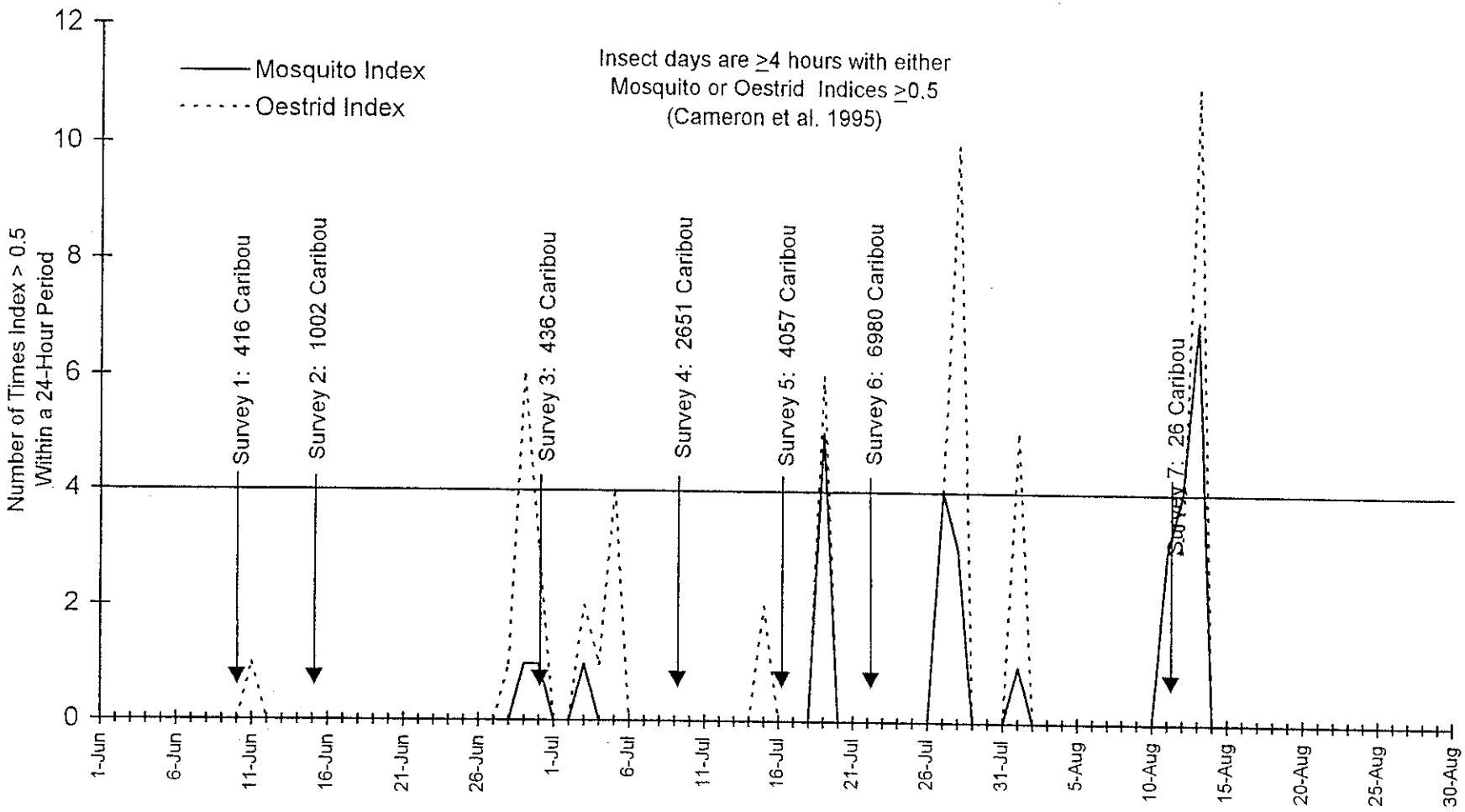

Figure 2. Mosquito and oestrid activity indices (Russel et al. 1993) based on hourly weather data collected at the Deadhorse Weather Station (ASCC 1998) and 1998 aerial caribou survey dates, Badami study area, Alaska.

Table 1. Sex and age classification for caribou and muskoxen observed during systematic aerial surveys in the Badami study area, Alaska, 10 June to 11 August 1998.

Flight	Date	Number of Caribou					Number Of Groups	Mean Group Size
		Bulls	Cows	Calves	Unclassified	Total		
Caribou Sightings								
1	10 Jun 98	1	264	132	19	416	94	4.4
2[a]	15 Jun 98	7	632	318	45	1,002	108	9.3
3	30 Jun 98	65	258	28	85	436	7	62.3
4	9 Jul 98	360	1,490	738	63	2,651	48	55.2
5	16 Jul 98	563	2,295	835	364	4,057	40	101.4
6	22 Jul 98	944	3,842	1,384	810	6,980	58	120.3
7	11 Aug 98	4	14	6	2	26	19	1.4
Muskoxen Sightings								
1	10 Jun 98	2	2	0	26	30	5	6.0
2[a]	15 Jun 98	0	0	0	1	1	1	-
3	30 Jun 98	3	23	7	3	36	3	12.0
4	9 July 98	2	14	7	9	32	2	16.0
5	16 July 98	3	0	0	15	18	1	-
6	22 July 98	0	0	3	18	21	1	-
7	11 Aug 98	1	0	8	11	20	1	-

[a]Coastal fog prevented surveying portions of some transects, resulting in approximately 94% coverage of the study area.

Table 2. Sex and age classification for caribou and muskoxen observed north of the Badami pipeline corridor during systematic aerial surveys in the Badami study area, Alaska, 10 June to 11 August 1998.

Flight	Date	Number of Caribou					Percent of Caribou North of Pipeline	Number of Groups
		Bulls	Cows	Calves	Unclassified	Total		
Caribou Sightings								
1	10 Jun 98	0	13	5	2	20	5	6
2[a]	15 Jun 98	1	4	4	0	9	1	3
3	30 Jun 98	65	235	20	0	320	73	2
4	9 Jul 98	1	6	4	0	11	0	2
5	16 Jul 98	202	1,055	433	102	1792	44	11
6	22 Jul 98	581	2,528	891	382	4,382	63	24
7	11 Aug 98	1	3	1	0	5	19	4
Muskoxen Sightings								
1	10 Jun 98	0	0	0	0	0	0	0
2[a]	15 Jun 98	0	0	0	0	0	0	0
3	30 Jun 98	2	16	7	0	25	69	1
4	9 July 98	0	0	0	0	0	0	0
5	16 July 98	0	0	0	0	0	0	0
6	22 July 98	0	0	0	0	0	0	0
7	11 Aug 98	1	0	8	11	20	100	1

[a]Coastal fog prevented surveying portions of some transects, resulting in approximately 94% coverage of the study area.

APPENDIX A. 1998 DATA

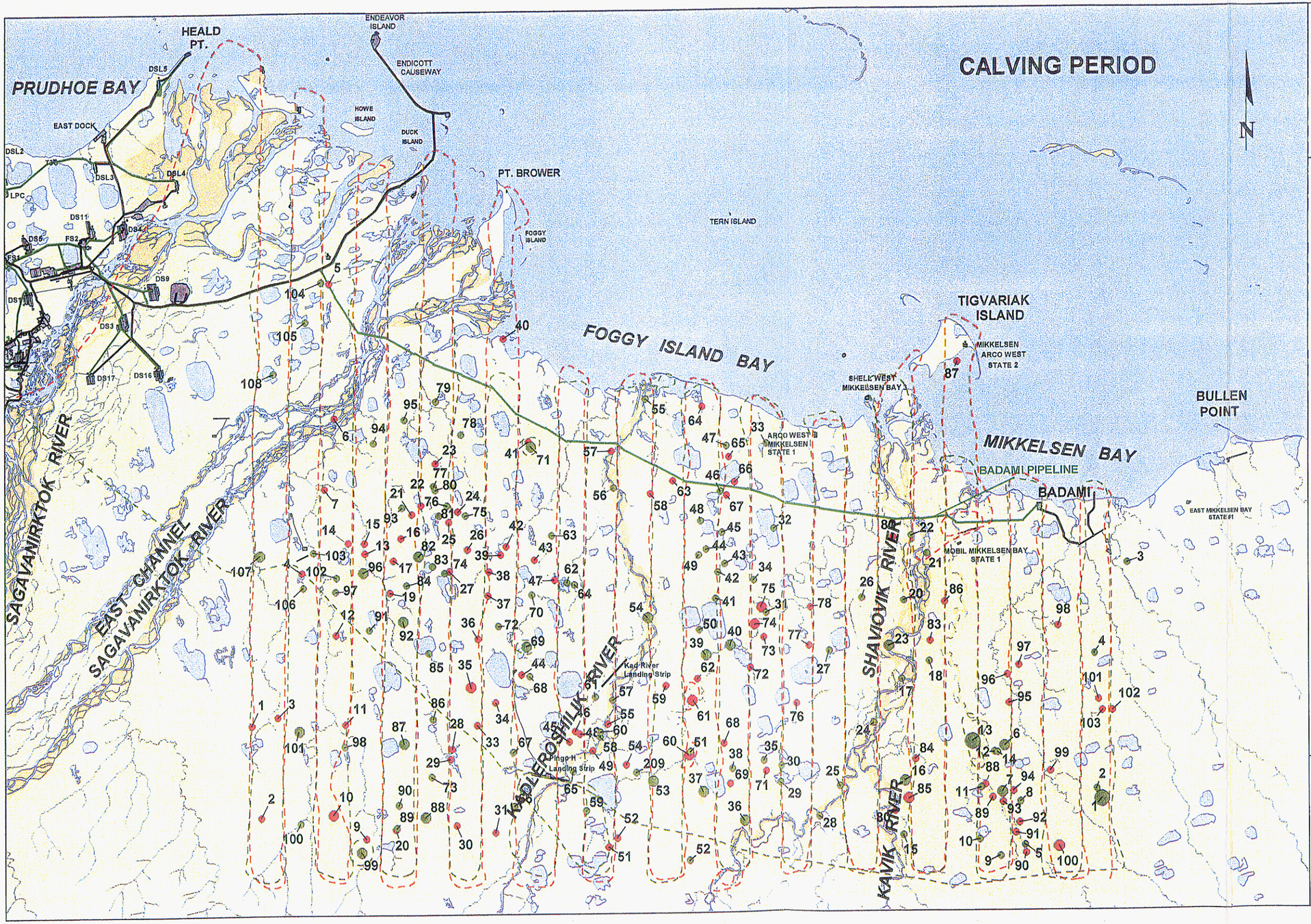

Figure A-1

Distribution of caribou observed in the Badami study area, Alaska, on 10 and 15 June 1998.

