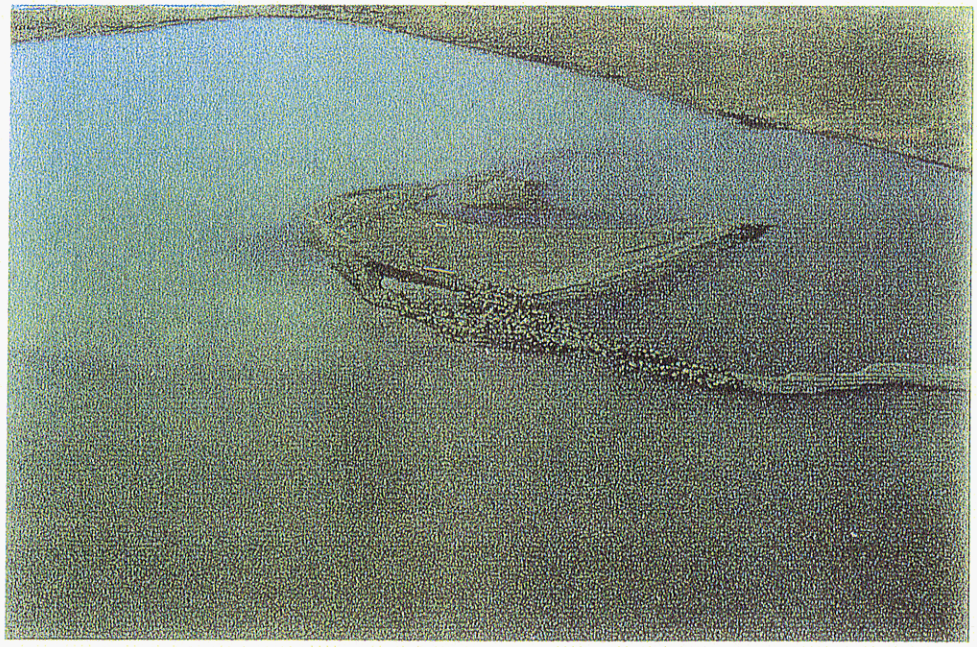
LGL
Project #: P421

FINAL REPORT
26 May 1999

Bullen Point to Staines River Large Mammal Distribution, Summer 1998



Prepared by

LGL ALASKA RESEARCH ASSOCIATES, INC.
4175 Tudor Centre Drive, Suite 202
Anchorage, Alaska 99508

Prepared for

BP EXPLORATION (ALASKA) INC.
Environmental and Regulatory Affairs Department
P.O. Box 196612
Anchorage, Alaska 99519-6612

FINAL REPORT
26 May 1999

Bullen Point to Staines River Large Mammal Distribution, Summer 1998

by
Lynn E. Noel
and
Tamara L. Olson

LGL ALASKA RESEARCH ASSOCIATES, INC.
4175 Tudor Centre Drive, Suite 202
Anchorage, Alaska 99508

Prepared for

BP EXPLORATION (ALASKA) INC.
Environmental and Regulatory Affairs Department
P.O. Box 196612
Anchorage, Alaska 99519-6612

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Large mammal distribution was documented from Bullen Point on the west to the Staines/Canning River on the east and from the Beaufort Sea coast on the north to 69° 54.5' N latitude, on the North Slope, Alaska. Seven 100% coverage systematic strip-transect surveys were flown from 12 June to 10 August 1998. During the caribou calving period surveys, caribou numbers within the study area ranged from 2,495 on 12 June (15.1 caribou/group) to 2,591 on 19 June (30.1 caribou/group). Sex-age composition of classified caribou for the combined calving period surveys was 62% cows, and 38% calves. Calf production was 69 calves/100 cows on 12 June and 56 calves/100 cows on 19 June 1998. The distribution of cow/calf caribou pairs between 1 June and 20 June has varied by year since surveys were initiated in 1993. Calving period distribution may reflect survey timing and/or spring snow and flood patterns. In all study years the northeastern portion of the Bullen Point to Staines River study area did not appear to be heavily used by calving caribou. During the post-calving period, caribou numbers within the study area ranged from 1 on 10 August to 2714 on 6 July 1998 (387.7 caribou/group). Sex-age composition of classified caribou for the combined post-calving period surveys was 23% bulls, 54% cows, and 23% calves. Coastal caribou distributions within the study area during the post-calving period appeared to concentrate in areas southeast of Bullen Point and south of Point Thomson, when 4 years of data were combined. Other species observed included 2 brown bears during the 12 June survey and muskoxen groups that ranged in size from 2 (12 June) to 17 animals (10 August).

Key words: Caribou, *Rangifer tarandus*, Alaska, Central Arctic Herd, oil field, muskoxen, North Slope, *Ovibos moschatus*

INTRODUCTION

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). PCH studies 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 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 2 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 high-density calving concentration areas 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 a broad area along the Arctic Coastal Plain between the Colville and Canning rivers for summer range (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). Lawhead and Curatolo (1984) reported that large aggregations of caribou sought relief on or near deltas of the Kuparuk, Shaviovik, and Canning rivers during intense insect harassment; although caribou groups were observed along the coast within the entire Oliktok Point to Canning River area.

Other large mammal species that occur between the Sagavanirktok and Staines rivers include muskoxen, moose, and brown bears. By the late 1800s, muskoxen were exterminated from the North Slope of Alaska and little is known about historic levels (Clough et al. 1987). Muskoxen were reintroduced into ANWR in 1969 and 1970 and the population has grown exponentially since 1974. Mixed-sex herds have dispersed into areas east of the Aichilik River (Clough et al. 1987). 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). Muskoxen are non-migratory, but 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 brown 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 Bullen Point to Staines River study area include: (a) displacement of caribou from traditional calving and post-calving habitats, or blocked access to such habitats; (b) reduced nutritional status and reproduction of female caribou due to stress and loss of habitat; (c) blockage of westward movements of the PCH from ANWR or blockage of North-south or eastward movements of the CAH into ANWR by roads, pipelines, or other facilities and oil field activities; and (d) blockage of northward movements to the Beaufort Sea coast by roads, pipelines, or other facilities and oil field activities. Pre-development data needed to assess development impacts include (a) distribution and abundance of caribou in the Bullen Point to Staines River area, and (b) reproductive status of caribou in the Bullen Point to Staines River area.

Objectives

During 1998, LGL Alaska Research Associates, Inc. (LGL) conducted systematic aerial surveys of large mammals within the area from Bullen Point to the Staines River to the east of Prudhoe Bay, Alaska. Effort focused on calving and post-calving caribou distribution within the study area. Our objectives during 1998 were 1) to determine the number, sex/age composition, and distribution of caribou and the distribution of other large mammals during the calving and post-calving seasons, and 2) to compare distribution and abundance with the adjacent Badami study area, between the Sagavanirktok River and Bullen Point (Fig. 1).

Study Area

The study area was bounded on the west by Bullen Point, extended east to the Staines River, north to the Beaufort Sea, and south to approximately 69° 54.5' latitude (Fig. 1). The Bullen Point to Staines River study area included transect numbers 48 to 70 (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 within five miles of the coast has little relief. Further inland the landscape begins a gradual assent from 25 feet above sea level to 350 feet above sea level at the southern edge of the study area, about 24 miles inland. Contours within the study area form concentric bands oriented north-northwest. This area has been referred to as the Canning alluvial fan, formed by sediment deposition from the Canning River. Vegetation in the southern portion of the study area is a mixture of dry or moist herbaceous tundra and wet herbaceous tundra. Moisture increases to the east, approaching the Canning River, and toward the coast (U.S. Geological Survey, Alaska Vegetation and Land Cover Series, Mt. Michelson Quadrangle, Map L-206).

METHODS

Aerial Surveys

During summer 1998, 7 systematic, strip-transect aerial surveys (Caughley 1977) were conducted from a Cessna 206 fixed-wing aircraft. Two observers recorded mammal sightings. Transect centerlines were spaced at 1.6 km intervals, providing for 100% study area coverage. 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 48 to 70, Fig. 1) were flown during each of 7 surveys. Systematic surveys were flown 90 m above ground level at approximately 115 km/hr airspeed. During surveys, 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 by comparison to survey maps. Species, number, sex/age composition, and group location were recorded for each observation.

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 record the location of the aircraft when animals were observed. Coordinates of animal sightings were calculated by 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 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 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 and circled the group to facilitate counting and classifying. The GPS allowed the aircraft to return to the point of departure from the transect, and no survey coverage was lost as a consequence of transect departures. Muskoxen were classified as adult (unclassified) or juvenile (calves), and brown bears were classified as adults or females with cubs.

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 Vertical Mapper™. Data collected in the study area during 1998 were analyzed using the distribution and abundance of bulls, calves and all sex/age classes of 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. 1992b), 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 2 to 1450 individuals; and (3) groups are not of fixed membership. However, location data are collected by caribou group; therefore individual caribou locations are not independent.

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. 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). Mosquito and oestrid activity indices for the 1998 field season, and the syntax used to calculate the indices, are presented in Appendix B.

RESULTS

Seven systematic surveys of the Bullen Point to Staines River study area were completed (Appendix A). Five surveys included 100% coverage of the study area, and 2 surveys, 19 June and 6 July, covered about 97% of the study area (Figs. A-1 to A-3). A total of 9916 caribou in 348 groups were recorded within the study area during the 7 systematic surveys from 12 June to 10 August 1998 (Table 1). The total number of caribou within the study area ranged from 1 on 10 August to 2714 on 6 July (Table 1). During the calving period (prior to 20 June), all classified caribou were cows and calves (2 surveys; 62% cows, 38% calves). During post-calving, 77% of classified caribou were cows and calves (5 surveys; 54% cows, 23% calves). During the post-calving period, bulls were 23% of classified caribou observed in the combined surveys. Twenty-eight muskoxen in 5 groups were observed during systematic surveys (Table A-2, Fig. A-4). In addition, 2 brown bears were seen on 12 June (Table A-2, Fig. A-4).

Caribou

Survey 1—12 June 1998

Survey weather conditions were good with overcast skies, winds at 9.8 to 10.8 meters per second (mps) from the northeast (60°) and a temperature of 5 to 7 °C from 1200 to 1600 Alaska Standard Time (AST) (ASCC 1998). A total of 2495 caribou in 165 groups were recorded within the study area, including 993 cow-calf pairs (Fig. A-1, Table 1). Mean group size was 15.1 ± 3.01 (95 percent confidence interval [95CI]). The composition of classified caribou was 59% cows and 41% calves (Table 1). Calf production was 69 calves/100 cows. Ninety-two percent of caribou (2300 of 2495; 93% of calves [920 of 993]) were more than 10-km inland; animals were most concentrated in the southwestern portion of the study area (Fig. A-1). Daily mean temperature was 4.6 °C and daily mean wind speed was 9.6 mps (Table B-1). Mosquito and oestrid activity indices indicated conditions were too cool for insect activity on 12 June (Fig. 2, Table B-1).

Survey 2—19 June 1998

Survey weather conditions were good, with scattered clouds, winds at 4.1 to 5.1 mps from the northeast (50° to 60°), and a temperature of 9 to 11 °C from 1200 to 1600 AST (ASCC 1998). Fog prevented surveying portions of some transects along the coast, resulting in approximately 97% coverage. A total of 2591 caribou in 86 groups were recorded within the study area, including 927 cow-calf pairs (Fig. A-1, Table 1). Mean group size was 30.1 ± 11.11 95CI. The composition of classified caribou was 64% cows and 36% calves (Table 1). Calf production was 56 calves/100 cows. Seventy percent of caribou (1817 of 2591, 75% of calves [701 of 927]) were within 10 km of the coast (Fig. A-1). Daily mean temperature was 7.0 °C and daily mean wind speed was 4.2 mps. Mosquito and oestrid activity indices indicated conditions were too cool for insect activity on 19 June (Fig. 2, Table B-1).

Survey 3—29 June 1998

Survey weather conditions were good, with scattered clouds, winds at 3.6 to 5.7 mps from the east northeast (50° to 100°), and a temperature of 21 to 23 °C between 1100 and 1500 AST (ASCC 1998). A total of 633 caribou in 5 groups was observed, including 67 cow-calf pairs (Fig. A-2, Table 1,). Mean group size was 126.6 ± 192.81 95CI. The composition of classified caribou was 20% bulls, 69% cows, and 11% calves (Table #1). Most caribou (631 of 633) were in 3 groups within a few 100 m of the coast; 2 groups were between Badami and Bullen Point and 1 group was near Point Thomson (Fig. A-2). Daily mean temperature was 16.9

°C and daily mean wind speed was 4.2 mps. Insect activity indices indicated favorable conditions for mosquito activity for 1 hour and oestrid activity for 6 hours on 29 June (Fig. 2, Table B-1). The clumped coastal distribution of caribou suggests that caribou were responding to parasitic insects.

Survey 4—6 July 1998

Survey weather conditions were good with overcast skies, winds at 4.1 to 6.2 mps from the north northeast (10° to 30°), and a temperature of 9 to 13°C from 1400 to 1800 AST (ASCC 1998). Fog prevented surveying portions of some transects along the coast, resulting in approximately 98% coverage. A total of 2714 caribou in 7 groups was observed, including 603 cow-calf pairs (Fig. A-2, Table 1). Mean group size was 387.7 ± 520.55 95CI. The composition of classified caribou was 30% bulls, 48% cows, and 22% calves (Table 1). All groups were within 3.5 km west of the Staines or Canning rivers. Most bulls (81%, 650 of 805) were seen in a group of 1450 animals along the Staines River in the southeastern corner of the study area (Fig. A-2, Table A-1; Attribute 7); that group also included 200 cow-calf pairs. Most other caribou (46% [1255 of 2714]; 66% of calves [400 of 603]) were in 2 groups of 450 and 805 animals located within about 2 km west of the Staines River (Fig. A-2, Table A-1, Attributes 2 and 5). Daily mean temperature was 9.2 °C and daily mean wind speed was 4.7 mps. Mosquito and oestrid activity indices indicated that conditions were too cool for insect activity on 6 July (Fig. 2, Table B-1), although conditions were suitable for oestrid activity on 5 July.

Survey 5—13 July 1998

Survey weather conditions were marginal, with scattered clouds at 250 m, winds at 15.4 mps, gusting to 18.0 mps, from the northeast, and a temperature of 10 °C at 1230 AST (ASCC 1998). A total of 673 caribou in 26 groups was observed, including 197 cow-calf pairs (Fig. A-2, Table 1). Mean group size was 25.9 ± 39.32 95CI. The composition of classified caribou was 21% bulls, 48% cows, and 31% calves. Seventy-four percent of caribou were in a single mixed group of 500 animals located approximately 20 km inland (Fig. A-2, Table A-1 Attribute 16). The remaining caribou observed within the study area (79% [136 of 173]) were more than 12 km from the coast, and groups ranged in size from 1 to 49 animals (Fig. A-2, Table A-1). In addition, a mixed group of approximately 750 caribou was observed just south of the study area on the Canning River delta.

Daily mean temperature was 7.5 °C and daily mean wind speed was 10.2 mps (Table B-1). Mosquito and oestrid indices indicated conditions were too windy for insect activity. However, Deadhorse weather data were unavailable between 1000 and 2400 AST, so no indices

were calculated for the warmest part of the day (Fig. 2, Table B-1). The inland-dispersed distribution of caribou suggests that caribou were not responding strongly to parasitic insects on 13 July.

Survey 6—26 July 1998

Survey weather conditions were good, with scattered clouds at 3500 m, winds at 5.1 to 8.7 mps from east northeast (60° to 100°), and a temperature of 11 to 14 °C from 1100 to 1500 AST (ASCC 1998). A total of 809 caribou in 58 groups was recorded in the study area (Fig. A-3, Table 1). Mean group size was 25.9 ± 39.32. The composition of classified caribou was 3% bulls, 66% cows, and 31% calves. Caribou were primarily distributed throughout the southern half of the study area, where the largest group, numbering 175 animals (cow-dominated), was along the Staines River (Fig. A-3 Table A-1 Attribute 2). Daily mean temperature was 10.7 °C and daily mean wind speed was 5.9 mps (Table B-1). Insect activity indices indicated conditions were not favorable for insect activity (Fig. 2, Table B-1).

Survey 7—10 August 1998

Survey weather conditions were good with overcast to broken ceilings, winds were variable at 2.6 to 4.6 mps from the west to north (230° to 20°), and a temperature of 10 to 12 °C from 1100 to 1500 AST (ASCC 1998). Only 1 cow was observed in the study area. Daily mean temperature was 10.3 °C and daily mean wind speed was 3.1 mps (Table B-1). Mosquito and oestrid activity indices indicated that conditions were not favorable for insect activity (Fig. 2, Table B-1).

Calving Period Distributions

The distribution of cow/calf caribou pairs between 1 June and 20 June varied by year since surveys were initiated in 1993 (Figs. 3 and 4). Distribution may reflect survey timing within the calving period (early or late June) and/or spring snow and flood patterns (Whitten and Cameron 1985, Gavin 1978). In all study years (1993, 1995, 1997, and 1998) the northeastern portion of the Bullen Point to Staines River study area did not appear to be heavily used by calving caribou (Figs. 3 and 4).

During 1998, the density of caribou, primarily cows and calves, within the Bullen Point to Staines River study area was 2.91 caribou/km^2 on 12 June compared to 0.45 caribou/km^2 on 10 June in the Badami study area (Fig. 1). However, a large proportion of caribou (57%) in the Bullen Point to Staines River study area were south of the 70° N latitude boundary for the Badami study area (Fig. 1, 3, and 4). Caribou density, again primarily cows and calves, increased to 3.02 caribou/km^2 on 19 June in the Bullen Point to Staines River area and to 1.08

caribou/km^2 on 15 June in the Badami study area. Unlike 12 June, however, a much smaller proportion (12%) of caribou within the Bullen Point to Staines River study area were south of 70° N latitude.