Caribou Group Size

	Groups
10 June	
Less than 10	86
10 to 100	8
101 to 1000	0
Greater than 1000	0
15 June	
Less than 10	86
10 to 100	20
101 to 1000	2
Greater than 1000	0

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

- 10 June Survey Flight Line
- 15 June 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: 1:197,900
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 98bdca_a1.wor

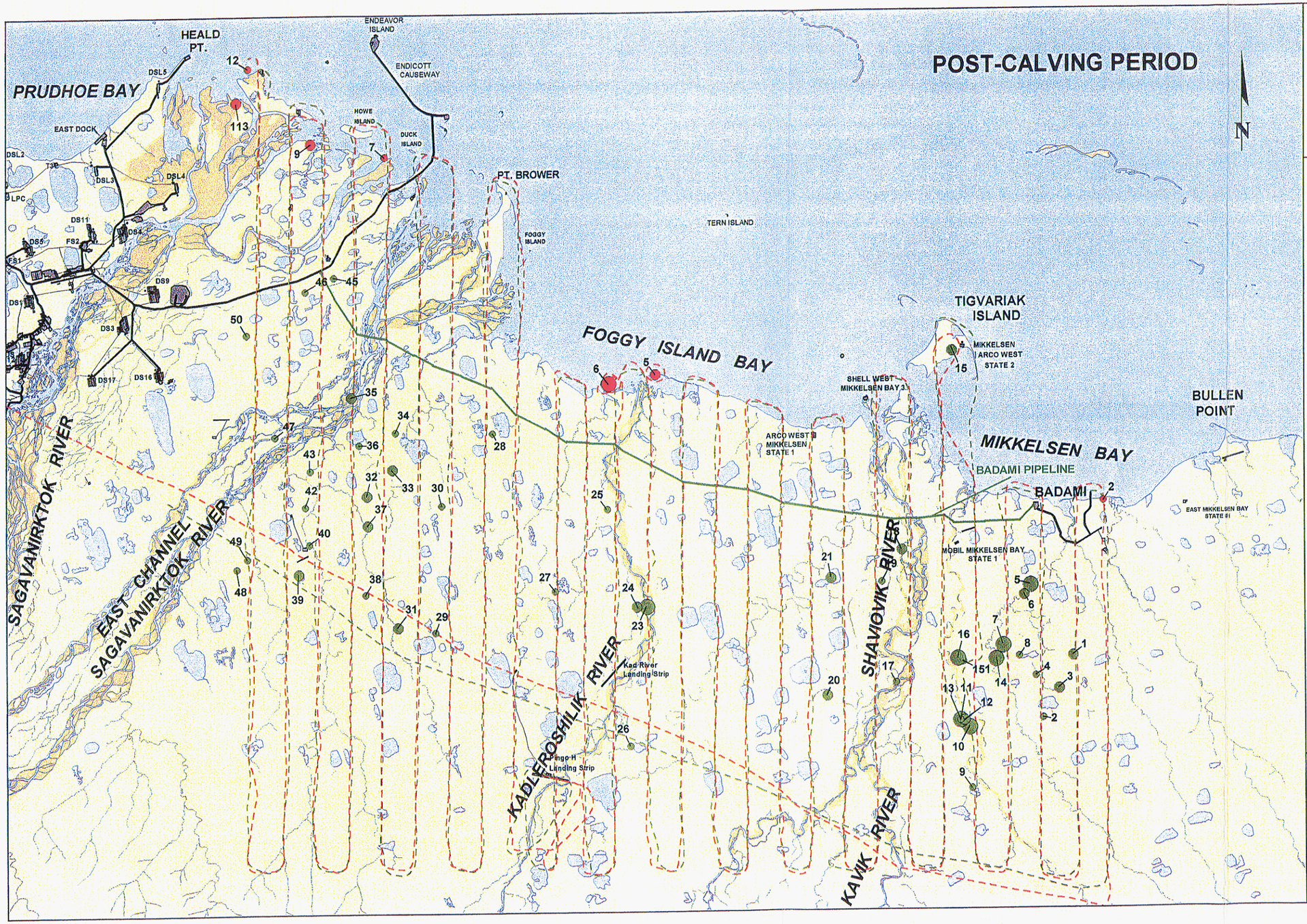

Figure A-2

Distribution of caribou observed in the Badami study area, Alaska, on 30 June and 9 July 1998.

Caribou Group Size

	Groups
30 June	
Less than 10	3
10 to 100	3
101 to 1000	1
Greater than 1000	0
9 July	
Less than 10	26
10 to 100	15
101 to 1000	7
Greater than 1000	0

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

- 30 June Survey Flight Line
- 9 July 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: 1:197,900
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 98bdca_a2.wor

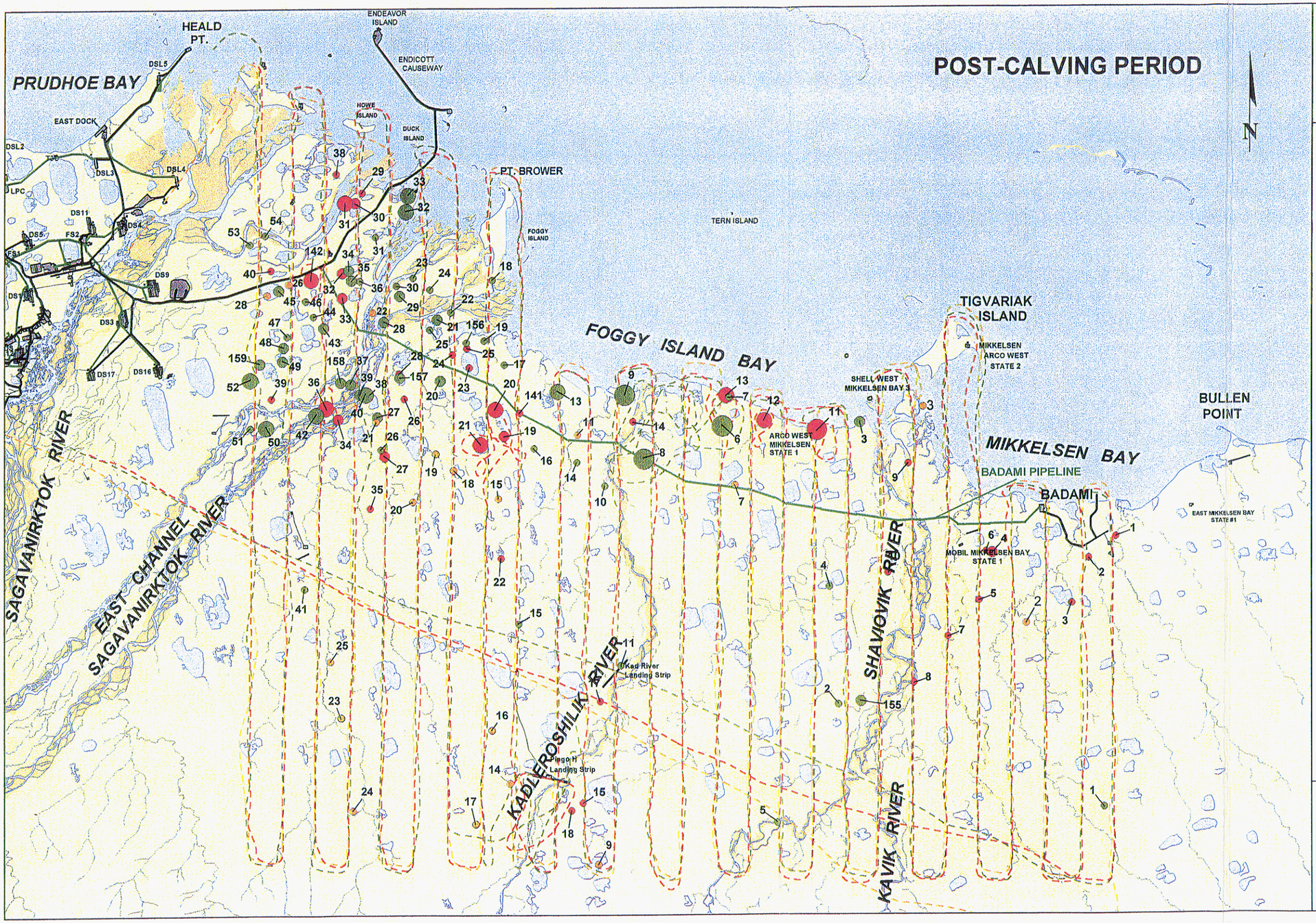

Figure A-3
Distribution of caribou observed in the Badami study area, Alaska, on 16 July, 22 July, and 11 August 1998.