Post-Calving Coastal Distributions

During the post-calving period, caribou tend to congregate in coastal insect-relief habitats in response to parasitic insect harassment. In the Bullen Point to Staines River study area, within 2 km of the coast, caribou appeared to concentrate in areas southeast of Bullen Point and south of Point Thomson (Figs. 5 and 6), when coastal distribution data from all surveys (1993 to 1998, n = 20) are combined. Weather conditions varied considerably between surveys, and caribou were not necessarily seeking insect-relief habitats during all surveys.

During 1998, caribou density peaked in the Bullen Point to Staines River study area on 6 July at 3.16 caribou/km^2. In the Badami study area, density peaked at 7.54 caribou/km^2 on 22 July. For 4 surveys from 29 June to 26 July, density in the Bullen Point to Staines River study area was 1.41 caribou/km^2 compared to 3.81 caribou/km^2 in the Badami study area.

Potential Blockage of Inland-Coastal Movements

Potential blockage of caribou movements between inland foraging habitats and coastal insect-relief habitats was assessed by comparison of caribou distribution within 8 km of the coast in the Bullen Point to Staines River study area with the Badami study area (Fig. 1, Table 2). The Badami study area contains a single elevated pipeline that crossed the entire study area. The Badami pipeline varies in distance from the coast, but is within 0.5 km to 4.5 km of the coast.

During the calving period on survey 1, caribou were equally distributed between the 1 to 4-km interval and the 5 to 8-km interval in both study areas, with about 50% of caribou on either side of 5 km from the coastline. On survey 2, fewer caribou were close to the coast in the Bullen Point to Staines River study area, while caribou were more evenly distributed in the Badami study area (Table 2).

During the post-calving period, patterns of distributions within 1 to 4-km and 5 to 8-km intervals were similar between the study area on all surveys except for survey 5 (13 and 16 July). During survey 5 caribou were evenly distributed between these intervals in the Bullen Point to Staines River study area, but more caribou were within the 1 to 4-km interval in the Badami study area. The similarities in proportions of caribou north and south of the approximate pipeline corridor between the 2 study areas, indicates that the elevated pipeline corridor in the Badami study area probably did not block caribou movements between coastal and inland habitats. In addition, the large numbers of caribou within the 1 to 4-km interval during surveys 5 and 6 in the

Badami study area (the majority of caribou were within 2 km of the coast [Table A-5]) indicates that many caribou successfully crossed the pipeline corridor.

Other Large Mammals

Two brown bears were observed within the study area on 12 June 1998 (Fig. A-4, Table A-2). Muskoxen were seen during 4 different surveys (Table A-4). The largest group, totaling 17 animals, was seen on 10 August 1998 on the Canning River delta (Fig. A-4, Table A-2).

DISCUSSION

During the 7 systematic strip–transect surveys conducted in the study area, 1 to 2714 caribou were recorded (Table 1). The most recent estimate of the population size of the CAH (1997) was 20000 (1997 count: 19730), with an estimated 8000 (1997 count: 7733) in the eastern segment of the CAH (E. Lenart, ADF&G, personal communication). Caribou calving between Bullen Point and the Canning River are generally considered 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 1997 population estimates, 12% to 13% of the CAH and 31% to 32% of the eastern segment of the CAH used the Bullen Point to Staines River study area during calving. During post-calving, these percentages were 0% to 14% of the CAH and 0% to 34% of the eastern segment of the CAH.

Sex and age composition of classified caribou varied between surveys, but for the combined post–calving surveys, 23% were bulls, 54% were cows, and 23% were calves (43 bulls/100 cows and 43 calves/100 cows). CAH composition in October 1996 was 61 bulls/100 cows and 67 calves/100 cows (Hicks 1997). Our composition counts are estimates and are not as comprehensive as the ADF&G composition surveys. However, both data sets show that bulls and calves were in approximately the same proportions to cows.

During the 2 calving period surveys (12 and 19 June 1998), the distribution of caribou appeared more uniform than during any of the post-calving period surveys. The area between Bullen Point and the Canning River has been used consistently by calving caribou in most years since 1969 (Pollard et al. 1992a). The distribution of cow/calf caribou pairs between 1 June and 20 June varied by year since surveys were initiated in 1993. Distribution may reflect survey timing within the calving period (early or late June) and/or spring snow and flood patterns (Whitten and Cameron 1985, Gavin 1978). In all study years (1993, 1995, 1997, and 1998) the northeastern portion of the Bullen Point to Staines River study area did not appear to be heavily used by calving caribou. Calf production within the study area on 16 June 1997 was 70

calves/100 cows (Noel 1998). Calf production (pregnancy rate) for the CAH during calving period surveys in June 1997 between the Colville River and the Canning River was 72 calves/100 cows (Hicks 1997). During 1998, calf production was 69 calves/100 cows on 12 June and 56 calves/100 cows on 19 June.

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). Caribou tend to drift inland and feed during periods of low temperatures and/or high wind velocities, which suppress mosquito activity (Curatolo et al. 1982, White et al. 1975, Dau 1986, Pollard et al. 1996b). Caribou distributions on 29 June and 6 July (Fig. A-2) suggest caribou were using coastal and riparian insect–relief habitats on these days. Coastal caribou distributions within the study area appeared to concentrate in areas southeast of Bullen Point and south of Point Thomson, when distribution data from all post-calving surveys were combined. In 1998, most caribou had left the study area by 10 August. Although caribou group size generally begins to increase after peak calving, mosquito harassment is thought to cause large aggregations (Roby 1978; Johnson and Lawhead 1989). During 1998, mean caribou group size fluctuated from 15.1 to 30.1 caribou per group during the calving period, increased to 387.7 on 6 July during the post-calving period, and then declined from 25.9 to 1.0 from 13 July to 10 August.

The number of caribou within 2 km of the Beaufort Sea coast increased from 625 caribou on 11 July to 1,159 on 17 July and 1,178 on 22 July (Fig. 5, Table A-4). This pattern may represent caribou movement from inland foothill locations toward coastal insect-relief habitat. This increase may also represent eastward movement of coastal caribou groups from areas to the west. However, group movements were not monitored during this period. The formation of large caribou groups and their coastal distribution within this period suggest that caribou were experiencing mosquito harassment (White et al. 1975; Dau 1986; Johnson and Lawhead 1989). Unfortunately, the incompleteness of midday hourly weather records prevents accurate modeling of insect activity during most of the post-calving period. Oil field infrastructure has been implicated in blockage of caribou movements between coastal insect-relief and inland foraging habitats, especially through the Prudhoe Bay oil field (Cameron et al. 1995). The similar proportions of caribou within 1 to 4-km and 5 to 8-km intervals (north and south of the approximate Badami pipeline corridor) in the Bullen Point to Staines River and in the Badami study areas, indicates that the elevated pipeline corridor in the Badami study area probably did not block caribou movements. In addition, the large numbers of caribou within the 1 to 4-km

interval during surveys 5 and 6 in the Badami study area indicate that many caribou successfully crossed the pipeline corridor.

ACKNOWLEDGMENTS

Jim Helmericks provided piloting expertise, Isaac Helmericks, Warren Ballard and Heather Whitlaw served as the second observers. Ray Jakubczak (BP Exploration (Alaska) Inc) provided support for this study.

LITERATURE CITED

ASCC (Alaska State Climate Center). 1998. Deadhorse Weather Station, May to September 1998 data. Environment and Natural Resources Institute, University of Alaska Anchorage, Anchorage, AK.

Cameron, R. D., E. A. Lenart, D. J. Reed, K. R. Whitten, and W. T. Smith. 1995. Abundance and movements of caribou in the oil field complex near Prudhoe Bay, Alaska. Rangifer, 15(1):3-7.

Cameron, W. T. Smith, and S. G. Fancy. 1989. Distribution and productivity of the Central Arctic Caribou herd in relationship to petroleum development. Alaska Dept. Fish and Game. Fed. Aid in Wildl. Rest. Prog. Rep. Projs. W–23–1 and W–23–2, Study 3.35. Juneau, AK. 52 p.

Cameron, and K. R. Whitten. 1978. Third interim report on the effects of the Trans-Alaska Pipeline on caribou movements. Spec. Rep. No. 22. Joint State/Fed. Fish and Wildl. Advis. Team, Anchorage, AK. 29p.

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 Co. by Renewable Resources Consulting Services Ltd., Sidney, B.C. 207pp.

Caughley, G. 1977. Sampling in aerial survey. J. Wildl. Manage. 41:605–615.

Clough, N. K., P. C. Patton, and A. C. Christiansen (eds). 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, v.1. 208 pp.

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 Rep. by Alaska Biological Research, Inc., Fairbanks, AK. for ARCO Alaska, Inc., Anchorage, AK 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. 149pp.

Gavin, A. 1983. Spring and Summer Caribou Movements, Prudhoe Bay, Alaska, 1969–1979. Report to Atlantic Richfield Co., Los Angeles. 50pp.

Hicks, M. V., editor. 1997. Annual Performance Report of Survey-Inventory Activities, 1 July 1996 - 30 June 1997. Caribou. Fed. Aid in Wildl. Rest. Prog. Rep., Proj. W-24-5, Study 3.0. Alaska Dept. Fish and Game, Juneau, AK.

Jakimchuk, R. D., S. H. Ferguson, and L. G. Sopuck. 1987. Differential habitat use and sexual segregation in the Central Arctic caribou herd. Can. J. Zool. 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, Inc., and Kuparuk River Unit, Anchorage, by Alaska Biological Research, Inc., Fairbanks. 71pp.

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, AK to ARCO Alaska, Inc., Anchorage, AK. 52pp.

Noel, L. E. 1998. Large mammal distribution in the Badami Study Area, summer 1997. Final report to BP Exploration (Alaska) Inc., by LGL Alaska Research Associates, Inc., Anchorage, AK. 19 pp. + App.

Pennycuick, C. J., and D. Western. 1972. An investigation of some sources of bias in aerial transect sampling of large mammal populations. E. Afr. Wildl. J. 10:175–191.

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

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

Pollard, R.H., P. C. Lent, M. E. Miller, and R. C. Wilkinson. 1992a. 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.

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

Pollard, R. H., M. E. Miller, and R. C. Wilkinson. 1992b. 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, and L.E. Noel. 1994. Large mammal surveys of the Badami Development area, summer 1994. Final Report to BP Exploration (Alaska) Inc., by LGL Alaska Research Associates, Inc., Anchorage, AK.

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) Inc., by LGL Alaska Research Associates, Inc.

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

Russell, D. E., A. M. Martell, and W. A. C. Nixon. 1993. Range ecology of the Porcupine caribou herd. Rangifer, Special Issue No. 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, AK. 43 pp.

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, NH.

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 (ed.). Ecological investigations of the tundra biome in the Prudhoe Bay region, Alaska. Biol. Pap., Univ. Alaska, Spec. Rep. No. 2. Univ. Alaska, Fairbanks.

Whitten, K. R., and R. D. Cameron. 1980. Composition and harvest of the Porcupine caribou herd. Fed. Aid in Wildl. Rest. Prog. Rep., Projs. W-17-9, W-17-10, W-17-11, W-17-21. Job 3.23R. Alaska Dept. Fish and Game, Juneau, AK.

Whitten, K. R., and R. D. Cameron. 1985. Distribution of caribou calving in relation to the Prudhoe Bay oil field. Pp. 35–39 *in* A.M. Martell and D.E. Russell, editors. Proc. 1st No. Amer. Caribou Workshop. Can. Wildl. Serv. Spec. Publ., Ottawa.

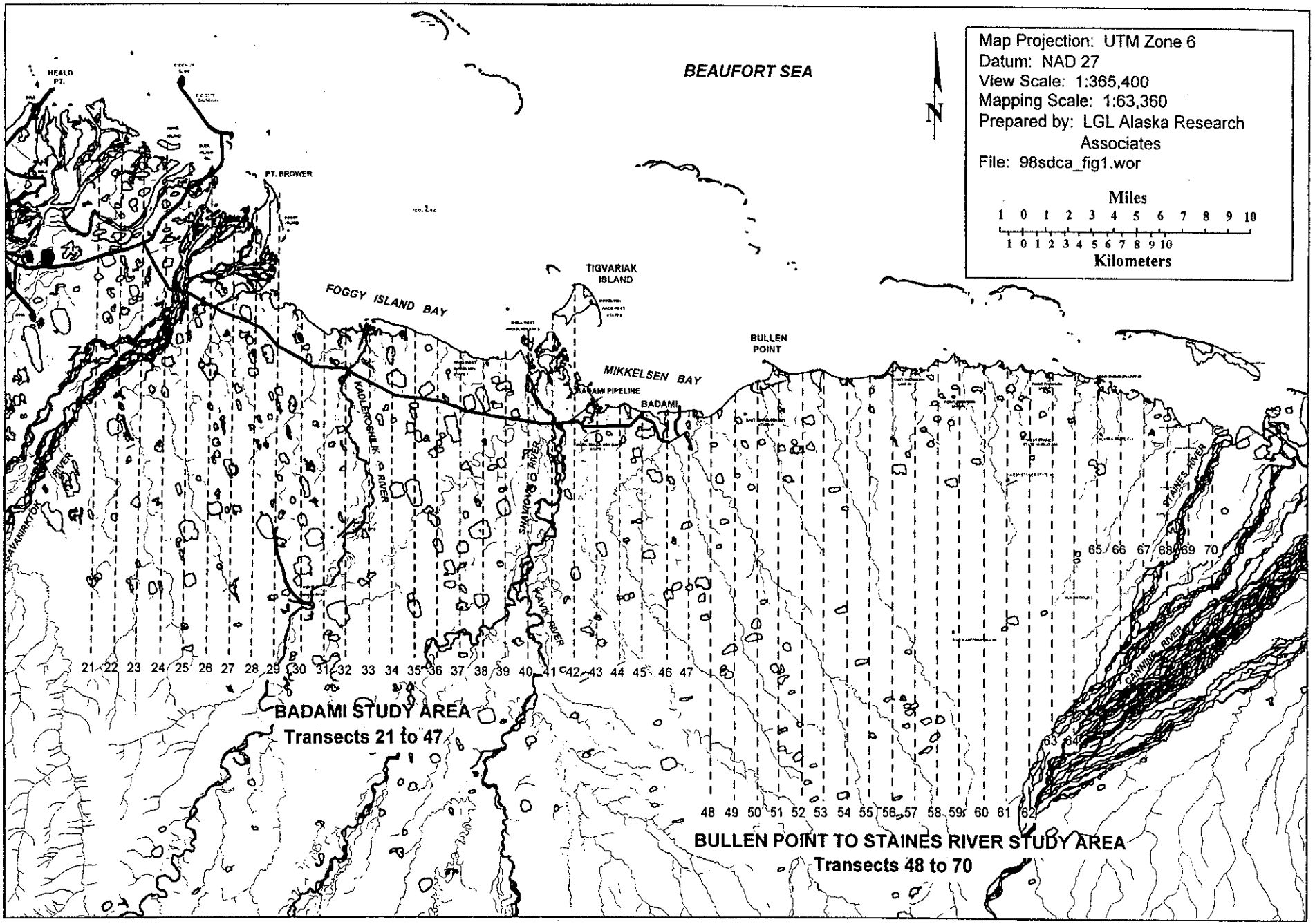


Figure 1. Survey transects in the Bullen Point to Staines River study area and in the Badami study area, Alaska, 1998.

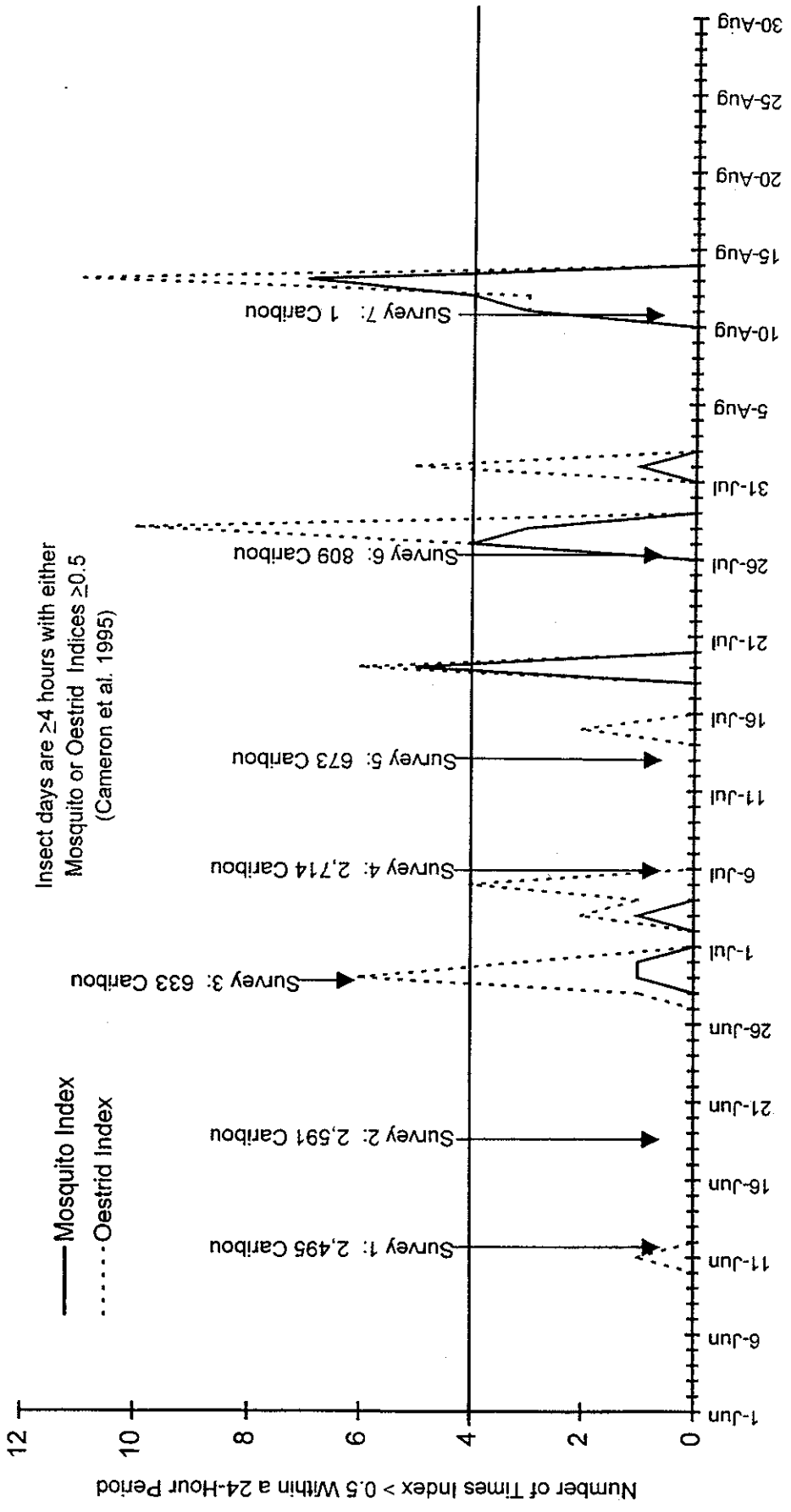


Figure 2. Mosquito and oestrid activity indices (Russel et al. 1993) based on hourly weather data collected at the Deadhorse Weather Station (ASCC 1998) and 1998 aerial caribou survey dates, Bullen Point to Staines River study area, Alaska.

CALVING PERIOD

Bullen Point

MIKKELSEN BAY

BADAMI

MOBIL MIKKELSEN BAY STATE 1

Pt. Thomson Unit #4

Pt. Thomson Unit #2

Pt. Thomson Unit #1

Point Thomson

Point Thomson Unit #3

West Staines State 10-09-23-180

West Staines State #2

Alaska State C-1

North Staines River #1

Staines River State #1

STAINES RIVER

Sourdough 3

Sourdough 2

Flaxman Island

Alaska State A-1

Alaska State G-2

Brownlow Point

N

Yukon Gold 1

CANNING RIVER

Study Area Boundary

Figure 3

Distribution of cows and calves observed in the Bullen Point to Staines River study area, Alaska, during calving period surveys in 1993, 1997, and 1998.

Group Size (Calves and/or Cows)

1993 (16 June)

- <10
- 10 to 25
- 26 to 50
- 51 to 100
- >100

1997 (16 June)

- <10
- 10 to 25
- 26 to 50
- 51 to 100
- >100

1998

12 June	19 June	
▼	○	<10
▼	○	10 to 25
▼	○	26 to 50
▼	○	51 to 100
▼	○	>100

Pipelines

Oil Production and Service Facilities

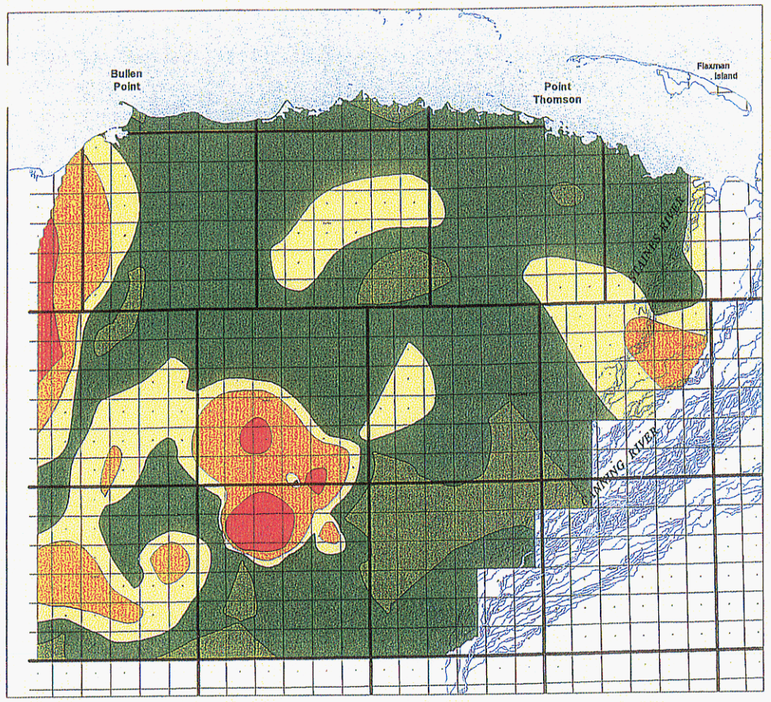
Miles

1 0 1 2 3 4 5

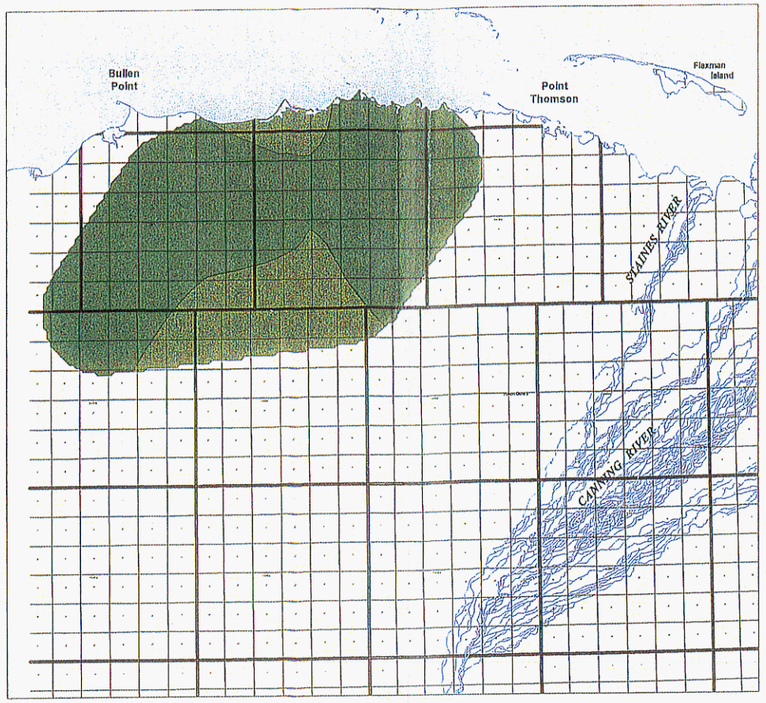
1 0 1 2 3 4 5

Kilometers

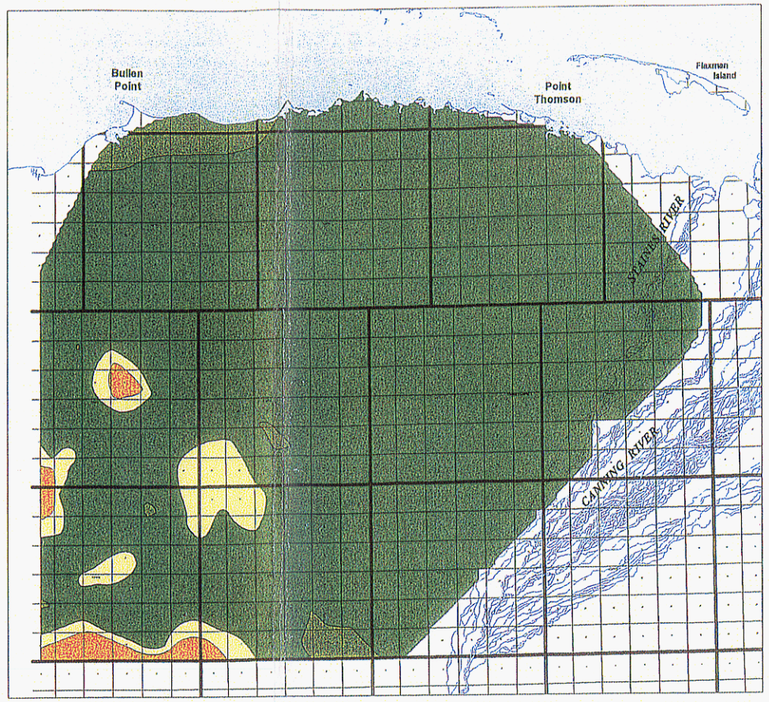
Map Projection: UTM Zone 6
Datum: NAD 27
View Scale: 1:167,600
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 9398sdca_fig3.wor



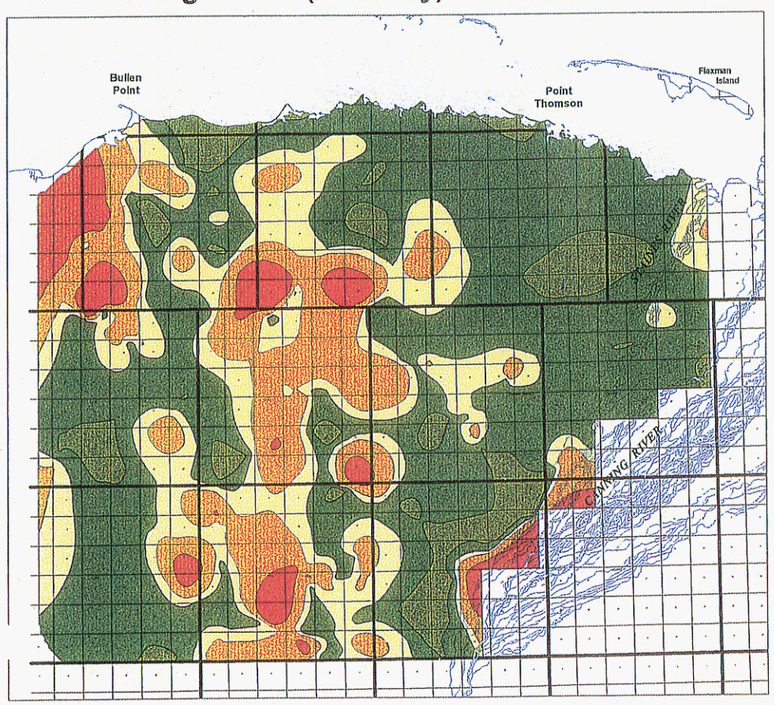
1993 Calving Period (1 Survey)



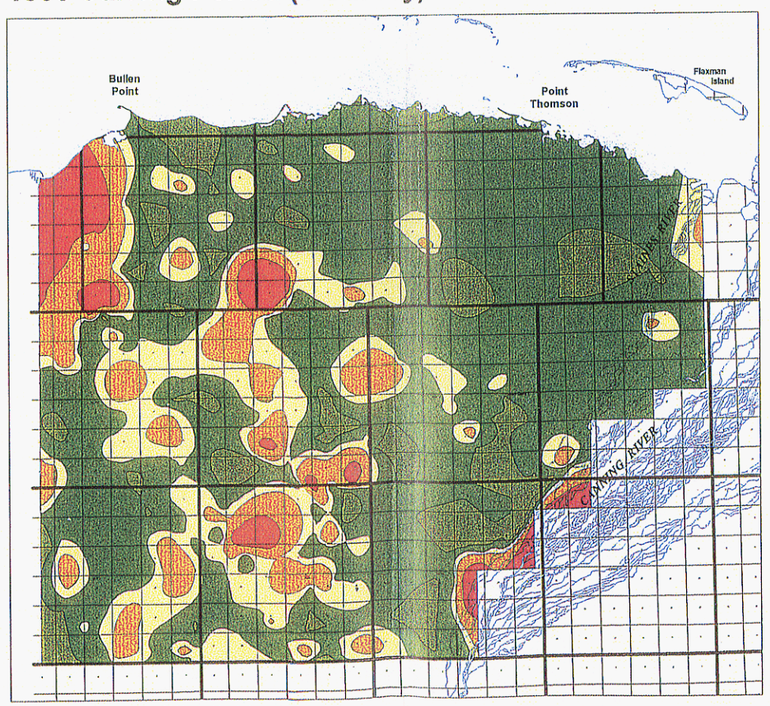
1995 Calving Period (1 Survey)



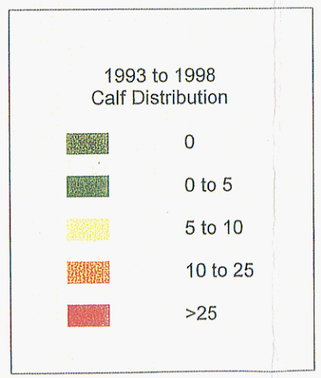
1997 Calving Period (1 Survey)



1998 Calving Period (2 surveys)



1993 to 1998 Average for the Calving Period (5 surveys)



Projection: UTM Zone 6
Datum: NAD 27
View Scale 1:329,500
Mapping Scale: 1:63,360
File: Fig5_98.wor

Figure 4. Distribution of calves during the calving period (before 20 June) as contours of the total number of calves by year and for combined 1993 to 1998 distributions (5 surveys), in the Bullen Point to Staines River study area, Alaska.

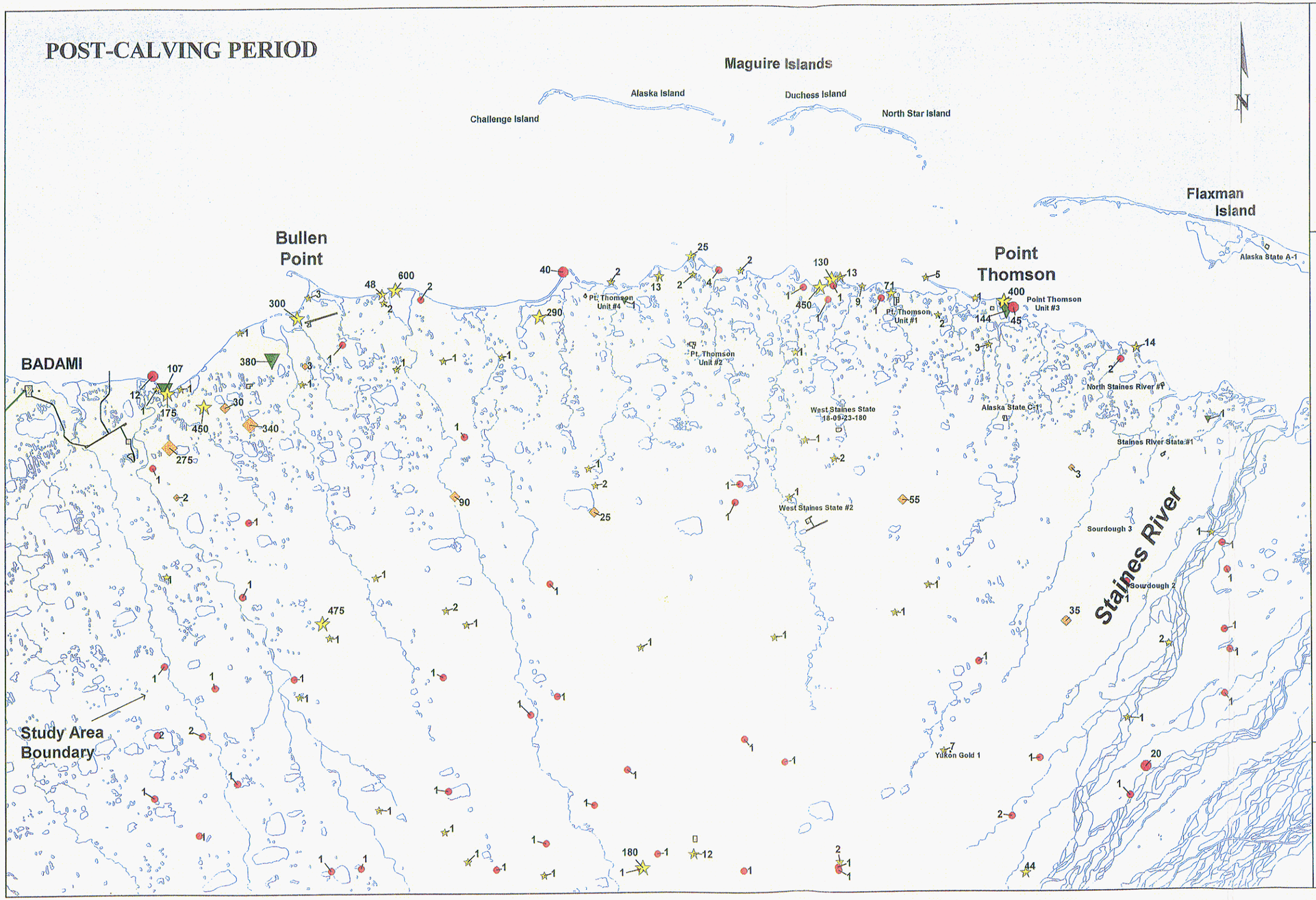


Figure 5

Post-calving distributions of caribou observed in the Bullen Point to Staines River study area, Alaska, during surveys with coastal concentrations of animals. Data are for 4 survey years.

Note that the 1995 survey area was limited to within approximately 10 km of the coast.