Caribou Group Size	Groups
16 July	
Less than 10	25
10 to 100	7
101 to 1000	7
Greater than 1000	1
22 July	
Less than 10	30
10 to 100	18
101 to 1000	7
Greater than 1000	3
11 August	
Less than 10	19
10 to 100	0
101 to 1000	0
Greater than 1000	0

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

- 16 July Survey Flight Line
- 22 July Survey Flight Line
- 11 August 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: 1:197,900
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
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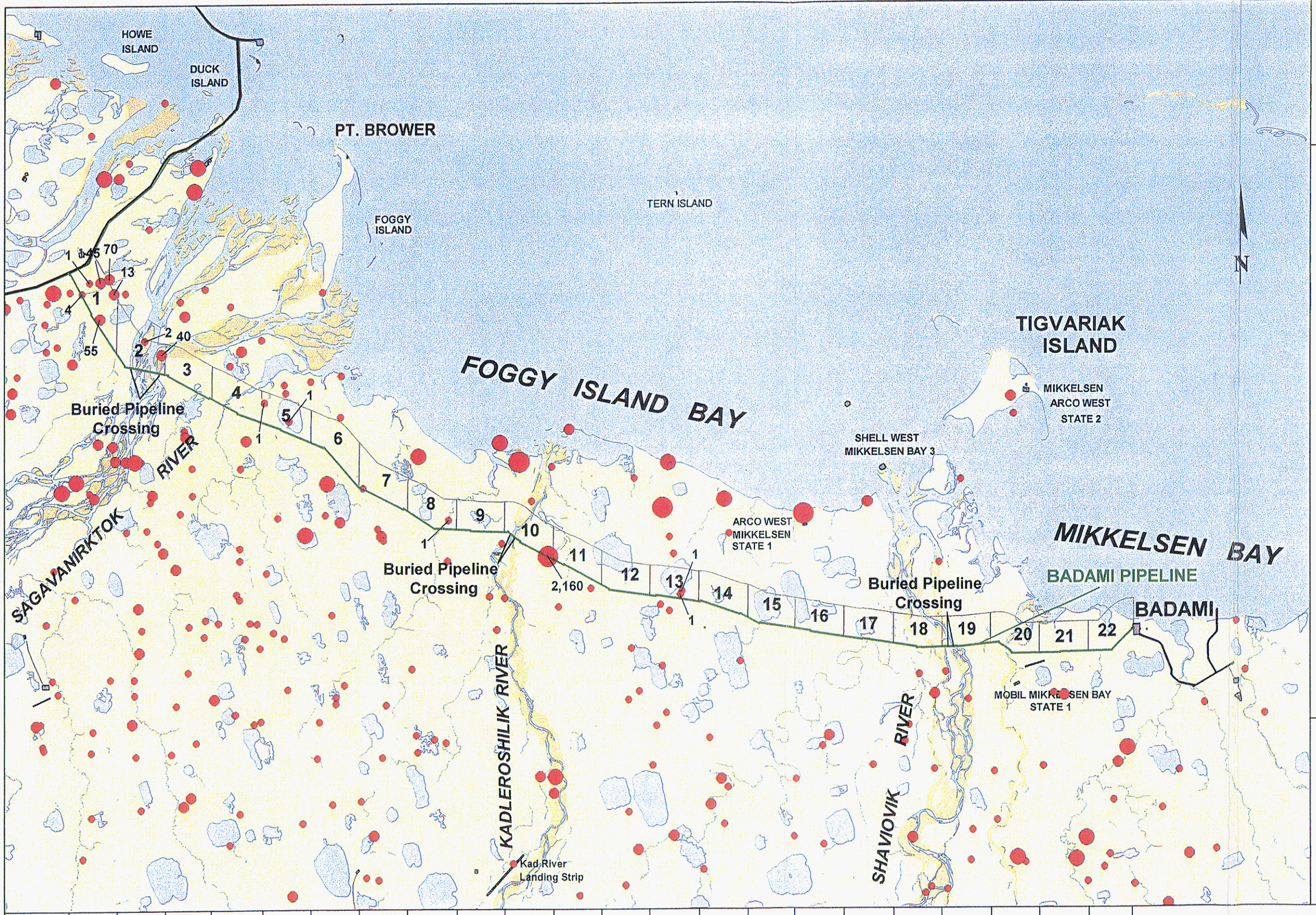

Segment:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Caribou per km^2 :	10.3	4.9	0	0.1	0.1	0	0	0.1	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0

Figure A-4

Distribution of caribou 1 km north of the Badami pipeline by pipeline segment, Badami study area, Alaska, from 10 June to 11 August 1998.

Caribou Group Size

- Less than 10
- 10 to 100
- 101 to 1000
- Greater than 1000

Mean caribou density for the seven surveys is based on available land area and is listed below the map.

22 — Total Number of Caribou (depicted for groups in or near the pipeline buffer)

- 1 km Buffer North of the Badami Pipeline
- Pipelines
- Roads
- Oil Production and Service Facilities

Map Projection: UTM Zone 6
Datum: NAD 27
View Scale: 1:133,800
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 98bdca_a4.wor

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

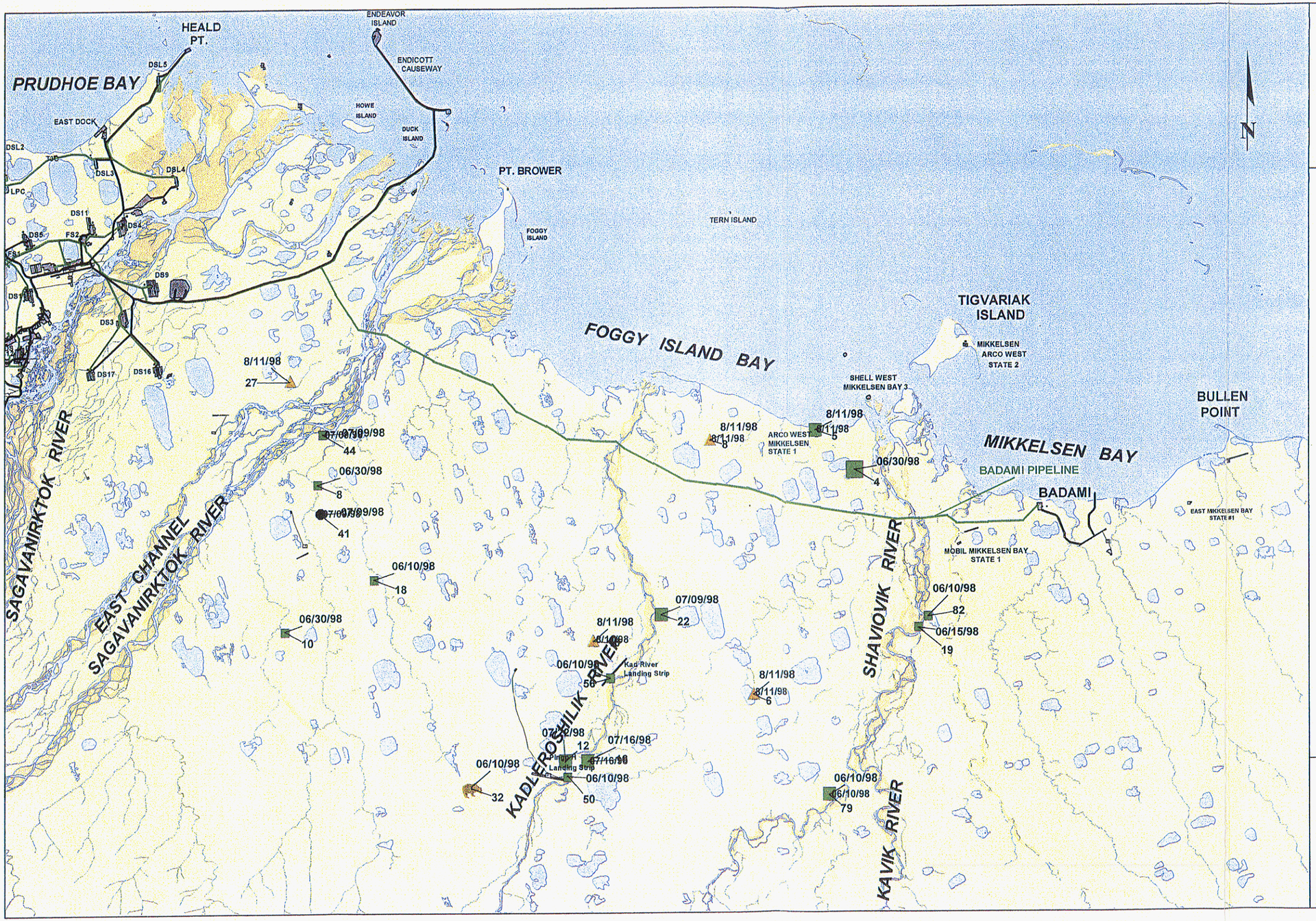

Figure A-5

Distribution of muskoxen, grizzly bear, moose, and fox dens observed in the Badami study area, Alaska, 10 June to 11 August 1998.