Caribou Group Size

1993	1995
<10	<10
10 to 100	10 to 100
>100	>100

1997	1998
<10	<10
10 to 100	10 to 100
>100	>100

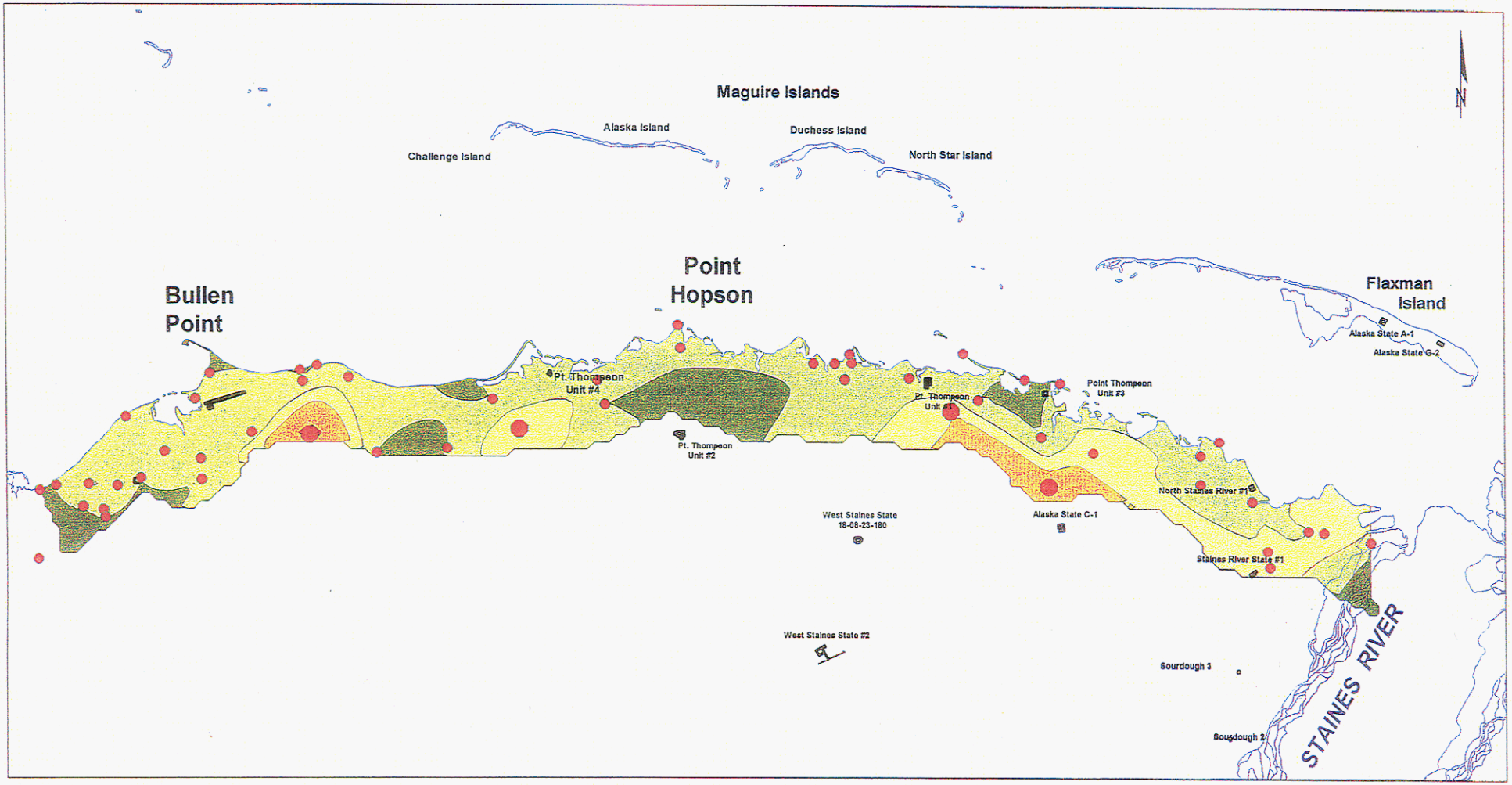
22 — Total Caribou

Pipelines

Oil Production and Service Facilities

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

Map Projection: UTM Zone 6
Datum: NAD 27
View Scale: 1:134,500
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 9398sdca_fig4.wor



1993 to 1998
Coastal Caribou Concentrations

- 0.00
- 0 to 5
- 5 to 10
- 10 to 20
- >25

Caribou Group Size
(Number of Groups)

- 10 to 101 (4)
- Less than 10 (48)

Figure 6. Coastal post-calving period (after 20 June) distribution as contours of the total number of caribou within 2 km of the coast for combined 1993 to 1998 caribou distributions (20 surveys), in the Bullen Point to Staines River study area, Alaska.

Projection: UTM Alaska Zone 6
Datum: NAD 1927
Scale: 1:160,000

Table 1. Sex and age classification for caribou observed during systematic aerial surveys in the Bullen Point to Staines River study area, Alaska, 12 June to 10 August 1998.

Flight	Date	Number of Caribou					Number Of Groups	Mean Group Size
		Bulls	Cows	Calves	Unclassified	Total		
1	12 Jun 98	0	1,440	993	62	2,495	165	15.1
2[a]	19 Jun 98	0	1,647	927	17	2,591	86	30.1
3	29 Jun 98	130	436	67	0	633	5	126.6
4[a]	6 Jul 98	805	1,306	603	0	2,714	7	387.7
5	13 Jul 98	133	302	197	41	673	26	25.9
6	26 Jul 98	24	500	230	57	809	58	13.9
7	10 Aug 98	0	1	0	0	1	1	1.0

[a]Coastal fog prevented surveying coastal portions of some transects, resulting in approximately 97 percent coverage on 19 June and 98 percent coverage on 6 July.

Table 2. Comparison of inland and coastal caribou distribution with and without an elevated pipeline during the calving and post-calving periods in the Bullen Point to Staines River and Badami study areas, Alaska, summer 1998.

	Bullen Point to Staines River (without elevated pipeline)				Badami (with elevated pipeline)			
	1 to 4-km Intervals		5 to 8-km Intervals		1 to 4-km Intervals		5 to 8-km Intervals	
	Number of Caribou	Occurrence (%)	Number of Caribou	Occurrence (%)	Number of Caribou	Occurrence (%)	Number of Caribou	Occurrence (%)
Calving Period (1 June to 20 June)								
Survey 1 (10, 12 June)	62	48	66	52	29	49	30	51
Survey 2 (15, 19 June)	336	26	955	74	62	42	86	58
Post-calving Period (21 June to 15 August)								
Survey 3 (29, 30 June)	633	100	0	0	436	100	0	0
Survey 4 (6, 9 July)	459	36	805	64	201	12	1,485	88
Survey 5 (13, 16 July)	15	41	22	59	3,110	77	941	23
Survey 6 (22, 26 July)	45	100	0	0	5,889	88	817	12
Survey 7 (10, 11 August)	1	100	0	0	11	65	6	35

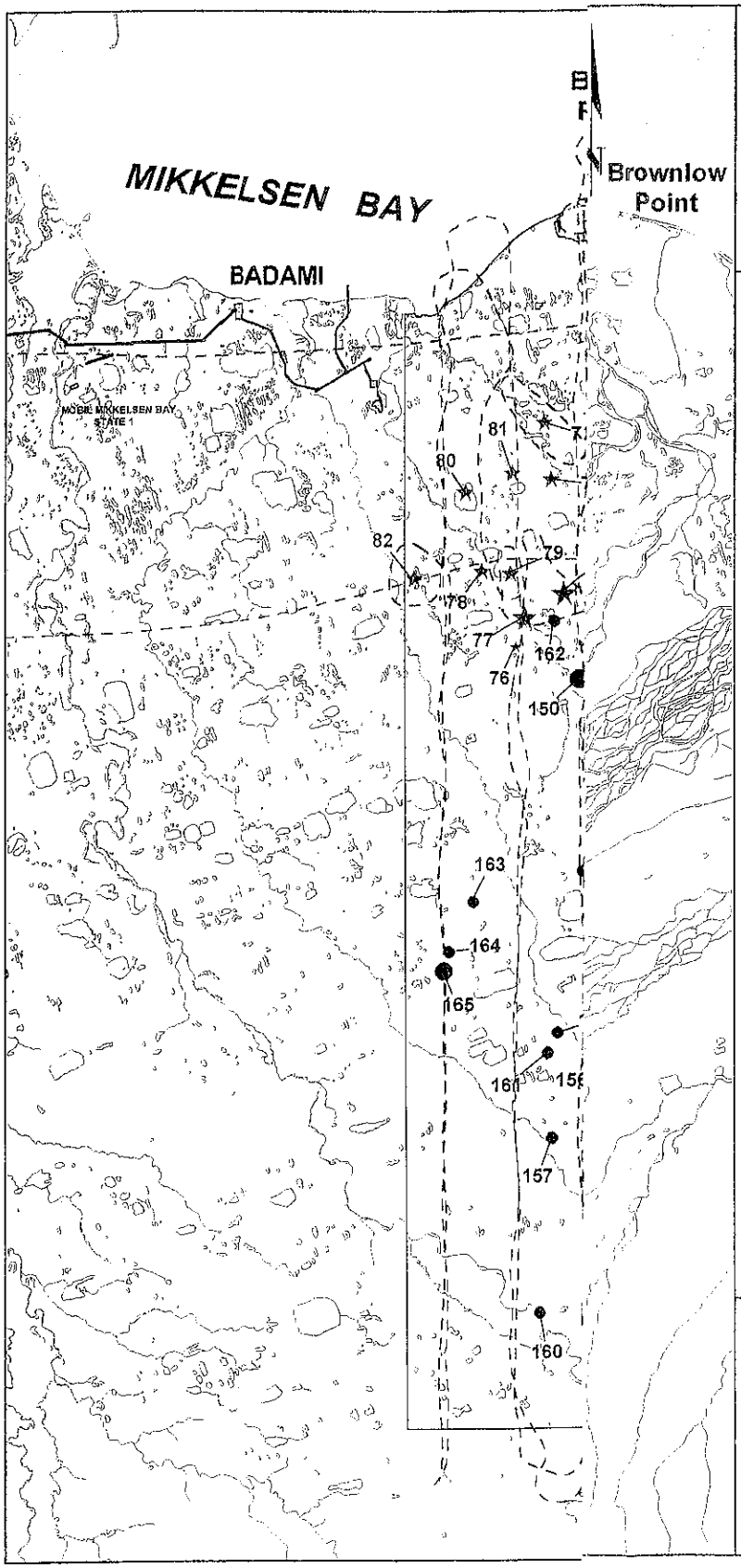


Figure A-1

Distribution of caribou observed in the Bullen Point to Staines River study area, Alaska, on 12 and 19 June 1998.

Caribou Group Size

	Groups
12 June	
Less than 10	99
10 to 100	66
101 to 1000	0
Greater than 1000	0
19 June	
Less than 10	46
10 to 100	33
101 to 1000	7
Greater than 1000	0

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

12 June Survey Flight Lines

19 June Survey Flight Lines

Pipelines

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: 1:167,800
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 98sdca_a1.wor

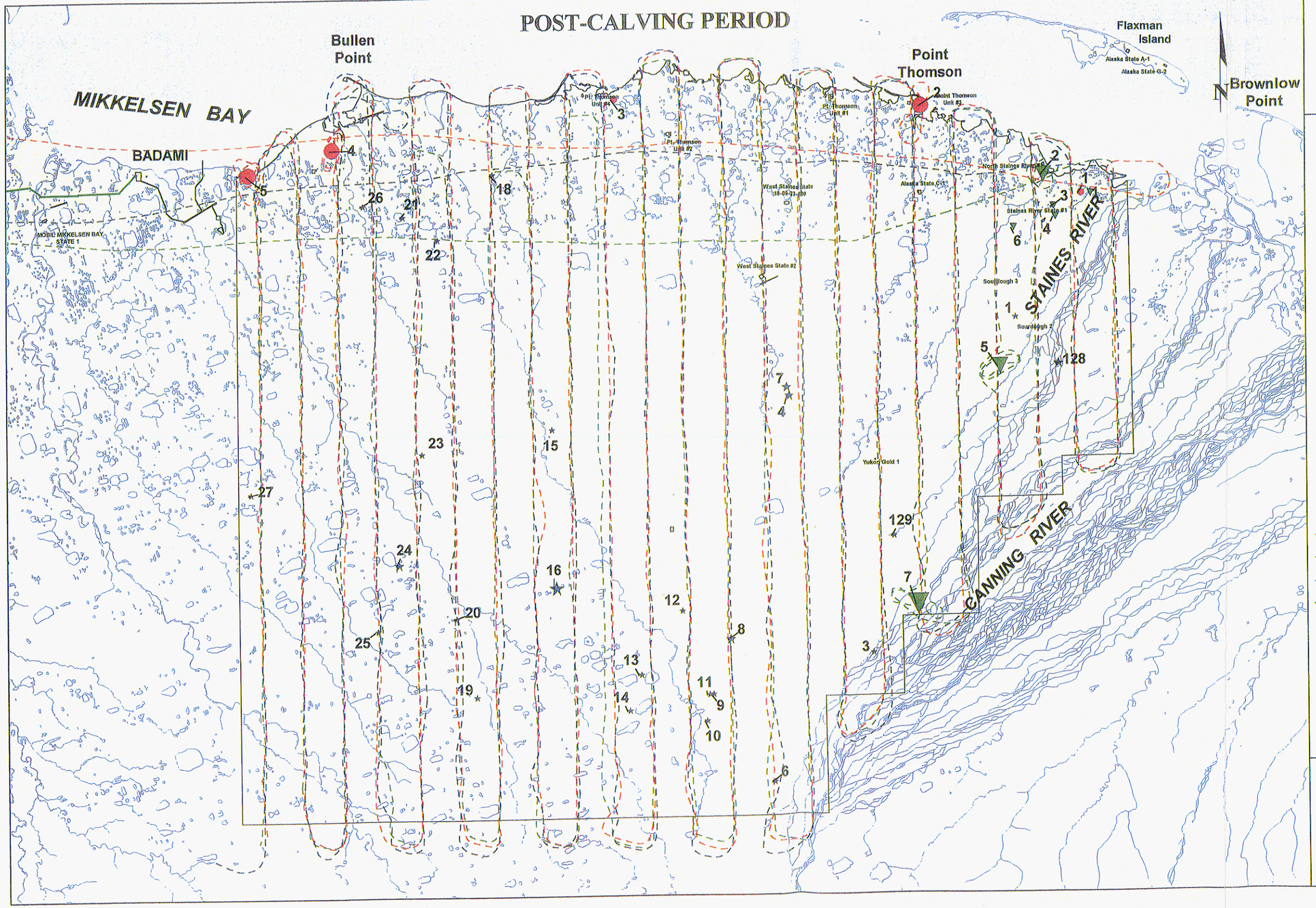


Figure A-2

Distribution of caribou observed in the Bullen Point to Staines River study area, Alaska, on 29 June, 6 July, and 13 July 1998.

Caribou Group Size	Groups
29 June	
Less than 10	2
10 to 100	0
101 to 1000	3
Greater than 1000	0
6 July	
Less than 10	4
10 to 100	0
101 to 1000	2
Greater than 1000	1
13 July	
Less than 10	20
10 to 100	5
101 to 1000	1
Greater than 1000	0

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

29 June Survey Flight Lines
6 July Survey Flight Lines
13 July Survey Flight Lines
Pipelines
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: 1:167,600
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 98sdca_a2.wor

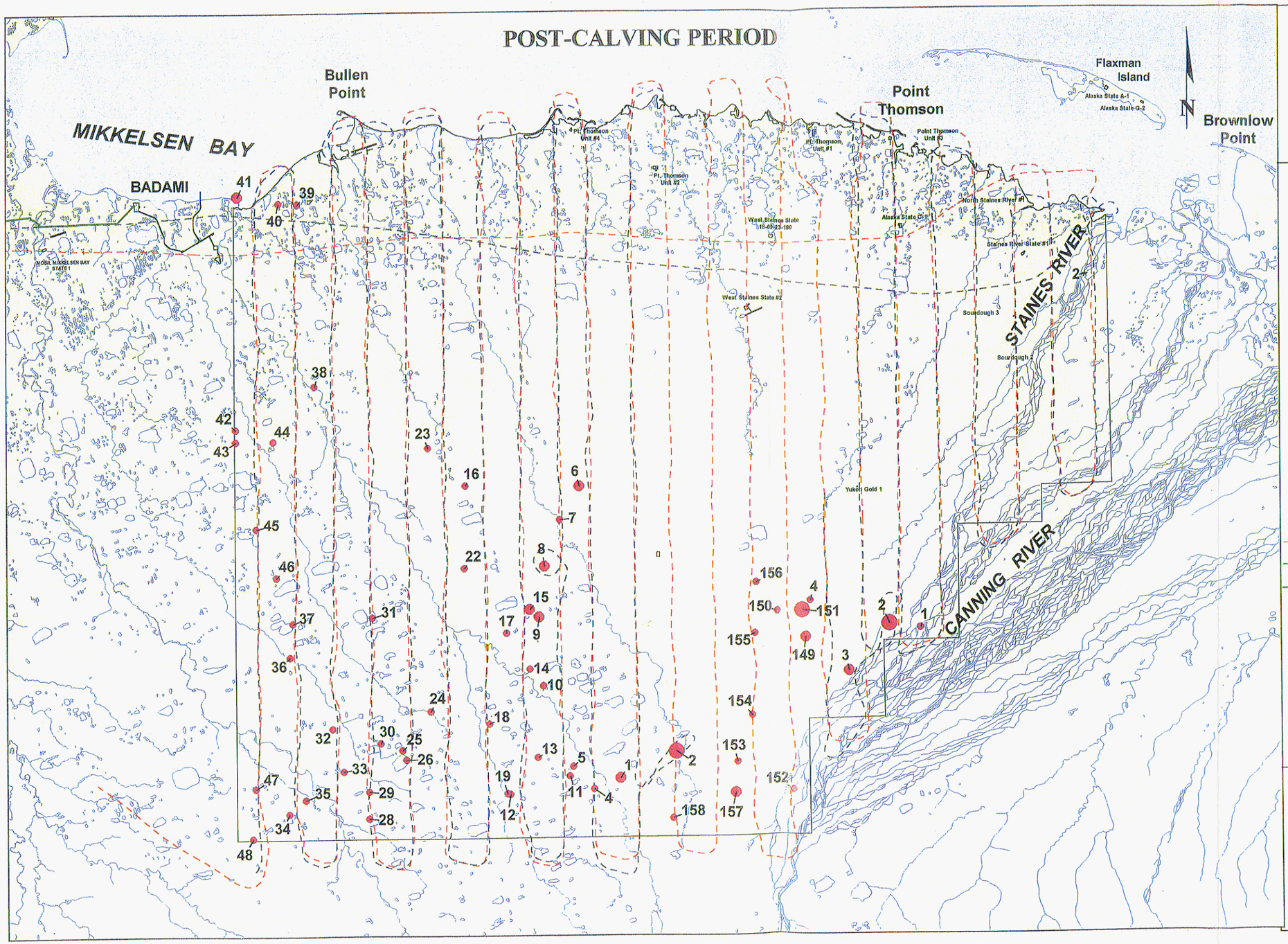


Figure A-3

Distribution of caribou observed in the Bullen Point to Staines River study area, Alaska, on 26 July and 10 August 1998.