Muskoxen Group Size

	Groups
Less than 10	8
10 to 24	5
25 to 50	1

- Grizzly Bear
- Fox Den
- Moose

6/10/98 > 22 — Sighting Date and Group Attribute Number (see Table A-2)

- 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: 1:197,900
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 98bdmisc_5.wor

Table A-1. Caribou sightings in the Badami study area, Alaska, summer 1998. Coordinates are longitude, latitude, and datum is WGS 84.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
148.107727	70.054652	10 Jun 98	16:16:29	1	1	ca	0	4	0	0	4
148.093633	70.014853	10 Jun 98	16:17:51	1	2	ca	0	2	2	0	4
148.074599	70.058376	10 Jun 98	16:21:51	1	3	ca	0	1	0	0	1
148.045773	70.121386	10 Jun 98	16:24:10	1	4	ca	0	0	0	1	1
148.016295	70.248321	10 Jun 98	16:35:19	1	5	ca	0	4	0	0	4
148.006789	70.189504	10 Jun 98	16:37:18	1	6	ca	0	3	1	0	4
148.017939	70.158313	10 Jun 98	16:38:22	1	7	ca	0	1	0	0	1
147.958191	70.006430	10 Jun 98	16:45:24	1	9	ca	0	0	0	1	1
148.000458	70.016533	10 Jun 98	16:45:47	1	10	ca	0	25	7	0	32
147.986490	70.055550	10 Jun 98	16:47:19	1	11	ca	0	1	0	0	1
148.000492	70.094490	10 Jun 98	16:48:44	1	12	ca	0	0	0	2	2
147.964701	70.130206	10 Jun 98	16:50:03	1	13	ca	0	1	0	0	1
147.986080	70.134787	10 Jun 98	16:50:13	1	14	ca	0	3	1	0	4
147.965132	70.134787	10 Jun 98	16:50:13	1	15	ca	0	2	0	0	2
147.918836	70.137035	10 Jun 98	17:02:21	1	16	ca	0	1	0	0	1
147.928385	70.127285	10 Jun 98	17:02:41	1	17	ca	0	1	0	0	1
147.931874	70.113155	10 Jun 98	17:03:09	1	19	ca	0	5	1	0	6
147.920918	70.010423	10 Jun 98	17:06:42	1	20	ca	0	1	0	0	1
147.905459	70.147605	10 Jun 98	17:13:59	1	21	ca	0	2	1	0	3
147.893489	70.151623	10 Jun 98	17:14:08	1	22	ca	0	1	1	0	2
147.875878	70.169984	10 Jun 98	17:14:49	1	23	ca	0	1	1	0	2
147.846525	70.148918	10 Jun 98	17:25:31	1	24	ca	1	2	1	0	4
147.857923	70.144356	10 Jun 98	17:25:40	1	25	ca	0	2	2	0	4
147.833605	70.132320	10 Jun 98	17:26:04	1	26	ca	0	0	0	1	1
147.855960	70.122791	10 Jun 98	17:26:23	1	27	ca	0	2	2	0	4
147.850177	70.045384	10 Jun 98	17:29:02	1	28	ca	0	2	1	0	3
147.852139	70.040953	10 Jun 98	17:29:11	1	29	ca	0	2	2	0	4
147.843292	70.012300	10 Jun 98	17:30:08	1	30	ca	0	1	1	0	2
147.793810	70.009364	10 Jun 98	17:32:18	1	31	ca	0	4	0	0	4
147.818549	70.055742	10 Jun 98	17:34:00	1	33	ca	0	2	2	2	6
147.795739	70.065624	10 Jun 98	17:34:22	1	34	ca	0	3	1	2	6
147.827046	70.072244	10 Jun 98	17:34:37	1	35	ca	0	7	6	0	13
147.818882	70.093246	10 Jun 98	17:35:24	1	36	ca	0	2	2	0	4
147.806914	70.112207	10 Jun 98	17:36:08	1	37	ca	0	1	1	0	2
147.805749	70.122813	10 Jun 98	17:36:33	1	38	ca	0	5	3	0	8
147.791190	70.130097	10 Jun 98	17:36:49	1	39	ca	0	3	2	0	5
147.790629	70.224911	10 Jun 98	17:40:19	1	40	ca	0	0	0	2	2
147.756924	70.179799	10 Jun 98	17:46:57	1	41	ca	0	2	1	0	3
147.784339	70.133749	10 Jun 98	17:48:31	1	42	ca	0	6	3	0	9

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
147.747545	70.127936	10 Jun 98	17:48:43	1	43	ca	0	0	0	2	2
147.762758	70.077711	10 Jun 98	17:50:24	1	44	ca	0	2	1	0	3
147.700167	70.048700	10 Jun 98	17:56:23	1	45	ca	0	1	1	0	2
147.692985	70.053174	10 Jun 98	17:56:33	1	46	ca	0	2	2	0	4
147.721183	70.119225	10 Jun 98	17:58:56	1	47	ca	0	1	1	0	2
147.686623	70.052131	10 Jun 98	18:08:19	1	48	ca	0	1	0	0	1
147.670114	70.044872	10 Jun 98	18:08:34	1	49	ca	0	2	0	0	2
147.648869	70.003560	10 Jun 98	18:11:32	1	51	ca	0	5	2	0	7
147.637999	70.007417	10 Jun 98	18:11:41	1	52	ca	0	3	3	0	6
147.627734	70.038939	10 Jun 98	18:12:51	1	54	ca	0	4	0	0	4
147.651166	70.056536	10 Jun 98	18:13:31	1	55	ca	0	2	2	0	4
147.649373	70.175859	10 Jun 98	18:18:07	1	57	ca	0	1	0	0	1
147.599720	70.157217	10 Jun 98	18:21:34	1	58	ca	0	1	1	0	2
147.578538	70.073125	10 Jun 98	18:24:31	1	59	ca	0	1	1	0	2
147.548171	70.043306	10 Jun 98	18:29:58	1	60	ca	0	9	7	0	16
147.544876	70.066826	10 Jun 98	18:31:59	1	61	ca	0	9	8	0	17
147.538670	70.076159	10 Jun 98	18:33:30	1	62	ca	0	2	2	0	4
147.571523	70.162818	10 Jun 98	18:36:50	1	63	ca	0	1	0	0	1
147.534488	70.195425	10 Jun 98	18:38:07	1	64	ca	0	1	1	0	2
147.499760	70.173187	10 Jun 98	18:40:09	1	65	ca	0	3	2	0	5
147.491991	70.162140	10 Jun 98	18:40:32	1	66	ca	0	1	0	0	1
147.502756	70.156385	10 Jun 98	18:40:44	1	67	ca	0	1	0	0	1
147.504401	70.048165	10 Jun 98	18:44:28	1	68	ca	0	2	2	0	4
147.496154	70.030834	10 Jun 98	18:45:05	1	69	ca	0	2	0	0	2
147.449447	70.036006	10 Jun 98	18:50:02	1	71	ca	0	1	1	0	2
147.471097	70.080934	10 Jun 98	18:51:44	1	72	ca	0	0	0	1	1
147.453559	70.094155	10 Jun 98	18:52:14	1	73	ca	0	2	2	0	4
147.465438	70.099813	10 Jun 98	18:52:26	1	74	ca	0	6	4	0	10
147.456558	70.107216	10 Jun 98	18:52:43	1	75	ca	0	11	5	0	16
147.408659	70.065198	10 Jun 98	19:01:13	1	76	ca	0	6	3	0	9
147.392822	70.090473	10 Jun 98	19:07:55	1	77	ca	0	4	3	0	7
147.391236	70.107222	10 Jun 98	19:08:34	1	78	ca	0	2	0	0	2
147.281886	70.018883	10 Jun 98	19:20:08	1	80	ca	0	2	2	0	4
147.285437	70.137912	10 Jun 98	19:24:48	1	81	ca	0	1	1	0	2
147.238061	70.092547	10 Jun 98	20:02:54	1	83	ca	0	0	0	1	1
147.256590	70.041163	10 Jun 98	20:04:34	1	84	ca	0	4	2	0	6
147.265086	70.024295	10 Jun 98	20:05:07	1	85	ca	0	7	3	0	10
147.219402	70.109565	10 Jun 98	20:10:50	1	86	ca	0	1	0	0	1
147.203575	70.214698	10 Jun 98	20:14:48	1	87	ca	0	4	2	0	6
147.167034	70.030157	10 Jun 98	20:22:46	1	88	ca	0	1	1	0	2

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
147.157903	70.024506	10 Jun 98	20:22:57	1	89	ca	0	0	0	1	1
147.115497	70.000677	10 Jun 98	20:24:41	1	90	ca	0	0	0	1	1
147.128898	70.009384	10 Jun 98	20:25:00	1	91	ca	0	1	1	0	2
147.123794	70.013667	10 Jun 98	20:25:10	1	92	ca	0	1	0	0	1
147.144662	70.022597	10 Jun 98	20:25:29	1	93	ca	0	3	0	1	4
147.131459	70.027245	10 Jun 98	20:25:39	1	94	ca	0	2	0	0	2
147.137019	70.065374	10 Jun 98	20:27:02	1	95	ca	0	1	1	0	2
147.139400	70.077673	10 Jun 98	20:27:28	1	96	ca	0	0	0	1	1
147.124659	70.081778	10 Jun 98	20:27:36	1	97	ca	0	1	1	0	2
147.075019	70.098921	10 Jun 98	20:33:16	1	98	ca	0	1	1	0	2
147.084602	70.035808	10 Jun 98	20:35:26	1	99	ca	0	4	0	0	4
147.074277	70.003404	10 Jun 98	20:36:32	1	100	ca	0	30	15	0	45
147.023093	70.066707	10 Jun 98	20:46:50	1	101	ca	0	1	1	0	2
147.004900	70.061997	10 Jun 98	20:46:59	1	102	ca	0	3	2	0	5
147.017992	70.061997	10 Jun 98	20:46:59	1	103	ca	0	2	0	0	2
147.018967	70.023646	15 Jun 98	14:51:29	2	1	ca	0	80	55	0	135
147.025689	70.027976	15 Jun 98	14:51:38	2	2	ca	0	3	2	0	5
146.985716	70.126169	15 Jun 98	14:55:16	2	3	ca	0	0	0	1	1
147.028294	70.086784	15 Jun 98	14:59:17	2	4	ca	0	1	1	0	2
147.116900	70.004132	15 Jun 98	15:03:27	2	5	ca	0	0	0	6	6
147.143172	70.046905	15 Jun 98	15:13:38	2	6	ca	0	9	6	0	15
147.145712	70.026968	15 Jun 98	15:14:20	2	7	ca	0	7	3	0	10
147.122542	70.022676	15 Jun 98	15:14:29	2	8	ca	0	4	3	0	7
147.147822	69.999500	15 Jun 98	15:15:18	2	9	ca	0	3	0	0	3
147.174170	70.006650	15 Jun 98	15:16:40	2	10	ca	2	0	0	0	2
147.172444	70.028967	15 Jun 98	15:17:30	2	11	ca	0	3	0	0	3
147.155576	70.044379	15 Jun 98	15:18:06	2	12	ca	0	4	2	0	6
147.183327	70.048847	15 Jun 98	15:19:59	2	13	ca	0	130	55	0	185
147.151788	70.044048	15 Jun 98	15:20:09	2	14	ca	0	2	2	0	4
147.271160	70.008565	15 Jun 98	15:32:43	2	15	ca	0	1	0	0	1
147.269307	70.031979	15 Jun 98	15:33:39	2	16	ca	0	12	5	0	17
147.273831	70.076079	15 Jun 98	15:35:22	2	17	ca	0	6	2	0	8
147.239374	70.083734	15 Jun 98	15:35:40	2	18	ca	0	7	0	0	7
147.271964	70.110247	15 Jun 98	15:36:40	2	20	ca	0	2	0	0	2
147.242127	70.130643	15 Jun 98	15:37:27	2	21	ca	0	0	0	1	1
147.262355	70.138593	15 Jun 98	15:37:46	2	22	ca	0	0	0	5	5
147.290479	70.090348	15 Jun 98	15:44:48	2	23	ca	0	11	7	0	18
147.309348	70.057014	15 Jun 98	15:45:57	2	24	ca	0	5	0	0	5
147.352015	70.029736	15 Jun 98	15:49:56	2	25	ca	2	6	0	0	8
147.325039	70.111347	15 Jun 98	15:53:08	2	26	ca	0	2	0	0	2