Caribou Group Size

	Groups
26 July	
Less than 10	46
10 to 100	9
101 to 1000	3
Greater than 1000	0
10 August	
Less than 10	1
10 to 100	0
101 to 1000	0
Greater than 1000	0

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

- 26 July Survey Flight Lines
- 12 August Survey Flight Lines
- Pipelines
- 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: 1:167,600
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 98sdca_a3.wor

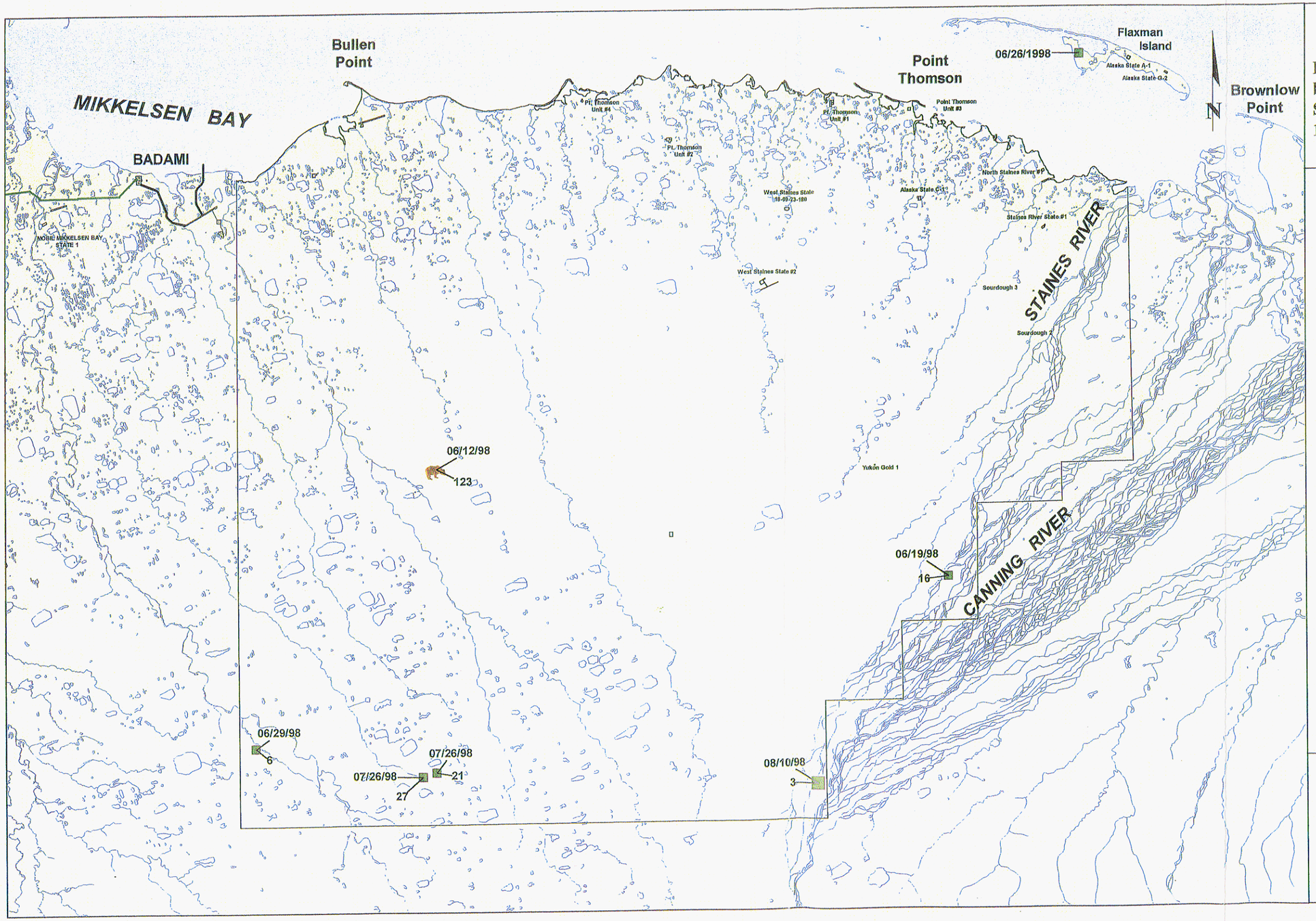


Figure A-4

Distribution of muskoxen and brown bear, observed in the Bullen Point to Staines River study area, Alaska, 12 June to 10 August 1998.

Muskoxen Group Size

	Groups
Less than 10	5
10 to 24	1
25 to 50	0

Brown Bear

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

Pipelines

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: 1:167,600
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 98sdmisc_a4.wor

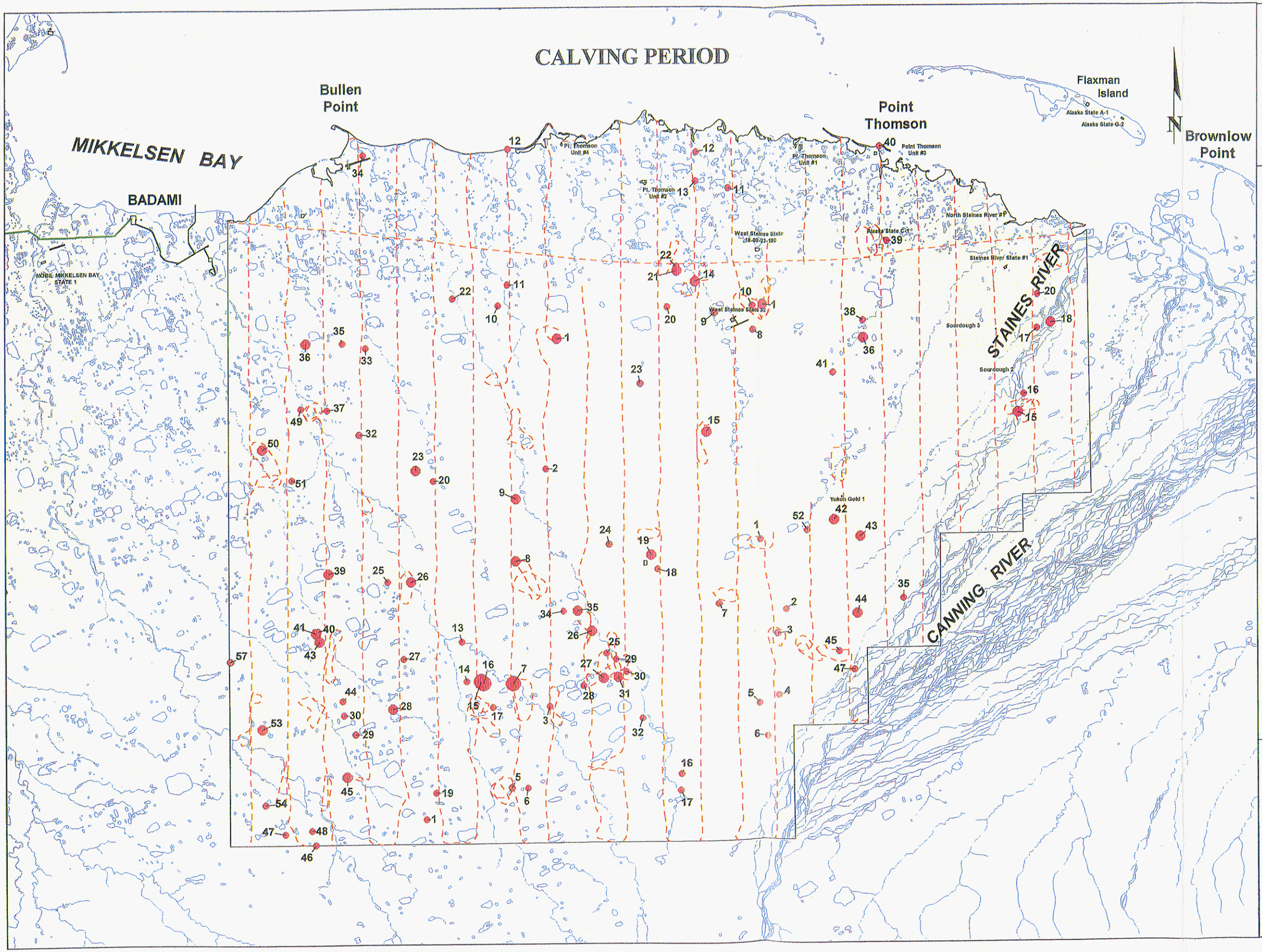


Figure C-1

Distribution of caribou observed in the Bullen Point to Staines River study area, Alaska, on 16 June 1993.

Caribou Group Size

	Groups
Less than 10	69
10 to 100	28
101 to 1000	3
Greater than 1000	0

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

Survey Flight Lines

Pipelines

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: 1:167,600
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 93sdca_c1.wor

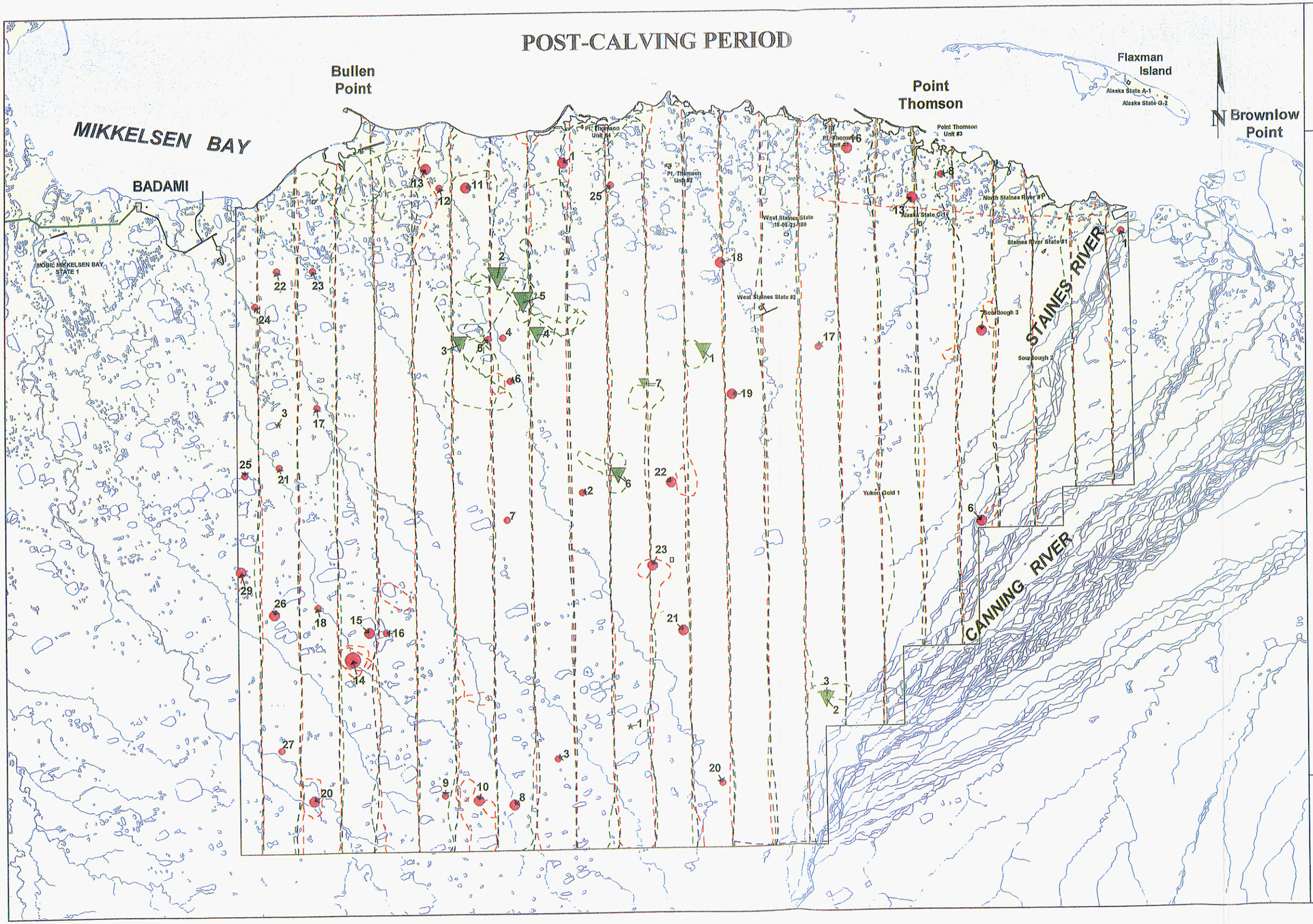


Figure C-2

Distribution of caribou observed in the Bullen Point to Staines River study area, Alaska, on 22 June, 6-7 July, and 20 July 1993.

Caribou Group Size	Groups
22 June	
Less than 10	22
10 to 100	18
101 to 1000	1
Greater than 1000	0
6-7 July	
Less than 10	1
10 to 100	1
101 to 1000	5
Greater than 1000	2
20 July	
Less than 10	2
10 to 100	0
101 to 1000	0
Greater than 1000	0

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

- 22 June Survey Flight Lines
- 6-7 July Survey Flight Lines
- 20 July Survey Flight Lines
- 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: 1:167,800
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 93sdca_c2.wor

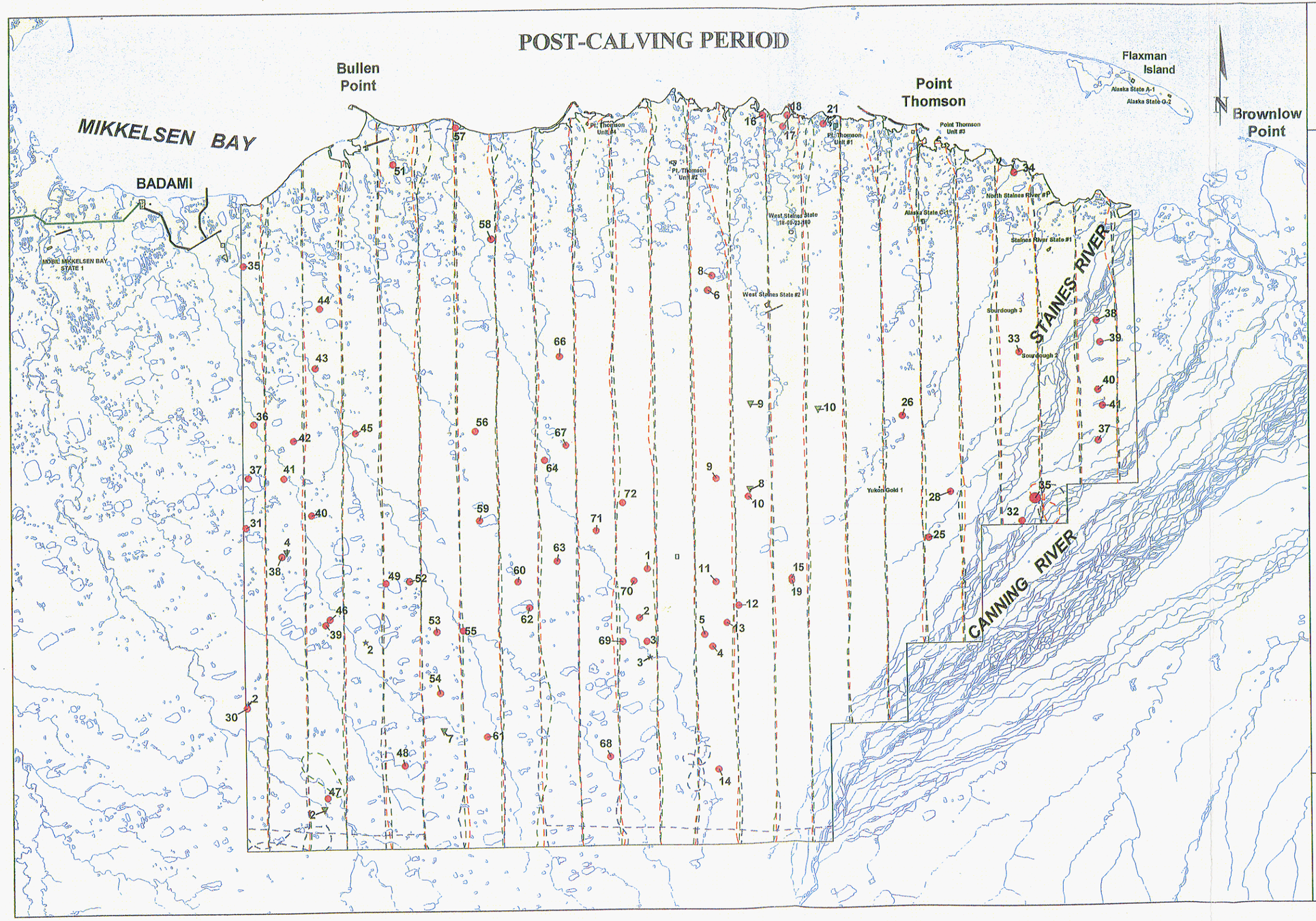


Figure C-3

Distribution of caribou observed in the Bullen Point to Staines River study area, Alaska, on 27 July, 5 August, and 18 August 1993.