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
147.366719	70.088305	15 Jun 98	16:00:22	2	27	ca	0	0	0	6	6
147.378708	70.016684	15 Jun 98	16:02:51	2	28	ca	0	2	0	0	2
147.430357	70.030993	15 Jun 98	16:05:26	2	29	ca	0	1	0	0	1
147.429315	70.038185	15 Jun 98	16:05:43	2	30	ca	0	2	2	0	4
147.450924	70.104814	15 Jun 98	16:08:18	2	31	ca	0	2	0	0	2
147.440967	70.141730	15 Jun 98	16:09:44	2	32	ca	0	2	0	0	2
147.451463	70.179316	15 Jun 98	16:11:10	2	33	ca	0	3	3	0	6
147.467077	70.119211	15 Jun 98	16:15:12	2	34	ca	1	0	0	0	1
147.452686	70.040596	15 Jun 98	16:17:58	2	35	ca	0	0	0	2	2
147.477437	70.014967	15 Jun 98	16:18:52	2	36	ca	0	7	3	0	10
147.530476	70.027437	15 Jun 98	16:21:15	2	37	ca	0	30	11	0	41
147.493626	70.037410	15 Jun 98	16:21:39	2	38	ca	0	2	0	0	2
147.527762	70.086522	15 Jun 98	16:23:34	2	39	ca	0	12	5	0	17
147.497004	70.090670	15 Jun 98	16:23:44	2	40	ca	0	17	13	0	30
147.515926	70.111072	15 Jun 98	16:24:30	2	41	ca	0	4	1	0	5
147.513126	70.122655	15 Jun 98	16:24:58	2	42	ca	0	2	2	0	4
147.504637	70.126365	15 Jun 98	16:25:06	2	43	ca	0	1	1	0	2
147.528396	70.132715	15 Jun 98	16:25:20	2	44	ca	0	1	0	0	1
147.508414	70.140235	15 Jun 98	16:25:37	2	45	ca	0	2	2	0	4
147.510543	70.158193	15 Jun 98	16:26:18	2	46	ca	0	1	0	0	1
147.503269	70.178198	15 Jun 98	16:27:03	2	47	ca	0	1	1	0	2
147.535631	70.145244	15 Jun 98	16:30:34	2	48	ca	0	3	2	0	5
147.537757	70.130156	15 Jun 98	16:31:06	2	49	ca	0	1	1	0	2
147.536416	70.097486	15 Jun 98	16:32:16	2	50	ca	0	0	0	2	2
147.546833	70.044722	15 Jun 98	16:34:06	2	51	ca	0	1	0	0	1
147.547031	69.997854	15 Jun 98	16:35:45	2	52	ca	0	1	0	0	1
147.594040	70.031936	15 Jun 98	16:38:08	2	53	ca	0	21	17	0	38
147.615266	70.035687	15 Jun 98	16:38:15	2	209	ca	0	3	0	0	3
147.601891	70.102796	15 Jun 98	16:40:52	2	54	ca	0	6	5	0	11
147.606734	70.198697	15 Jun 98	16:44:24	2	55	ca	1	0	0	0	1
147.646215	70.159761	15 Jun 98	16:47:34	2	56	ca	0	5	4	0	9
147.645067	70.067012	15 Jun 98	16:50:51	2	57	ca	0	1	0	0	1
147.661106	70.050953	15 Jun 98	16:51:24	2	58	ca	0	2	0	0	2
147.677760	70.018998	15 Jun 98	17:27:19	2	59	ca	0	2	1	0	3
147.660585	70.053122	15 Jun 98	17:28:32	2	60	ca	0	0	0	1	1
147.667188	70.068225	15 Jun 98	17:29:06	2	61	ca	0	1	0	0	1
147.705293	70.118086	15 Jun 98	17:30:59	2	62	ca	0	0	0	1	1
147.725725	70.138644	15 Jun 98	17:37:01	2	63	ca	0	4	2	0	6
147.695416	70.117178	15 Jun 98	17:37:45	2	64	ca	0	1	1	0	2
147.695057	70.035822	15 Jun 98	17:40:34	2	65	ca	0	0	0	5	5

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
147.770047	70.020855	15 Jun 98	17:43:33	2	66	ca	0	2	2	0	4
147.772584	70.044000	15 Jun 98	17:44:26	2	67	ca	0	1	1	0	2
147.752174	70.077044	15 Jun 98	17:45:42	2	68	ca	0	0	0	1	1
147.756625	70.089932	15 Jun 98	17:46:17	2	69	ca	0	8	3	0	11
147.750297	70.112623	15 Jun 98	17:47:58	2	70	ca	0	1	1	0	2
147.753503	70.177683	15 Jun 98	17:50:22	2	71	ca	0	12	5	0	17
147.792974	70.098859	15 Jun 98	17:56:43	2	72	ca	0	0	0	1	1
147.875738	70.033152	15 Jun 98	18:02:14	2	73	ca	0	0	0	2	2
147.862140	70.122045	15 Jun 98	18:05:31	2	74	ca	0	4	3	0	7
147.836948	70.147315	15 Jun 98	18:06:27	2	75	ca	0	4	1	0	5
147.860678	70.151568	15 Jun 98	18:06:36	2	76	ca	0	1	0	0	1
147.878103	70.160058	15 Jun 98	18:06:55	2	77	ca	0	4	2	0	6
147.844156	70.182792	15 Jun 98	18:07:44	2	78	ca	0	4	3	0	7
147.876562	70.197291	15 Jun 98	18:11:36	2	79	ca	0	0	0	6	6
147.875765	70.158517	15 Jun 98	18:12:55	2	80	ca	0	2	2	0	4
147.870384	70.147148	15 Jun 98	18:13:19	2	81	ca	0	2	1	0	3
147.896117	70.129217	15 Jun 98	18:13:55	2	82	ca	0	5	5	0	10
147.877833	70.124897	15 Jun 98	18:14:03	2	83	ca	0	4	2	0	6
147.911033	70.116479	15 Jun 98	18:14:20	2	84	ca	0	1	0	0	1
147.881144	70.086904	15 Jun 98	18:15:19	2	85	ca	0	1	1	0	2
147.874896	70.058328	15 Jun 98	18:16:16	2	86	ca	0	3	1	0	4
147.911571	70.047620	15 Jun 98	18:16:37	2	87	ca	0	28	20	0	48
147.883026	70.015726	15 Jun 98	18:17:42	2	88	ca	0	10	7	0	17
147.919584	70.011010	15 Jun 98	18:17:51	2	89	ca	0	3	2	0	5
147.917535	70.020956	15 Jun 98	18:19:57	2	90	ca	0	4	3	0	7
147.957582	70.096800	15 Jun 98	18:22:44	2	91	ca	0	0	0	2	2
147.914870	70.100533	15 Jun 98	18:22:52	2	92	ca	0	9	5	0	14
147.918448	70.150574	15 Jun 98	18:24:42	2	93	ca	0	7	2	0	9
147.956054	70.178737	15 Jun 98	18:25:43	2	94	ca	0	1	1	0	2
147.917054	70.189248	15 Jun 98	18:26:06	2	95	ca	0	2	2	0	4
147.966531	70.121794	15 Jun 98	18:33:39	2	96	ca	0	6	4	0	10
148.001723	70.113347	15 Jun 98	18:33:56	2	97	ca	0	2	1	0	3
147.987273	70.045978	15 Jun 98	18:36:13	2	98	ca	0	2	0	0	2
147.964003	70.000499	15 Jun 98	18:38:13	2	99	ca	0	26	13	0	39
148.043200	70.012639	15 Jun 98	18:40:28	2	100	ca	0	2	2	0	4
148.046174	70.052409	15 Jun 98	18:41:56	2	101	ca	0	7	3	0	10
148.000681	70.119500	15 Jun 98	18:44:23	2	102	ca	0	6	0	0	6
148.031153	70.130369	15 Jun 98	18:44:46	2	103	ca	0	3	0	0	3
148.026985	70.248785	15 Jun 98	18:49:03	2	104	ca	1	0	0	0	1
148.046624	70.231349	15 Jun 98	18:52:56	2	105	ca	0	2	0	0	2