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

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

- 27 July Survey Flight Lines
- 5 August Survey Flight Lines
- 18 August Survey Flight Lines
- 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: 1:167,800
Mapping Scale: 1:63,360
Prepared by: LGL Alaska Research Associates
File: 93sdca_a3.wor

APPENDIX A.

1998 DATA

Table A-1. Caribou sightings in the Bullen Point to Staines River 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
146.061117	70.102752	12 Jun 98	14:09:59	1	2	ca	0	3	3	0	6
146.056949	70.106913	12 Jun 98	14:10:08	1	3	ca	0	9	9	0	18
146.162116	70.035363	12 Jun 98	14:26:51	1	4	ca	0	0	0	2	2
146.185876	70.022587	12 Jun 98	14:37:12	1	5	ca	0	11	8	0	19
146.267806	70.001682	12 Jun 98	14:45:47	1	6	ca	0	4	0	0	4
146.231279	70.023866	12 Jun 98	14:46:36	1	7	ca	0	3	2	0	5
146.231511	70.086740	12 Jun 98	14:48:54	1	8	ca	0	0	0	2	2
146.229901	70.160554	12 Jun 98	14:51:38	1	9	ca	0	2	1	0	3
146.272312	70.104091	12 Jun 98	14:55:20	1	10	ca	0	0	0	2	2
146.285897	70.076220	12 Jun 98	14:56:15	1	11	ca	0	1	1	0	2
146.301480	70.065162	12 Jun 98	14:56:36	1	12	ca	0	1	1	0	2
146.309016	70.051422	12 Jun 98	14:57:04	1	13	ca	0	1	0	0	1
146.313765	70.047483	12 Jun 98	14:57:12	1	14	ca	0	3	1	0	4
146.271549	69.983340	12 Jun 98	14:59:21	1	15	ca	0	0	0	3	3
146.326100	69.976744	12 Jun 98	15:05:36	1	17	ca	0	1	0	0	1
146.354482	70.015032	12 Jun 98	15:07:01	1	18	ca	0	0	0	1	1
146.343435	70.035784	12 Jun 98	15:07:46	1	19	ca	0	1	2	0	3
146.311661	70.040031	12 Jun 98	15:07:56	1	20	ca	0	1	0	0	1
146.315618	70.081231	12 Jun 98	15:09:27	1	21	ca	0	2	2	0	4
146.381474	70.170660	12 Jun 98	15:14:28	1	22	ca	0	1	1	0	2
146.371656	70.161486	12 Jun 98	15:14:45	1	23	ca	0	4	2	0	6
146.379996	70.028142	12 Jun 98	15:19:10	1	24	ca	0	2	2	0	4
146.384527	69.924892	12 Jun 98	15:22:36	1	25	ca	0	4	2	0	6
146.436803	69.917849	12 Jun 98	15:24:28	1	26	ca	0	1	0	1	2
146.401173	69.961783	12 Jun 98	15:26:05	1	27	ca	0	3	0	0	3
146.436713	69.966279	12 Jun 98	15:26:15	1	28	ca	0	1	1	0	2
146.394339	69.997616	12 Jun 98	15:27:24	1	29	ca	0	7	2	0	9
146.397129	70.029138	12 Jun 98	15:28:34	1	30	ca	0	0	0	3	3
146.412340	70.033167	12 Jun 98	15:28:43	1	31	ca	0	1	1	0	2
146.438548	70.050977	12 Jun 98	15:29:22	1	32	ca	0	4	2	0	6
146.428748	70.055352	12 Jun 98	15:29:32	1	33	ca	0	1	1	0	2
146.426129	70.055352	12 Jun 98	15:29:32	1	34	ca	0	18	12	0	30
146.411811	70.058896	12 Jun 98	15:29:40	1	266	ca	0	6	5	0	11
146.481001	70.110408	12 Jun 98	15:37:44	1	35	ca	0	2	0	0	2
146.471068	70.105376	12 Jun 98	15:37:54	1	36	ca	0	14	6	0	20
146.452535	70.061381	12 Jun 98	15:39:21	1	37	ca	0	2	2	0	4
146.465621	70.057810	12 Jun 98	15:39:28	1	38	ca	0	3	3	0	6
146.444088	70.032296	12 Jun 98	15:40:19	1	39	ca	0	6	3	0	9
146.438731	70.014464	12 Jun 98	15:40:55	1	40	ca	0	0	0	2	2
146.481982	69.990268	12 Jun 98	15:41:44	1	41	ca	0	1	1	0	2
146.444623	69.978950	12 Jun 98	15:42:06	1	42	ca	0	0	0	2	2
146.450174	69.923843	12 Jun 98	15:43:55	1	43	ca	0	0	0	2	2
146.485589	69.936953	12 Jun 98	15:47:19	1	44	ca	0	1	1	0	2
146.527603	69.963276	12 Jun 98	15:48:18	1	45	ca	0	2	2	0	4
146.498260	69.983753	12 Jun 98	15:49:04	1	46	ca	0	2	2	0	4
146.522608	70.041722	12 Jun 98	15:51:11	1	47	ca	0	22	0	0	22
146.514764	70.082882	12 Jun 98	15:52:41	1	48	ca	0	1	1	0	2
146.485741	70.138334	12 Jun 98	15:54:44	1	49	ca	0	2	2	0	4
146.484297	70.152355	12 Jun 98	15:55:17	1	50	ca	0	0	0	8	8
146.522444	70.162465	12 Jun 98	15:55:39	1	51	ca	0	4	3	0	7
146.527793	70.089344	12 Jun 98	16:00:35	1	52	ca	0	1	1	0	2
146.535121	70.050172	12 Jun 98	16:01:53	1	53	ca	0	27	18	0	45
146.529721	70.039389	12 Jun 98	16:02:16	1	54	ca	0	49	20	0	69
146.534315	70.001247	12 Jun 98	16:03:35	1	55	ca	0	50	47	0	97
146.529306	69.965362	12 Jun 98	16:04:48	1	56	ca	0	17	13	0	30
146.537742	69.960630	12 Jun 98	16:04:58	1	57	ca	0	4	3	0	7

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
146.544700	69.952714	12 Jun 98	16:05:14	1	267	ca	0	3	3	0	6
146.531197	69.946134	12 Jun 98	16:05:27	1	58	ca	0	15	11	0	26
146.528258	69.931562	12 Jun 98	16:05:57	1	59	ca	0	3	2	0	5
146.568401	69.923700	12 Jun 98	16:06:14	1	60	ca	0	8	5	0	13
146.530027	69.919171	12 Jun 98	16:06:23	1	61	ca	0	20	15	0	35
146.604456	69.911437	12 Jun 98	16:08:57	1	64	ca	0	10	7	0	17
146.613146	69.915551	12 Jun 98	16:09:07	1	65	ca	0	60	25	0	85
146.571249	69.915551	12 Jun 98	16:09:07	1	66	ca	0	0	0	18	18
146.610527	69.915551	12 Jun 98	16:09:07	1	67	ca	0	1	1	0	2
146.601625	69.947380	12 Jun 98	16:10:20	1	68	ca	0	4	3	0	7
146.580663	69.947551	12 Jun 98	16:10:20	1	268	ca	0	14	13	0	27
146.575385	69.951328	12 Jun 98	16:10:28	1	69	ca	0	28	27	0	55
146.585845	69.951574	12 Jun 98	16:10:29	1	70	ca	0	25	20	0	45
146.604175	69.951574	12 Jun 98	16:10:29	1	71	ca	0	35	30	0	65
146.564897	69.951574	12 Jun 98	16:10:29	1	72	ca	0	1	1	0	2
146.568585	69.965343	12 Jun 98	16:11:00	1	269	ca	0	3	1	0	4
146.587655	69.986810	12 Jun 98	16:11:48	1	73	ca	0	1	1	0	2
146.568240	69.995964	12 Jun 98	16:12:08	1	74	ca	0	1	0	0	1
146.570101	70.016407	12 Jun 98	16:12:52	1	75	ca	0	1	0	0	1
146.610494	70.038696	12 Jun 98	16:13:40	1	76	ca	0	12	8	0	20
146.569264	70.134699	12 Jun 98	16:17:13	1	77	ca	0	3	3	0	6
146.618816	70.091572	12 Jun 98	16:22:43	1	78	ca	0	4	3	0	7
146.640307	70.051399	12 Jun 98	16:24:02	1	79	ca	0	30	20	0	50
146.632628	70.042709	12 Jun 98	16:24:20	1	270	ca	0	7	4	0	11
146.611102	70.039221	12 Jun 98	16:24:26	1	80	ca	0	14	10	0	24
146.639186	70.034308	12 Jun 98	16:24:36	1	81	ca	0	12	9	0	21
146.633949	70.034308	12 Jun 98	16:24:36	1	82	ca	0	12	11	0	23
146.642902	69.962583	12 Jun 98	16:26:59	1	83	ca	0	25	18	0	43
146.619699	69.957584	12 Jun 98	16:27:09	1	84	ca	0	42	25	0	67
146.609225	69.957584	12 Jun 98	16:27:09	1	85	ca	0	15	10	0	25
146.609623	69.924355	12 Jun 98	16:28:15	1	86	ca	0	0	0	1	1
146.610691	69.916025	12 Jun 98	16:28:32	1	87	ca	0	32	25	0	57
146.614316	69.911480	12 Jun 98	16:28:41	1	88	ca	0	4	3	0	7
146.655481	69.926942	12 Jun 98	16:30:42	1	89	ca	0	5	5	0	10
146.661104	69.931206	12 Jun 98	16:30:51	1	90	ca	0	42	38	0	80
146.674210	69.931336	12 Jun 98	16:30:51	1	91	ca	0	8	5	0	13
146.661117	69.931336	12 Jun 98	16:30:51	1	92	ca	0	14	13	0	27
146.655880	69.931336	12 Jun 98	16:30:51	1	93	ca	0	13	12	0	25
146.689370	70.011771	12 Jun 98	16:33:49	1	94	ca	0	0	0	1	1
146.650650	70.016102	12 Jun 98	16:33:58	1	95	ca	0	65	30	0	95
146.683537	70.056818	12 Jun 98	16:35:28	1	96	ca	0	14	10	0	24
146.655300	70.080088	12 Jun 98	16:36:19	1	97	ca	0	2	2	0	4
146.688542	70.083594	12 Jun 98	16:36:27	1	98	ca	0	18	15	0	33
146.697690	70.159368	12 Jun 98	17:06:37	1	99	ca	0	3	2	0	5
146.696207	70.134135	12 Jun 98	17:07:30	1	100	ca	0	6	4	0	10
146.734780	70.128575	12 Jun 98	17:07:42	1	101	ca	0	12	8	0	20
146.711179	70.112008	12 Jun 98	17:08:16	1	102	ca	0	2	0	0	2
146.695395	70.084643	12 Jun 98	17:09:14	1	103	ca	0	26	18	0	44
146.733329	70.071504	12 Jun 98	17:09:40	1	104	ca	0	24	15	0	39
146.692295	70.059489	12 Jun 98	17:10:05	1	105	ca	0	14	11	0	25
146.712060	69.979289	12 Jun 98	17:12:51	1	106	ca	0	18	11	0	29
146.712829	69.960707	12 Jun 98	17:13:30	1	107	ca	0	10	10	0	20
146.705281	69.943104	12 Jun 98	17:14:07	1	271	ca	0	15	8	0	23
146.719801	69.938939	12 Jun 98	17:14:16	1	108	ca	0	3	2	0	5
146.707937	69.934642	12 Jun 98	17:14:25	1	109	ca	0	3	2	0	5
146.704321	69.932278	12 Jun 98	17:14:30	1	272	ca	0	2	2	1	5

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
146.715792	69.926881	12 Jun 98	17:14:42	1	110	ca	0	4	4	2	10
146.731158	69.922764	12 Jun 98	17:14:50	1	111	ca	0	18	10	0	28
146.753622	69.914082	12 Jun 98	17:16:30	1	112	ca	0	13	10	0	23
146.773277	69.934030	12 Jun 98	17:17:16	1	113	ca	0	1	1	0	2
146.760526	69.937654	12 Jun 98	17:17:24	1	114	ca	0	1	1	0	2
146.774501	69.954621	12 Jun 98	17:18:04	1	115	ca	0	18	15	0	33
146.731116	69.958452	12 Jun 98	17:18:13	1	116	ca	0	5	3	0	8
146.736176	69.965808	12 Jun 98	17:18:30	1	117	ca	0	9	9	0	18
146.737864	69.978938	12 Jun 98	17:19:01	1	118	ca	0	8	8	0	16
146.735105	69.982890	12 Jun 98	17:19:10	1	119	ca	0	42	20	0	62
146.737724	69.982890	12 Jun 98	17:19:10	1	120	ca	0	22	10	0	32
146.732686	69.999388	12 Jun 98	17:19:49	1	121	ca	0	0	0	1	1
146.750120	70.015356	12 Jun 98	17:20:26	1	122	ca	0	1	1	0	2
146.745819	70.081830	12 Jun 98	17:23:04	1	124	ca	0	2	2	0	4
146.753561	70.113830	12 Jun 98	17:24:21	1	125	ca	0	1	0	0	1
146.749433	70.117609	12 Jun 98	17:24:30	1	126	ca	0	1	1	0	2
146.741567	70.124842	12 Jun 98	17:24:47	1	127	ca	0	4	2	0	6
146.758262	70.127765	12 Jun 98	17:24:54	1	128	ca	0	1	1	0	2
146.753746	70.138668	12 Jun 98	17:25:19	1	129	ca	0	1	0	0	1
146.741012	70.151872	12 Jun 98	17:25:50	1	130	ca	0	4	0	0	4
146.777226	70.156177	12 Jun 98	17:28:28	1	131	ca	0	0	0	1	1
146.784566	70.125270	12 Jun 98	17:29:31	1	132	ca	0	3	2	0	5
146.784022	70.075271	12 Jun 98	17:31:13	1	133	ca	0	1	1	0	2
146.791363	70.038117	12 Jun 98	17:32:31	1	134	ca	0	1	0	1	2
146.784478	69.999295	12 Jun 98	17:33:52	1	135	ca	0	6	6	0	12
146.783446	69.994481	12 Jun 98	17:34:02	1	136	ca	0	12	10	0	22
146.546123	69.994481	12 Jun 98	17:34:02	1	137	ca	0	6	0	1	7
146.797553	69.974063	12 Jun 98	17:34:44	1	138	ca	0	5	5	0	10
146.804485	69.969913	12 Jun 98	17:34:53	1	139	ca	0	16	15	0	31
146.778706	69.953503	12 Jun 98	17:35:28	1	140	ca	0	35	30	0	65
146.799189	69.948869	12 Jun 98	17:35:38	1	141	ca	0	16	14	0	30
146.786096	69.948869	12 Jun 98	17:35:38	1	142	ca	0	23	21	0	44
146.778240	69.948869	12 Jun 98	17:35:38	1	143	ca	0	12	10	0	22
146.792198	69.912427	12 Jun 98	17:36:54	1	144	ca	0	0	0	1	1
146.841050	69.957081	12 Jun 98	17:40:06	1	145	ca	0	3	3	0	6
146.852777	69.976004	12 Jun 98	17:40:50	1	146	ca	0	2	1	0	3
146.849958	69.980992	12 Jun 98	17:41:02	1	147	ca	0	2	2	0	4
146.843760	70.067102	12 Jun 98	17:44:21	1	148	ca	0	15	11	0	26
146.826441	70.139099	12 Jun 98	17:47:08	1	149	ca	0	1	1	0	2
146.881213	70.071736	12 Jun 98	17:53:25	1	150	ca	0	18	16	0	34
146.856519	70.066956	12 Jun 98	17:53:35	1	151	ca	0	13	0	0	13
146.879292	70.029998	12 Jun 98	17:54:51	1	152	ca	0	1	0	0	1
146.864228	70.006063	12 Jun 98	17:55:41	1	154	ca	0	0	0	1	1
146.895452	69.995146	12 Jun 98	17:56:04	1	155	ca	0	1	1	0	2
146.866866	69.979069	12 Jun 98	17:56:37	1	156	ca	0	2	2	0	4
146.899398	69.972569	12 Jun 98	17:56:50	1	157	ca	0	3	3	0	6
146.866123	69.951446	12 Jun 98	17:57:35	1	158	ca	0	2	2	0	4
146.907530	69.935276	12 Jun 98	18:01:20	1	160	ca	0	5	3	0	8
146.901688	69.990872	12 Jun 98	18:03:32	1	161	ca	0	0	0	1	1
146.896700	70.084292	12 Jun 98	18:07:11	1	162	ca	0	0	0	1	1
146.949515	70.023556	12 Jun 98	18:15:50	1	163	ca	0	0	0	2	2
146.964109	70.012814	12 Jun 98	18:16:13	1	164	ca	0	0	0	1	1
146.967485	70.008565	12 Jun 98	18:16:23	1	165	ca	0	10	10	0	20
146.027891	70.057433	12 Jun 98	14:23:28	2	1	ca	0	0	0	3	3
146.094233	70.076324	12 Jun 98	14:26:14	2	2	ca	0	11	9	0	20
146.062764	70.080726	12 Jun 98	14:26:23	2	3	ca	0	6	3	0	9