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
148.043647	70.114933	15 Jun 98	18:56:51	2	106	ca	0	0	0	2	2
148.100541	70.128887	15 Jun 98	19:06:39	2	107	ca	0	11	0	0	11
148.086854	70.208867	15 Jun 98	19:09:44	2	108	ca	0	0	0	1	1
147.011030	70.153325	30 Jun 98	12:36:21	3	2	ca	0	2	0	0	2
147.591832	70.209756	30 Jun 98	14:26:00	3	5	ca	20	15	8	0	43
147.652008	70.205615	30 Jun 98	14:27:43	3	6	ca	45	220	12	0	277
147.946621	70.304038	30 Jun 98	16:25:06	3	7	ca	0	1	1	0	2
148.043188	70.309433	30 Jun 98	16:49:43	3	9	ca	0	12	6	0	18
148.126314	70.341654	30 Jun 98	17:15:10	3	12	ca	0	8	1	0	9
148.140700	70.326900	30 Jun 98		3	113	ca	0	0	0	85	85
147.051729	70.085519	9 Jul 98	16:13:41	4	1	ca	5	60	20	0	85
147.089288	70.058540	9 Jul 98	16:19:47	4	2	ca	1	0	0	0	1
147.069795	70.071126	9 Jul 98	16:20:16	4	3	ca	8	2	2	0	12
147.098930	70.076851	9 Jul 98	16:20:30	4	4	ca	0	1	1	0	2
147.105189	70.116413	9 Jul 98	16:22:04	4	5	ca	15	80	40	0	135
147.113324	70.112196	9 Jul 98	16:25:38	4	6	ca	0	0	0	12	12
147.140437	70.090184	9 Jul 98	16:26:23	4	7	ca	25	250	150	0	425
147.120060	70.085479	9 Jul 98	16:26:33	4	8	ca	0	1	1	0	2
147.180707	70.028068	9 Jul 98	16:31:16	4	9	ca	2	0	0	0	2
147.183480	70.054487	9 Jul 98	16:32:19	4	10	ca	40	250	125	0	415
147.195477	70.057592	9 Jul 98	16:32:27	4	11	ca	25	85	45	0	155
147.190240	70.057592	9 Jul 98	16:32:27	4	12	ca	15	65	20	0	100
147.195477	70.057592	9 Jul 98	16:32:27	4	13	ca	0	3	3	0	6
147.191721	70.083178	9 Jul 98	16:33:36	4	151	ca	0	5	3	0	8
147.149278	70.084092	9 Jul 98	16:33:47	4	14	ca	100	275	125	0	500
147.206599	70.219835	9 Jul 98	16:40:47	4	15	ca	0	6	4	0	10
147.198985	70.084569	9 Jul 98	16:45:31	4	16	ca	45	180	100	0	325
147.278864	70.074185	9 Jul 98	16:52:07	4	17	ca	0	1	1	0	2
147.271688	70.132270	9 Jul 98	16:54:28	4	18	ca	15	0	0	0	15
147.297474	70.118332	9 Jul 98	17:00:55	4	19	ca	3	0	0	0	3
147.367316	70.068437	9 Jul 98	17:08:52	4	20	ca	0	25	10	0	35
147.362749	70.119908	9 Jul 98	17:10:53	4	21	ca	2	20	12	0	34
147.600875	70.107568	9 Jul 98	17:57:04	4	23	ca	40	85	35	0	160
147.613967	70.107568	9 Jul 98	17:57:04	4	24	ca	0	13	0	0	13
147.652812	70.150386	9 Jul 98	18:03:28	4	25	ca	2	3	1	0	6
147.621405	70.046814	9 Jul 98	18:07:06	4	26	ca	0	0	0	1	1
147.719833	70.114310	9 Jul 98	18:20:55	4	27	ca	0	1	0	0	1
147.802871	70.183730	9 Jul 98	19:08:44	4	28	ca	0	2	0	0	2
147.872912	70.095993	9 Jul 98	19:19:05	4	29	ca	0	5	1	0	6
147.866517	70.151751	9 Jul 98	19:21:13	4	30	ca	2	0	0	0	2

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
147.920920	70.097945	9 Jul 98	19:42:03	4	31	ca	4	25	20	0	49
147.962720	70.155831	9 Jul 98	19:44:14	4	32	ca	0	22	12	0	34
147.930593	70.167438	9 Jul 98	19:44:39	4	33	ca	0	0	0	12	12
147.927353	70.183884	9 Jul 98	19:45:17	4	34	ca	0	4	1	0	5
147.984582	70.199223	9 Jul 98	19:54:48	4	35	ca	0	9	5	0	14
147.973992	70.178243	9 Jul 98	19:55:30	4	36	ca	0	1	1	0	2
147.961067	70.142656	9 Jul 98	19:56:43	4	37	ca	0	0	0	20	20
147.962805	70.112317	9 Jul 98	19:57:45	4	38	ca	0	1	0	0	1
148.049694	70.121000	9 Jul 98	20:06:41	4	39	ca	0	0	0	10	10
148.036306	70.134232	9 Jul 98	20:07:10	4	40	ca	0	1	0	0	1
148.042354	70.150728	9 Jul 98	20:07:48	4	42	ca	0	1	0	0	1
148.036704	70.166639	9 Jul 98	20:08:24	4	43	ca	4	2	0	1	7
148.009871	70.251605	9 Jul 98	20:11:36	4	45	ca	1	0	0	0	1
148.046627	70.245452	9 Jul 98	20:17:27	4	46	ca	0	0	0	7	7
148.083587	70.181453	9 Jul 98	20:19:37	4	47	ca	5	0	0	0	5
148.130007	70.123310	9 Jul 98	20:31:01	4	48	ca	0	2	0	0	2
148.116190	70.127663	9 Jul 98	20:31:11	4	49	ca	0	4	0	0	4
148.122182	70.226286	9 Jul 98	20:34:53	4	50	ca	1	0	0	0	1
147.003051	70.138886	16 Jul 98	17:43:22	5	1	ca	0	1	0	0	1
147.038645	70.129459	16 Jul 98	17:45:22	5	2	ca	1	0	0	0	1
147.060439	70.109878	16 Jul 98	17:46:01	5	3	ca	0	1	0	0	1
147.160230	70.131822	16 Jul 98	17:58:16	5	4	ca	0	0	0	60	60
147.177148	70.111135	16 Jul 98	18:07:52	5	5	ca	1	0	0	0	1
147.168480	70.132371	16 Jul 98	18:08:41	5	6	ca	0	1	0	0	1
147.216519	70.095458	16 Jul 98	18:17:44	5	7	ca	0	1	0	0	1
147.259787	70.075353	16 Jul 98	18:24:42	5	8	ca	1	0	0	0	1
147.268668	70.170812	16 Jul 98	18:28:16	5	9	ca	0	2	2	0	4
147.294172	70.123148	16 Jul 98	18:32:59	5	10	ca	0	1	0	0	1
147.386417	70.185201	16 Jul 98	18:48:04	5	11	ca	110	700	300	0	1,110
147.456012	70.189366	16 Jul 98	19:04:26	5	12	ca	50	150	60	0	260
147.504986	70.200156	16 Jul 98	19:19:58	5	13	ca	40	200	70	0	310
147.624226	70.188435	16 Jul 98	19:39:00	5	14	ca	0	0	0	2	2
147.682503	70.022982	16 Jul 98	19:46:23	5	15	ca	0	1	0	0	1
147.662147	70.066632	16 Jul 98	19:48:00	5	17	ca	0	1	0	0	1
147.697369	70.019565	16 Jul 98	19:59:47	5	18	ca	0	1	1	0	2
147.790102	70.181739	16 Jul 98	20:30:22	5	19	ca	0	0	0	50	50
147.801716	70.193160	16 Jul 98	20:38:22	5	20	ca	120	450	150	0	720
147.819974	70.177835	16 Jul 98	20:42:06	5	21	ca	55	275	100	0	430
147.791679	70.128164	16 Jul 98	20:45:25	5	22	ca	0	1	0	0	1
147.835446	70.211402	16 Jul 98	20:58:04	5	23	ca	0	1	0	0	1