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
146.084068	70.083861	19 Jun 98	14:26:30	2	183	ca	0	1	2	0	3
146.081450	70.083861	19 Jun 98	14:26:30	2	184	ca	0	3	2	0	5
146.096841	70.101483	19 Jun 98	14:27:08	2	4	ca	0	0	0	1	1
146.081839	70.119869	19 Jun 98	14:27:48	2	5	ca	0	0	0	1	1
146.089210	70.123736	19 Jun 98	14:27:56	2	6	ca	0	5	3	0	8
146.115212	70.066418	19 Jun 98	14:31:46	2	7	ca	0	1	0	0	1
146.140918	70.050756	19 Jun 98	14:32:18	2	8	ca	0	0	0	2	2
146.182995	70.029011	19 Jun 98	14:34:30	2	9	ca	0	1	1	0	2
146.141719	70.050898	19 Jun 98	14:35:15	2	10	ca	0	4	4	0	8
146.160831	70.060304	19 Jun 98	14:35:34	2	11	ca	0	1	0	0	1
146.166483	70.146198	19 Jun 98	14:38:39	2	12	ca	0	4	2	0	6
146.226250	70.075218	19 Jun 98	14:42:10	2	13	ca	0	0	0	4	4
146.193144	70.016349	19 Jun 98	14:44:11	2	14	ca	0	1	0	0	1
146.223304	70.006221	19 Jun 98	14:45:45	2	15	ca	0	24	18	0	42
146.281055	69.978942	19 Jun 98	14:49:12	2	187	ca	0	36	0	0	36
146.273328	69.975722	19 Jun 98	14:49:31	2	17	ca	0	90	40	0	130
146.246635	70.002540	19 Jun 98	14:50:28	2	18	ca	0	5	3	0	8
146.263412	70.005956	19 Jun 98	14:50:36	2	185	ca	0	3	4	0	7
146.236412	70.028609	19 Jun 98	14:51:25	2	19	ca	0	8	3	0	11
146.265733	70.058851	19 Jun 98	14:52:29	2	20	ca	0	15	4	0	19
146.228562	70.073911	19 Jun 98	14:53:01	2	21	ca	0	8	3	0	11
146.267558	70.109552	19 Jun 98	14:54:16	2	22	ca	0	2	1	0	3
146.232007	70.113661	19 Jun 98	14:54:25	2	23	ca	0	0	0	2	2
146.254002	70.148079	19 Jun 98	14:55:38	2	24	ca	0	1	1	0	2
146.252058	70.152033	19 Jun 98	14:55:46	2	25	ca	0	1	0	0	1
146.361234	69.949758	19 Jun 98	15:06:03	2	27	ca	0	85	54	0	139
146.342308	69.963673	19 Jun 98	15:06:34	2	28	ca	0	4	1	0	5
146.343813	69.987196	19 Jun 98	15:07:24	2	29	ca	0	1	1	0	2
146.310900	70.048548	19 Jun 98	15:09:33	2	30	ca	0	40	20	0	60
146.327771	70.083030	19 Jun 98	15:11:48	2	31	ca	0	1	0	0	1
146.366955	70.118059	19 Jun 98	15:17:02	2	32	ca	0	2	2	1	5
146.391542	70.033270	19 Jun 98	15:19:55	2	33	ca	0	13	11	0	24
146.360183	70.020579	19 Jun 98	15:20:21	2	186	ca	0	22	17	0	39
146.395277	69.948859	19 Jun 98	15:26:39	2	34	ca	0	1	0	0	1
146.394265	70.038734	19 Jun 98	15:29:51	2	35	ca	0	12	6	0	18
146.424360	70.113795	19 Jun 98	15:32:23	2	36	ca	0	30	16	0	46
146.467920	70.169515	19 Jun 98	15:36:18	2	37	ca	0	1	1	0	2
146.447049	70.149435	19 Jun 98	15:36:58	2	38	ca	0	3	3	0	6
146.470750	70.134225	19 Jun 98	15:37:29	2	39	ca	0	1	1	0	2
146.482729	70.092160	19 Jun 98	15:38:55	2	40	ca	0	11	6	0	17
146.475924	70.052783	19 Jun 98	15:40:10	2	41	ca	0	67	21	0	88
146.524938	70.024461	19 Jun 98	15:51:20	2	42	ca	0	0	0	1	1
146.534873	70.091163	19 Jun 98	15:53:46	2	43	ca	0	102	55	0	157
146.499805	70.157925	19 Jun 98	15:57:15	2	44	ca	0	1	1	0	2
146.528179	70.164499	19 Jun 98	15:57:29	2	45	ca	0	6	4	0	10
146.536222	70.161415	19 Jun 98	15:58:27	2	46	ca	0	10	7	0	17
146.531821	70.143217	19 Jun 98	15:59:04	2	47	ca	0	2	0	0	2
146.598514	70.023100	19 Jun 98	16:11:54	2	48	ca	0	1	1	0	2
146.587784	70.042184	19 Jun 98	16:12:35	2	49	ca	0	1	0	0	1
146.571275	70.113015	19 Jun 98	16:15:06	2	50	ca	0	8	5	0	13
146.564269	70.138969	19 Jun 98	16:16:00	2	51	ca	0	4	3	0	7
146.603385	70.163900	19 Jun 98	16:16:53	2	52	ca	0	5	3	0	8
146.590198	70.170388	19 Jun 98	16:17:06	2	53	ca	0	2	2	0	4
146.632919	70.155594	19 Jun 98	16:18:08	2	54	ca	0	13	10	0	23
146.631412	70.152231	19 Jun 98	16:18:15	2	188	ca	0	2	2	0	4
146.615878	70.151036	19 Jun 98	16:18:18	2	55	ca	0	22	12	0	34

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
146.614250	70.102022	19 Jun 98	16:19:58	2	56	ca	0	27	13	0	40
146.653947	70.091823	19 Jun 98	16:33:47	2	57	ca	0	145	110	0	255
146.697462	70.144615	19 Jun 98	16:39:08	2	58	ca	0	15	9	0	24
146.712368	70.139855	19 Jun 98	16:39:18	2	59	ca	0	1	0	0	1
146.774283	70.042287	19 Jun 98	16:52:48	2	60	ca	0	0	0	1	1
146.779538	70.110098	19 Jun 98	16:55:04	2	61	ca	0	48	18	0	66
146.781729	70.144296	19 Jun 98	16:57:35	2	62	ca	0	22	15	0	37
146.781263	70.153835	19 Jun 98	17:00:48	2	63	ca	0	3	0	0	3
146.815365	70.149232	19 Jun 98	17:00:57	2	64	ca	0	6	3	0	9
146.807509	70.149232	19 Jun 98	17:00:57	2	65	ca	0	22	15	0	37
146.798514	70.122584	19 Jun 98	17:01:50	2	66	ca	0	1	0	0	1
146.803662	70.027116	19 Jun 98	17:04:57	2	67	ca	0	110	17	0	127
146.858069	70.084434	19 Jun 98	17:17:24	2	68	ca	0	10	6	0	16
146.826386	70.094587	19 Jun 98	17:17:46	2	69	ca	0	12	0	0	12
146.820708	70.113243	19 Jun 98	17:18:26	2	70	ca	0	0	0	1	1
146.861927	70.138293	19 Jun 98	17:22:13	2	71	ca	0	2	2	0	4
146.902850	70.127222	19 Jun 98	17:22:31	2	72	ca	0	57	36	0	93
146.898224	70.115006	19 Jun 98	17:24:52	2	73	ca	0	34	20	0	54
146.890456	70.090278	19 Jun 98	17:25:41	2	74	ca	0	72	60	0	132
146.865381	70.085787	19 Jun 98	17:25:51	2	75	ca	0	12	8	0	20
146.921479	70.078788	19 Jun 98	17:38:45	2	76	ca	0	3	0	0	3
146.915620	70.085059	19 Jun 98	17:41:08	2	77	ca	0	165	120	0	285
146.943341	70.095218	19 Jun 98	17:42:37	2	78	ca	0	18	10	0	28
146.924879	70.094787	19 Jun 98	17:42:50	2	79	ca	0	55	32	0	87
146.953806	70.112367	19 Jun 98	17:43:16	2	80	ca	0	47	32	0	79
146.923728	70.116454	19 Jun 98	17:43:25	2	81	ca	0	8	5	0	13
146.985463	70.093707	19 Jun 98	17:47:28	2	82	ca	0	48	28	0	76
146.069502	70.137894	29 Jun 98	13:10:42	3	1	ca	0	1	0	0	1
146.242673	70.171213	29 Jun 98	13:38:02	3	2	ca	25	89	30	0	144
146.578089	70.175892	29 Jun 98	15:01:33	3	3	ca	0	1	0	0	1
146.886564	70.159221	29 Jun 98	16:04:04	3	4	ca	80	275	25	0	380
146.978607	70.150456	29 Jun 98	16:27:21	3	5	ca	25	70	12	0	107
146.058462	70.137536	6 Jul 98	16:27:55	4	1	ca	0	1	0	0	1
146.108959	70.145009	6 Jul 98	16:29:30	4	2	ca	50	250	150	0	450
146.098663	70.133255	6 Jul 98	16:32:07	4	3	ca	0	3	1	0	4
146.097157	70.129343	6 Jul 98	16:32:15	4	4	ca	0	1	1	0	2
146.159976	70.074758	6 Jul 98	16:38:25	4	5	ca	105	450	250	0	805
146.142259	70.125778	6 Jul 98	16:43:35	4	6	ca	0	1	1	0	2
146.254613	69.987039	6 Jul 98	16:53:36	4	7	ca	650	600	200	0	1450
146.097275	70.075371	13 Jul 98	15:02:30	5	128	ca	0	0	0	15	15
146.142429	70.092886	13 Jul 98	15:07:51	5	1	ca	0	1	0	0	1
146.279464	70.012752	13 Jul 98	15:19:30	5	129	ca	1	0	0	0	1
146.303375	69.969620	13 Jul 98	15:33:18	5	3	ca	0	1	0	0	1
146.391907	70.065836	13 Jul 98	15:48:24	5	4	ca	5	15	10	0	30
146.416200	69.922913	13 Jul 98	15:55:34	5	6	ca	1	3	0	0	4
146.394701	70.068937	13 Jul 98	16:01:05	5	7	ca	0	0	0	20	20
146.460222	69.975650	13 Jul 98	16:13:07	5	8	ca	25	4	20	0	49
146.479633	69.955535	13 Jul 98	16:13:48	5	9	ca	0	0	0	2	2
146.486936	69.945750	13 Jul 98	16:17:58	5	10	ca	0	0	0	2	2
146.483652	69.955432	13 Jul 98	16:18:21	5	11	ca	0	0	0	1	1
146.511565	69.986367	13 Jul 98	16:19:32	5	12	ca	0	1	0	0	1
146.557232	69.962983	13 Jul 98	16:35:21	5	13	ca	1	0	0	0	1
146.570083	69.949839	13 Jul 98	16:39:47	5	14	ca	0	1	0	0	1
146.651073	70.054482	13 Jul 98	16:53:23	5	15	ca	0	1	1	0	2
146.648515	69.995456	13 Jul 98	16:55:23	5	16	ca	100	250	150	0	500
146.712545	70.149376	13 Jul 98	17:10:36	5	18	ca	0	1	1	0	2

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
146.735802	69.955495	13 Jul 98	17:21:28	5	19	ca	0	1	0	0	1
146.756119	69.984590	13 Jul 98	17:22:33	5	20	ca	0	0	0	1	1
146.809769	70.134332	13 Jul 98	17:31:52	5	21	ca	0	5	4	0	9
146.772171	70.125693	13 Jul 98	17:32:09	5	22	ca	0	5	1	0	6
146.791360	70.046122	13 Jul 98	17:34:51	5	23	ca	0	1	1	0	2
146.817733	70.004933	13 Jul 98	17:36:12	5	24	ca	0	8	6	0	14
146.841469	69.980360	13 Jul 98	17:43:07	5	25	ca	0	1	1	0	2
146.853606	70.138575	13 Jul 98	17:48:58	5	26	ca	0	2	2	0	4
146.977800	70.031920	13 Jul 98	18:33:47	5	27	ca	0	1	0	0	1
146.231253	69.987473	26 Jul 98	13:36:58	6	1	ca	0	0	0	6	6
146.265400	69.989156	26 Jul 98	13:50:50	6	2	ca	0	61	42	0	103
146.310739	69.971660	26 Jul 98	13:56:06	6	3	ca	0	20	10	0	30
146.352632	69.998549	26 Jul 98	13:57:06	6	4	ca	0	1	1	0	2
146.566957	69.932689	26 Jul 98	14:55:06	6	1	ca	0	2	0	8	10
146.504794	69.942446	26 Jul 98	14:56:00	6	2	ca	2	140	35	0	175
146.595802	69.928726	26 Jul 98	14:59:50	6	4	ca	0	2	1	0	3
146.618118	69.937145	26 Jul 98	15:00:08	6	5	ca	0	1	1	0	2
146.608261	70.043245	26 Jul 98	15:04:03	6	6	ca	0	12	8	0	20
146.629955	70.030407	26 Jul 98	15:14:48	6	7	ca	0	5	1	0	6
146.647843	70.012876	26 Jul 98	15:15:48	6	8	ca	5	45	15	0	65
146.654414	69.993662	26 Jul 98	15:17:11	6	9	ca	2	0	10	40	52
146.650636	69.967678	26 Jul 98	15:18:04	6	10	ca	0	3	1	0	4
146.622309	69.933640	26 Jul 98	15:19:11	6	11	ca	0	1	1	0	2
146.688272	69.926977	26 Jul 98	15:21:23	6	12	ca	0	1	0	0	1
146.657577	69.940714	26 Jul 98	15:21:54	6	13	ca	0	1	0	0	1
146.665541	69.974002	26 Jul 98	15:23:07	6	14	ca	0	3	2	0	5
146.664906	69.996557	26 Jul 98	15:23:56	6	15	ca	3	25	7	0	35
146.734723	70.043788	26 Jul 98	15:35:32	6	16	ca	0	1	1	0	2
146.690862	69.987684	26 Jul 98	15:37:23	6	17	ca	0	5	3	0	8
146.710591	69.953487	26 Jul 98	15:38:31	6	18	ca	0	1	0	0	1
146.692076	69.927366	26 Jul 98	15:39:23	6	19	ca	0	1	0	0	1
146.736664	70.012400	26 Jul 98	15:44:42	6	22	ca	0	1	0	0	1
146.775096	70.058326	26 Jul 98	15:46:26	6	23	ca	0	1	1	0	2
146.774713	69.958267	26 Jul 98	15:58:49	6	24	ca	0	1	0	0	1
146.806185	69.943873	26 Jul 98	15:59:18	6	25	ca	0	1	1	0	2
146.801534	69.940290	26 Jul 98	15:59:25	6	26	ca	1	0	0	0	1
146.844066	69.918357	26 Jul 98	16:01:45	6	28	ca	0	1	1	0	2
146.843857	69.928386	26 Jul 98	16:02:06	6	29	ca	0	1	1	0	2
146.830709	69.946487	26 Jul 98	16:02:46	6	30	ca	0	1	0	0	1
146.838541	69.993947	26 Jul 98	16:04:32	6	31	ca	0	1	0	0	1
146.884138	69.952117	26 Jul 98	16:36:27	6	32	ca	0	1	0	0	1
146.871633	69.936049	26 Jul 98	16:36:59	6	33	ca	0	1	0	0	1
146.933216	69.920342	26 Jul 98	16:39:06	6	34	ca	0	1	0	0	1
146.914689	69.925537	26 Jul 98	16:39:17	6	35	ca	0	1	1	0	2
146.931269	69.979212	26 Jul 98	16:41:19	6	36	ca	0	1	0	0	1
146.927774	69.992043	26 Jul 98	16:41:48	6	37	ca	0	1	0	0	1
146.901843	70.082212	26 Jul 98	16:45:11	6	38	ca	0	0	0	1	1
146.920342	70.150899	26 Jul 98	16:47:48	6	39	ca	0	4	2	0	6
146.941181	70.151295	26 Jul 98	16:47:49	6	40	ca	0	2	2	0	4
146.987276	70.154178	26 Jul 98	16:48:55	6	41	ca	0	25	10	0	35
146.990295	70.065911	26 Jul 98	16:51:48	6	42	ca	0	0	0	1	1
146.990295	70.061294	26 Jul 98	16:51:57	6	43	ca	0	0	0	1	1
146.948398	70.061294	26 Jul 98	16:51:57	6	44	ca	0	1	0	0	1
146.968054	70.028066	26 Jul 98	16:53:03	6	45	ca	0	1	1	0	2
146.945608	70.009427	26 Jul 98	16:53:40	6	46	ca	0	1	0	0	1
146.970581	69.929964	26 Jul 98	16:56:15	6	47	ca	0	2	0	0	2