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
147.856989	70.216927	16 Jul 98	20:58:17	5	24	ca	0	1	0	0	1
147.838949	70.219762	16 Jul 98	20:58:23	5	25	ca	0	1	1	0	2
147.917827	70.197371	16 Jul 98	21:05:22	5	26	ca	0	0	0	2	2
147.941860	70.172190	16 Jul 98	21:18:58	5	27	ca	10	35	15	0	60
147.925019	70.208362	16 Jul 98	21:20:20	5	28	ca	1	0	0	0	1
147.977110	70.286509	16 Jul 98	21:26:07	5	29	ca	0	3	1	0	4
147.985907	70.282046	16 Jul 98	21:26:17	5	30	ca	0	10	3	0	13
147.999000	70.282046	16 Jul 98	21:26:17	5	31	ca	40	110	0	50	200
148.000529	70.251755	16 Jul 98	21:27:20	5	32	ca	0	0	0	45	45
148.000395	70.240997	16 Jul 98	21:27:42	5	33	ca	0	0	0	55	55
148.002842	70.188122	16 Jul 98	21:29:30	5	34	ca	0	0	0	100	100
147.770400	70.191819	16 Jul 98	20:30:45	5	141	ca	2	0	0	0	2
147.959198	70.149300	16 Jul 98	21:30:48	5	35	ca	0	4	3	0	7
148.018637	70.192820	16 Jul 98	21:43:13	5	36	ca	65	200	75	0	340
148.041226	70.248606	16 Jul 98	21:48:17	5	142	ca	65	140	54	0	259
148.010832	70.294334	16 Jul 98	21:50:34	5	38	ca	0	3	0	0	3
148.089591	70.196606	16 Jul 98	22:10:58	5	39	ca	0	1	0	0	1
148.093176	70.252501	16 Jul 98	22:13:04	5	40	ca	2	0	0	0	2
147.018345	70.021928	22 Jul 98	13:19:24	6	1	ca	0	1	0	0	1
147.355923	70.065986	22 Jul 98	14:21:55	6	2	ca	0	1	0	0	1
147.327665	70.067291	22 Jul 98	14:21:58	6	155	ca	0	10	4	0	14
147.331223	70.188713	22 Jul 98	14:26:25	6	3	ca	6	25	15	0	46
147.368310	70.116902	22 Jul 98	14:30:06	6	4	ca	1	0	0	0	1
147.435218	70.014823	22 Jul 98	14:35:18	6	5	ca	0	1	0	0	1
147.509472	70.186735	22 Jul 98	14:57:27	6	6	ca	150	650	300	0	1,100
147.502052	70.199174	22 Jul 98	15:00:07	6	7	ca	1	2	0	0	3
147.609472	70.172164	22 Jul 98	15:01:53	6	8	ca	260	1,500	400	0	2,160
147.635205	70.200009	22 Jul 98	15:07:09	6	9	ca	250	920	315	0	1,485
147.659360	70.160240	22 Jul 98	15:28:51	6	10	ca	1	0	0	0	1
147.636378	70.082104	22 Jul 98	15:31:38	6	11	ca	0	1	0	0	1
147.722302	70.201374	22 Jul 98	15:43:44	6	13	ca	15	75	25	0	115
147.696026	70.170512	22 Jul 98	15:44:49	6	14	ca	0	1	0	0	1
147.768542	70.099852	22 Jul 98	16:26:43	6	15	ca	0	1	1	0	2
147.751907	70.176406	22 Jul 98	16:29:28	6	16	ca	0	5	2	0	7
147.791031	70.212801	22 Jul 98	16:30:48	6	17	ca	0	1	0	0	1
147.808294	70.249466	22 Jul 98	16:35:36	6	18	ca	0	3	1	0	4
147.817220	70.223210	22 Jul 98	16:36:32	6	19	ca	4	0	0	0	4
147.872172	70.205529	22 Jul 98	16:58:13	6	20	ca	0	12	10	0	22
147.840011	70.222131	22 Jul 98	16:58:48	6	156	ca	2	1	1	0	4
147.877088	70.231970	22 Jul 98	16:59:10	6	21	ca	0	0	0	12	12

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
147.860113	70.235237	22 Jul 98	16:59:17	6	22	ca	0	2	0	0	2
147.909027	70.250047	22 Jul 98	17:04:13	6	23	ca	0	5	2	0	7
147.886941	70.245053	22 Jul 98	17:04:23	6	24	ca	1	1	0	0	2
147.886436	70.227685	22 Jul 98	17:04:58	6	25	ca	0	1	0	0	1
147.946793	70.175032	22 Jul 98	17:19:36	6	26	ca	0	2	0	0	2
147.951839	70.189285	22 Jul 98	17:20:06	6	27	ca	0	0	0	75	75
147.923859	70.206517	22 Jul 98	17:20:42	6	157	ca	0	0	0	15	15
147.945636	70.230771	22 Jul 98	17:21:37	6	28	ca	0	30	10	0	40
147.926101	70.242129	22 Jul 98	17:22:02	6	29	ca	2	7	3	0	12
147.930157	70.246406	22 Jul 98	17:22:11	6	30	ca	2	3	0	0	5
147.958530	70.267452	22 Jul 98	17:22:57	6	31	ca	0	1	0	0	1
147.919657	70.278535	22 Jul 98	17:23:21	6	32	ca	0	0	0	120	120
147.917020	70.285448	22 Jul 98	17:23:37	6	33	ca	0	0	0	250	250
147.992623	70.252855	22 Jul 98	17:27:32	6	34	ca	15	40	15	0	70
147.988663	70.248530	22 Jul 98	17:27:41	6	35	ca	3	8	2	0	13
147.978189	70.248530	22 Jul 98	17:27:41	6	36	ca	0	3	2	0	5
147.987314	70.203514	22 Jul 98	17:29:12	6	37	ca	0	0	5	25	30
147.962259	70.199018	22 Jul 98	17:29:22	6	38	ca	4	0	5	0	9
147.975352	70.199018	22 Jul 98	17:29:22	6	39	ca	25	10	0	0	35
147.967496	70.199018	22 Jul 98	17:29:22	6	40	ca	10	65	45	0	120
148.042573	70.113906	22 Jul 98	17:40:48	6	41	ca	0	1	0	0	1
148.030966	70.189800	22 Jul 98	17:43:38	6	42	ca	140	250	100	0	490
148.000302	70.204256	22 Jul 98	17:44:10	6	158	ca	10	45	15	0	70
148.023682	70.227780	22 Jul 98	17:44:59	6	43	ca	0	0	0	10	10
148.037353	70.232711	22 Jul 98	17:45:09	6	44	ca	0	3	0	0	3
148.082640	70.243809	22 Jul 98	17:52:00	6	45	ca	5	10	4	0	19
148.047986	70.239309	22 Jul 98	17:52:09	6	46	ca	0	0	0	8	8
148.071201	70.223806	22 Jul 98	17:52:40	6	47	ca	0	2	2	0	4
148.075370	70.219064	22 Jul 98	17:52:50	6	48	ca	0	20	10	0	30
148.076137	70.213039	22 Jul 98	17:53:02	6	49	ca	0	0	15	45	60
148.095282	70.184030	22 Jul 98	17:53:58	6	50	ca	0	0	0	250	250
148.115564	70.183773	22 Jul 98	18:07:17	6	51	ca	0	3	0	0	3
148.116904	70.204728	22 Jul 98	18:08:05	6	52	ca	20	90	50	0	160
148.105060	70.211886	22 Jul 98	18:08:21	6	159	ca	15	30	25	0	70
148.120473	70.263590	22 Jul 98	18:10:16	6	53	ca	1	0	0	0	1
148.101160	70.267534	22 Jul 98	18:10:24	6	54	ca	1	0	0	0	1
147.116764	70.101185	11 Aug 98	12:37:32	7	2	ca	1	0	0	0	1
147.250005	70.195489	11 Aug 98	12:58:04	7	3	ca	1	0	0	0	1
147.493211	70.161185	11 Aug 98	14:06:02	7	7	ca	0	1	0	0	1
147.661434	69.996602	11 Aug 98	14:15:43	7	9	ca	0	0	0	1	1

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
147.695437	70.182571	11 Aug 98	14:45:46	7	11	ca	0	1	0	0	1
147.776423	70.031055	11 Aug 98	14:48:52	7	14	ca	1	0	0	0	1
147.796022	70.154275	11 Aug 98	14:51:25	7	15	ca	0	1	0	0	1
147.800272	70.053772	11 Aug 98	14:59:58	7	16	ca	0	1	1	0	2
147.818784	70.013344	11 Aug 98	15:14:51	7	17	ca	0	1	0	0	1
147.853020	70.166464	11 Aug 98	15:18:34	7	18	ca	1	0	0	0	1
147.876059	70.173674	11 Aug 98	15:20:03	7	19	ca	0	0	0	1	1
147.904362	70.152407	11 Aug 98	15:26:57	7	20	ca	0	1	1	0	2
147.953723	70.187163	11 Aug 98	15:36:24	7	21	ca	0	1	1	0	2
147.960440	70.234785	11 Aug 98	15:37:11	7	22	ca	0	1	1	0	2
147.992312	70.058364	11 Aug 98	15:49:47	7	23	ca	0	1	1	0	2
147.975401	70.018352	11 Aug 98	15:51:22	7	24	ca	0	1	0	0	1
148.007545	70.082475	11 Aug 98	16:03:34	7	25	ca	0	1	0	0	1
148.070107	70.246551	11 Aug 98	16:05:03	7	26	ca	0	1	1	0	2
148.097383	70.241768	11 Aug 98	16:20:41	7	28	ca	0	2	0	0	2

Table A-2. Muskoxen (mx), moose (mo), brown bear (bb), and Arctic fox den (fd) sightings in the Badami study area, Alaska, summer 1998. Coordinates are longitude, latitude, and datum is WGS 84.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
147.952030	70.117650	10 Jun 98	17:03:00	1	18	mx	1	0	0	0	1
147.822671	70.028438	10 Jun 98	17:33:00	1	32	bb	0	0	0	2	2
147.701980	70.033134	10 Jun 98	18:08:59	1	50	mx	1	2	0	0	3
147.648012	70.076055	10 Jun 98	18:14:16	1	56	mx	0	0	0	7	7
147.366095	70.026246	10 Jun 98	19:17:41	1	79	mx	0	0	0	18	18
147.240530	70.103374	10 Jun 98	20:02:33	1	82	mx	0	0	0	1	1
147.252769	70.098567	15 Jun 98	15:36:14	2	19	mx	0	0	0	1	1
147.335623	70.167398	30 Jun 98	13:38:09	3	4	mx	2	16	7	0	25
148.027004	70.159099	30 Jun 98	16:43:48	3	8	mx	0	0	0	3	3
148.066126	70.094545	30 Jun 98	16:58:12	3	10	mx	1	7	0	0	8
147.583160	70.103722	9 Jul 98	17:56:55	4	22	mx	2	14	7	0	23
148.022490	70.146555	9 Jul 98	20:07:38	4	41	mo	0	0	0	1	1
148.021275	70.181242	9 Jul 98	20:08:58	4	44	mx	0	0	0	9	9
147.675882	70.040311	16 Jul 98	19:47:01	5	16	mx	3	0	0	15	18
147.704892	70.040181	22 Jul 98	15:36:39	6	12	mx	0	0	3	18	21
147.386726	70.184691	11 Aug 98	13:28:56	7	5	mx	1	0	8	11	20
147.465434	70.069475	11 Aug 98	13:46:16	7	6	fd	0	0	0	1	1
147.522990	70.180423	11 Aug 98	14:15:03	7	8	fd	0	0	0	1	1
147.670586	70.092360	11 Aug 98	14:41:46	7	10	fd	0	0	0	1	1
148.064562	70.204605	11 Aug 98	16:09:15	7	27	fd	0	0	0	1	1

Table A-3. Opportunistic large mammal sightings recorded while conducting surveys of the Badami study area, Alaska, summer 1998. Coordinates are longitude, latitude, and datum is WGS 84.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
147.497987	69.989024	10 Jun 98	18:46:35	1	70	mx	0	0	6	31	37
147.666559	69.991086	9 Jul 98	18:09:09	4	152	mo	0	0	0	1	1
147.339202	70.035763	22 Jul 98	13:13:37	6	160	bb	0	0	0	1	1

APPENDIX B. MOSQUITO AND OESTRID ACTIVITY INDICES

MOSQUITO ACTIVITY INDEX

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 $WI_m = 0$
$WI_m = (6\text{-wind})/6$
$I_m = TI_m \times WI_m$
where:

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

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

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

Syntax was:

IF (logical test, value if true, value if false)
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 $I_m = TI_m \times WI_m$

OESTRID ACTIVITY INDEX

IF temperature >18°C THEN $TI_o = 1$
IF temperature <13°C THEN $TI_o = 0$
$TI_o = 1-((18\text{-temperature})/10)$
$WI_o = (9\text{-wind})/9$
$I_o = TI_o \times WI_o$
where:

TI_o = Temperature Index for Oestrids
WI_o = Wind Index for Oestrids
I_o = Oestrid Activity Index
T_h = Temperature in °C recorded hourly at Deadhorse Weather Station
V_h = Wind velocity in mps recorded hourly at Deadhorse Weather Station

These parameters were translated into IF statements for TI_o and WI_o which were then multiplied to give I_o. Syntax was:

TI_o = IF (T_h <13, 0, IF(T_h >18, 1, (1-((18-T_h)/10))))
WI_o = IF (V_h >9, 0, ((9-V_h)/9))

Table B-1. Daily average temperature and wind velocity recorded at the Deadhorse Weather Station (ASCC 1998), with tabulations of hourly mosquito and oestrid activity indices (Russel et al. 1993). Daily totals of ≥4 hours with either mosquito or oestrid indices ≥0.5 were considered "insect days" (Cameron et al. 1995).

				Mosquito Index		Oestrid Index	
Date	Mean Temperature °C	Mean Wind Speed (mps)	*n*	Number of Records <0.5	Number of Records ≥0.5	Number of Records <0.5	Number of Records ≥0.5
1-Jun-98	9.29	4.84	24	24	0	24	0
2-Jun-98	4.89	4.52	19	19	0	19	0
3-Jun-98	7.62	4.43	21	21	0	21	0
4-Jun-98	3.65	9.42	23	23	0	23	0
5-Jun-98	3.35	5.09	20	20	0	20	0
6-Jun-98	4.67	4.97	6	6	0	6	0
7-Jun-98	6.29	5.87	24	24	0	24	0
8-Jun-98	3.05	6.38	22	22	0	22	0
9-Jun-98	0.94	6.61	19	19	0	19	0
10-Jun-98	1.05	4.40	22	22	0	22	0
11-Jun-98	3.25	6.36	22	22	0	21	1
12-Jun-98	4.63	9.61	19	19	0	19	0
13-Jun-98	3.04	11.29	23	23	0	23	0
14-Jun-98	3.71	9.90	21	21	0	21	0
15-Jun-98	4.55	5.48	20	20	0	20	0
16-Jun-98	4.63	10.63	24	24	0	24	0
17-Jun-98	2.96	9.65	24	24	0	24	0
18-Jun-98	4.79	5.66	24	24	0	24	0
19-Jun-98	6.95	4.22	19	19	0	19	0
20-Jun-98	11.41	4.93	22	22	0	22	0
21-Jun-98	9.04	5.32	23	23	0	23	0
22-Jun-98	4.80	11.52	5	5	0	5	0
23-Jun-98	4.40	10.83	20	20	0	20	0
24-Jun-98	3.40	10.57	20	20	0	20	0
25-Jun-98	4.10	9.77	21	21	0	21	0
26-Jun-98	5.59	5.42	22	22	0	22	0
27-Jun-98	10.61	3.24	23	23	0	23	0
28-Jun-98	15.17	4.18	24	24	0	23	1
29-Jun-98	16.91	4.23	22	21	1	16	6
30-Jun-98	14.27	4.56	22	21	1	19	3
1-Jul-98	10.95	7.03	21	21	0	21	0
2-Jul-98	11.16	3.44	19	19	0	19	0
3-Jul-98	11.29	4.95	24	23	1	22	2

Table B-1. Continued.

Date	Mean Temperature °C	Mean Wind Spead (mps)	*n*	Mosquito Index Number of Records <0.5	Mosquito Index Number of Records ≥0.5	Oestrid Index Number of Records <0.5	Oestrid Index Number of Records ≥0.5
4-Jul-98	13.29	4.78	24	24	0	23	1
5-Jul-98	13.36	3.60	22	22	0	18	4
6-Jul-98	9.17	4.69	18	18	0	18	0
7-Jul-98	7.76	7.02	17	17	0	17	0
8-Jul-98	9.00	10.26	21	21	0	21	0
9-Jul-98	9.14	10.73	22	22	0	22	0
10-Jul-98	9.32	9.45	22	22	0	22	0
11-Jul-98	9.00	8.92	21	21	0	21	0
12-Jul-98	9.09	10.76	22	22	0	22	0
13-Jul-98	7.50	10.19	10	10	0	10	0
14-Jul-98	8.15	7.99	13	13	0	13	0
15-Jul-98	14.21	3.95	19	19	0	17	2
16-Jul-98	11.00	7.24	12	12	0	12	0
17-Jul-98	10.86	7.72	21	21	0	21	0
18-Jul-98	11.20	2.85	15	15	0	15	0
19-Jul-98	12.65	2.03	20	15	5	14	6
20-Jul-98	11.39	7.34	18	18	0	18	0
21-Jul-98	9.75	7.20	20	20	0	20	0
22-Jul-98	10.13	7.99	15	15	0	15	0
23-Jul-98	8.69	12.06	16	16	0	16	0
24-Jul-98	8.72	10.35	18	18	0	18	0
25-Jul-98	7.89	9.43	18	18	0	18	0
26-Jul-98	10.71	5.92	24	24	0	24	0
27-Jul-98	11.73	3.13	22	18	4	18	4
28-Jul-98	15.76	3.04	21	18	3	11	10
29-Jul-98	12.90	5.32	21	21	0	21	0
30-Jul-98	15.92	6.34	12	12	0	12	0
31-Jul-98	9.57	5.46	23	23	0	23	0
1-Aug-98	13.37	4.22	19	18	1	14	5
2-Aug-98	17.06	5.89	18	18	0	18	0
3-Aug-98	13.43	5.75	23	23	0	23	0
4-Aug-98	9.26	4.34	23	23	0	23	0
5-Aug-98	10.32	5.75	22	22	0	22	0
6-Aug-98	9.83	7.98	23	23	0	23	0
7-Aug-98	10.00	5.61	20	20	0	20	0
8-Aug-98	10.54	3.54	24	24	0	24	0

Table B-1. Continued.

Date	Mean Temperature °C	Mean Wind Spead (mps)	*n*	Mosquito Index Number of Records <0.5	Mosquito Index Number of Records ≥0.5	Oestrid Index Number of Records <0.5	Oestrid Index Number of Records ≥0.5
9-Aug-98	9.82	2.76	22	22	0	22	0
10-Aug-98	10.29	3.09	21	21	0	21	0
11-Aug-98	12.70	3.65	23	20	3	20	3
12-Aug-98	13.17	2.76	24	20	4	21	3
12-Aug-98	13.17	2.76	24	20	4	21	3
13-Aug-98	15.29	3.43	24	17	7	13	11
14-Aug-98	12.48	6.27	21	21	0	21	0
15-Aug-98	9.46	6.69	24	24	0	24	0
16-Aug-98	6.23	5.35	22	22	0	22	0
17-Aug-98	5.74	3.87	23	23	0	23	0
18-Aug-98	7.78	5.46	23	23	0	23	0
19-Aug-98	12.17	6.04	23	23	0	23	0
20-Aug-98	14.25	5.70	24	24	0	24	0
21-Aug-98	8.25	6.28	24	24	0	24	0
22-Aug-98	8.71	5.68	24	24	0	24	0
23-Aug-98	7.52	6.40	23	23	0	23	0
24-Aug-98	9.00	5.93	21	21	0	21	0
25-Aug-98	8.42	3.13	24	24	0	24	0
26-Aug-98	9.52	6.20	23	23	0	23	0
27-Aug-98	8.63	7.27	24	24	0	24	0
28-Aug-98	8.55	5.38	22	22	0	22	0
29-Aug-98	7.31	5.50	16	16	0	16	0
30-Aug-98	5.63	5.40	24	24	0	24	0