Table A-1. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
146.974123	69.911185	26 Jul 98	16:56:53	6	48	ca	0	1	1	0	2
146.358503	69.984667	26 Jul 98		6	149	ca	0	9	6	0	15
146.390593	69.994833	26 Jul 98		6	150	ca	0	1	0	0	1
146.361789	69.994833	26 Jul 98		6	151	ca	11	80	40	0	131
146.374833	69.927333	26 Jul 98		6	152	ca	0	3	2	0	5
146.438060	69.938333	26 Jul 98		6	153	ca	0	1	1	0	2
146.420785	69.955667	26 Jul 98		6	154	ca	0	1	1	0	2
146.416669	69.986500	26 Jul 98		6	155	ca	0	1	0	0	1
146.414333	70.005833	26 Jul 98		6	156	ca	0	1	0	0	1
146.440385	69.926833	26 Jul 98		6	157	ca	0	20	20	0	40
146.509119	69.917500	26 Jul 98		6	158	ca	0	1	0	0	1
146.042683	70.119744	10 Aug 98	13:17:05	7	2	ca	0	1	0	0	1

Table A-2. Brown bear and muskoxen sightings in the Bullen Point to Staines River 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
146.775663	70.042388	12 Jun 98	17:21:31	1	123	bb	0	0	0	2	2
146.220099	69.999223	19 Jun 98	14:46:14	2	16	mx	0	0	0	5	5
146.973622	69.939377	29 Jun 98	16:37:00	3	6	mx	4	0	0	0	4
146.778614	69.929772	26 Jul 98	15:41:38	6	21	mx	1	0	0	0	1
146.793441	69.928266	26 Jul 98	15:59:48	6	27	mx	1	0	0	0	1
146.365740	69.923602	10 Aug 98	14:19:16	7	3	mx	0	2	0	15	17

Table A-3. Opportunistic large mammal sightings recorded outside the defined Bullen Point to Staines River 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
146.054997	70.010955	12 Jun 98	13:57:56	1	1	mx	0	0	0	1	1
146.313277	69.952414	12 Jun 98	15:04:43	1	16	ca	0	1	0	0	1
146.565674	69.906786	12 Jun 98	16:06:48	1	62	ca	0	30	15	0	45
146.567479	69.901911	12 Jun 98	16:06:58	1	63	ca	0	8	3	0	11
146.241260	69.979747	13 Jun 98	15:18:13	5	2	ca	0	1	0	0	1
146.319067	69.928097	13 Jun 98	15:33:55	5	130	ca	0	0	0	750	750
146.394796	69.908088	13 Jun 98	15:53:46	5	5	ca	0	0	0	1	1
147.260477	70.142928	26 Jul 98	12:54:02	6	159	ca	0	0	0	112	112
146.309195	69.935600	26 Jul 98	13:54:28	6	160	ca	0	0	0	20	20
146.309125	69.935800	26 Jul 98	13:54:29	6	161	ca	0	0	0	15	15
146.541618	69.902430	26 Jul 98	14:58:11	6	3	ca	0	2	2	0	4
146.763933	69.909733	26 Jul 98	15:40:54	6	20	ca	0	1	0	0	1

Table A-4. Caribou density (number/km^2) by sex/age class for 1-km intervals from the Beaufort Sea coast in the Bullen Point to Staines River study area, Alaska, 12 June to 10 August 1998.

	One-Kilometer Intervals																				Area and Caribou Totals
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Area	43.4	36.2	35.4	35.0	34.5	33.7	33.8	34.3	33.4	33.2	32.9	32.4	31.1	31.2	31.0	29.1	29.1	29.3	29.1	27.7	655.9
Survey 1 (12 June 1998)																					
Bulls	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)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	0
Calves	0.05	0.11	0.08	0.37	0.26	0.39	0.03	0.00	0.18	0.66	1.55	0.49	0.35	1.98	1.23	2.10	0.10	1.09	0.55	2.05	
	(2)	(4)	(3)	(13)	(9)	(13)	(1)	(0)	(6)	(22)	(51)	(16)	(11)	(62)	(38)	(61)	(3)	(32)	(16)	(57)	420
Total	0.12	0.30	0.34	0.97	0.61	0.98	0.15	0.20	0.60	1.42	3.95	1.26	0.90	4.93	3.00	6.46	0.34	3.62	1.27	4.58	
	(5)	(11)	(12)	(34)	(21)	(33)	(5)	(7)	(20)	(47)	(130)	(41)	(28)	(154)	(93)	(188)	(10)	(106)	(37)	(127)	1109
Survey 2 (19 June 1998)																					
Bulls	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)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	0
Calves	0.07	0.17	1.67	1.80	1.77	0.86	2.04	6.12	0.81	5.24	0.12	0.12	0.64	0.80	0.19	0.96	1.45	0.03	0.00	0.04	
	(3)	(6)	(59)	(63)	(61)	(29)	(69)	(210)	(27)	(174)	(4)	(4)	(20)	(25)	(6)	(28)	(42)	(1)	(0)	(1)	832
Total	0.14	0.47	4.29	4.59	4.59	2.46	6.00	14.88	2.52	13.31	0.30	0.59	1.93	3.23	0.68	5.19	3.30	0.10	0.00	1.37	
	(6)	(17)	(152)	(161)	(158)	(83)	(203)	(511)	(84)	(442)	(10)	(19)	(60)	(101)	(21)	(151)	(96)	(3)	(0)	(38)	2316
Survey 3 (29 June 1998)																					
Bulls	3.00	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	
	(130)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	130
Calves	1.54	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	
	(67)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	67
Total	14.59	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	
	(633)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	633

Table A-4. Continued.

	One-Kilometer Intervals																				Area and Caribou Totals
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Area	43.4	36.2	35.4	35.0	34.5	33.7	33.8	34.3	33.4	33.2	32.9	32.4	31.1	31.2	31.0	29.1	29.1	29.3	29.1	27.7	655.9
Survey 4 (6 July 1998)																					
Bulls	1.15	0.00	0.00	0.00	0.00	0.00	0.00	3.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.36	0.00	
	(50)	(0)	(0)	(0)	(0)	(0)	(0)	(105)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(650)	(0)	805
Calves	3.46	0.06	0.03	0.00	0.00	0.00	0.00	7.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.88	0.00	
	(150)	(2)	(1)	(0)	(0)	(0)	(0)	(250)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(200)	(0)	603
Total	10.39	0.17	0.06	0.00	0.00	0.00	0.00	23.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	49.87	0.00	
	(451)	(6)	(2)	(0)	(0)	(0)	(0)	(805)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	####	(0)	2714
Survey 5 (13 July 1998)																					
Bulls	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.03	0.00	0.00	3.60	
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(5)	(0)	(0)	(0)	(1)	(0)	(0)	(100)	106
Calves	0.00	0.00	0.08	0.11	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.06	0.00	0.00	0.00	0.20	0.00	5.44	
	(0)	(0)	(3)	(4)	(0)	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(10)	(2)	(0)	(0)	(0)	(6)	(0)	(151)	177
Total	0.00	0.00	0.17	0.26	0.00	0.21	0.00	0.44	0.00	0.00	0.00	0.62	1.00	0.13	0.00	0.00	0.03	0.48	0.00	18.10	
	(0)	(0)	(6)	(9)	(0)	(7)	(0)	(15)	(0)	(0)	(0)	(20)	(31)	(4)	(0)	(0)	(1)	(14)	(0)	(502)	609
Survey 6 (26 July 1998)																					
Bulls	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	0.17	0.50	
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(5)	(14)	19
Calves	0.28	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.29	0.00	0.03	0.00	1.99	1.69	
	(12)	(2)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(2)	(0)	(9)	(0)	(1)	(0)	(58)	(47)	131
Total	0.90	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.13	0.00	0.71	0.03	0.21	0.07	6.16	6.02	
	(39)	(6)	(0)	(0)	(0)	(0)	(0)	(0)	(2)	(2)	(0)	(0)	(4)	(0)	(22)	(1)	(6)	(2)	(179)	(167)	430
Survey 7 (10 August 1998)																					
Bulls	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)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	0
Calves	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)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	0
Total	0.00	0.00	0.03	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)	(0)	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	1

Table A-5. Caribou density (number/km^2) by sex/age class for 1-km intervals from the Beaufort Sea coast in the Badami study area, Alaska, 10 June to 11 August 1998.

	One-Kilometer Intervals																				Area and Caribou Totals
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Area (km^2)	92.2	55.5	46.0	42.7	44.2	42.2	43.1	43.9	43.2	42.8	40.4	41.2	42.0	39.8	40.8	39.9	36.2	31.4	27.3	26.0	860.8
Survey 1 (10 June 1998)																					
Bulls	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	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)	(0)	(0)	(0)	(0)	(0)	(0)	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	1
Calves	0.01	0.00	0.09	0.07	0.07	0.00	0.07	0.07	0.25	0.33	0.17	0.00	0.21	0.08	0.44	0.60	0.30	0.00	0.11	0.00	
	(1)	(0)	(4)	(3)	(3)	(0)	(3)	(3)	(11)	(14)	(7)	(0)	(9)	(3)	(18)	(24)	(11)	(0)	(3)	(0)	117
Total	0.04	0.09	0.24	0.21	0.23	0.00	0.19	0.27	0.86	0.93	0.47	0.12	0.62	0.35	1.05	1.71	0.91	0.10	0.29	0.15	
	(4)	(5)	(11)	(9)	(10)	(0)	(8)	(12)	(37)	(40)	(19)	(5)	(26)	(14)	(43)	(68)	(33)	(3)	(8)	(4)	359
Survey 2 (15 June 1998)																					
Bulls	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00	
	(1)	(1)	(0)	(0)	(0)	(0)	(0)	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(2)	(2)	(0)	(0)	(0)	(0)	7
Calves	0.00	0.05	0.07	0.28	0.02	0.17	0.14	0.25	0.19	0.33	0.25	1.89	0.31	1.61	0.00	0.05	0.03	0.57	1.36	0.12	
	(0)	(3)	(3)	(12)	(1)	(7)	(6)	(11)	(8)	(14)	(10)	(78)	(13)	(64)	(0)	(2)	(1)	(18)	(37)	(3)	291
Total	0.01	0.23	0.26	0.84	0.07	0.50	0.53	0.89	0.39	1.10	0.92	6.36	1.05	4.19	0.20	0.43	0.39	1.53	4.07	0.35	
	(1)	(13)	(12)	(36)	(3)	(21)	(23)	(39)	(17)	(47)	(37)	(262)	(44)	(167)	(8)	(17)	(14)	(48)	(111)	(9)	929
Survey 3 (30 June 1998)																					
Bulls	0.70	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	
	(65)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	65
Calves	0.29	0.02	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	
	(27)	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	28
Total	4.63	0.16	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	
	(427)	(9)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	436

Table A-5. Continued.

	One-Kilometer Intervals																				Area and Caribou Totals
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Survey 4 (9 July 1998)																					
Bulls	0.00	0.02	0.00	0.70	0.07	0.19	0.67	3.69	0.00	0.96	1.98	0.00	0.10	0.05	0.00	0.00	0.00	0.00	0.00	0.00	
	(0)	(1)	(0)	(30)	(3)	(8)	(29)	(162)	(0)	(41)	(80)	(0)	(4)	(2)	(0)	(0)	(0)	(0)	(0)	(0)	360
Calves	0.00	0.00	0.09	1.08	0.05	0.47	4.06	5.26	0.00	0.84	4.77	0.24	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	(0)	(0)	(4)	(46)	(2)	(20)	(175)	(231)	(0)	(36)	(193)	(10)	(21)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	738
Total	0.00	0.14	0.22	4.29	0.48	2.08	11.53	20.01	0.02	4.16	16.72	1.12	1.41	0.10	0.00	0.03	0.00	0.00	0.00	0.00	
	(0)	(8)	(10)	(183)	(21)	(88)	(497)	(879)	(1)	(178)	(676)	(46)	(59)	(4)	(0)	(1)	(0)	(0)	(0)	(0)	2651
Survey 5 (16 July 1998)																					
Bulls	2.60	1.24	2.65	0.00	2.96	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	(240)	(69)	(122)	(0)	(131)	(0)	(0)	(0)	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	563
Calves	4.74	0.97	3.26	0.00	4.30	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	
	(437)	(54)	(150)	(0)	(190)	(0)	(0)	(3)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(1)	835
Total	20.71	6.61	17.01	1.19	21.08	0.00	0.02	0.18	0.05	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.04	0.08	
	(1909)	(367)	(783)	(51)	(932)	(0)	(1)	(8)	(2)	(0)	(0)	(0)	(0)	(1)	(0)	(0)	(0)	(0)	(1)	(2)	4057
Survey 6 (22 July 1998)																					
Bulls	3.07	7.73	0.43	0.84	0.00	3.67	0.46	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	(283)	(429)	(20)	(36)	(0)	(155)	(20)	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	944
Calves	4.15	12.93	1.17	0.52	0.27	3.31	1.16	0.00	0.00	0.00	0.10	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	(383)	(718)	(54)	(22)	(12)	(140)	(50)	(0)	(0)	(0)	(4)	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	1384
Total	23.18	60.58	3.65	5.18	0.81	14.68	3.71	0.02	5.86	0.00	0.35	0.07	0.05	0.03	0.00	0.00	0.00	0.03	0.00	0.00	
	(2137)	#####	(168)	(221)	(36)	(620)	(160)	(1)	(253)	(0)	(14)	(3)	(2)	(1)	(0)	(0)	(0)	(1)	(0)	(0)	6980
Survey 7 (11 August 1998)																					
Bulls	0.01	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	
	(1)	(0)	(0)	(0)	(1)	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(1)	(0)	4
Calves	0.01	0.02	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	
	(1)	(1)	(0)	(1)	(0)	(0)	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(1)	(1)	(0)	(0)	6
Total	0.03	0.05	0.04	0.07	0.05	0.02	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.06	0.06	0.04	0.00	
	(3)	(3)	(2)	(3)	(2)	(1)	(3)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(1)	(0)	(2)	(2)	(1)	(0)	23

APPENDIX B.

MOSQUITO AND OESTRID ACTIVITY INDICES

Appendix B. Mosquito and Oestrid Activity Indices.

Mosquito Activity Index

IF temperature >18°C THEN $TI_m = 1$
IF temperature <6°C THEN $TI_m = 0$
$TI_m = 1\text{-}((18\text{-temperature})/13)$
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 is IF (logical test, value if true, value if false)

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

Oestrid Activity Index

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

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.

$TI_o = IF\ (T_h < 13, 0, IF(T_h > 18, 1, (1\text{-}((18\text{-}T_h)/10))))$
$WI_o = IF\ (V_h > 9, 0, ((9\text{-}V_h)/9))$
and $I_o = TI_o \times Wi_o$

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		Oestrid Index	
				Number of Records <0.5	Number of Records ≥0.5	Number of Records <0.5	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

APPENDIX C.

1993 DATA

Table C-1. Sex and age classification for caribou observed during systematic aerial surveys in the Bullen Point to Staines River study area, Alaska, 16 June to 18 August 1993.

Flight	Date	Number of Caribou					Number	Mean
		Bulls	Cows	Calves	Unclassified	Total	Of Groups	Group Size
1	16 Jun 93	74	935	563	55	1627	100	16.3
2	22 Jun 93	0	341	297	45	683	41	16.7
3	6-7 Jul 93	561	2921	1978	270	5730	9	636.7
4	20 July 93	3	0	0	0	3	2	1.5
5	27 July 93	139	11	6	42	198	73	2.7
6	5 Aug 93	6	2	2	0	10	6	1.7
7	18 Aug 93	1	1	0	1	3	3	1.0

Table C-2. Caribou sightings in the Bullen Point to Staines River study area, Alaska, summer 1993. Coordinates are longitude, latitude, and datum is WGS 84.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
146.099124	70.072318	16 Jun 93	12:52:11	2	15	ca	0	25	14	0	39
146.092411	70.079223	16 Jun 93	12:55:06	2	16	ca	0	1	1	0	2
146.076335	70.104556	16 Jun 93	12:56:22	2	17	ca	0	3	2	0	5
146.060528	70.106564	16 Jun 93	12:56:28	2	18	ca	0	6	4	0	10
146.075229	70.117520	16 Jun 93	12:57:01	2	20	ca	0	5	3	0	8
146.229767	70.001666	16 Jun 93	13:52:33	2	35	ca	0	0	0	2	2
146.271705	70.102091	16 Jun 93	13:57:15	2	36	ca	0	12	8	1	21
146.271787	70.108859	16 Jun 93	13:57:34	2	38	ca	0	2	2	0	4
146.243648	70.139062	16 Jun 93	13:58:59	2	39	ca	0	2	0	0	2
146.250730	70.174902	16 Jun 93	14:03:23	2	40	ca	0	2	2	0	4
146.306087	70.088963	16 Jun 93	14:08:04	2	41	ca	0	5	1	0	6
146.307030	70.032354	16 Jun 93	14:11:58	2	42	ca	2	0	0	17	19
146.277938	70.025722	16 Jun 93	14:12:16	2	43	ca	11	0	0	4	15
146.281973	69.996209	16 Jun 93	14:13:36	2	44	ca	12	5	0	0	17
146.303168	69.981845	16 Jun 93	14:14:15	2	45	ca	3	0	0	2	5
146.286254	69.974742	16 Jun 93	14:15:59	2	47	ca	2	0	0	0	2
146.337099	70.028461	16 Jun 93	14:31:58	2	52	ca	0	1	0	0	1
146.385858	70.116127	16 Jun 93	14:44:08	2	1	ca	0	6	4	0	10
146.391624	70.025415	16 Jun 93	14:49:48	2	1	ca	0	3	3	0	6
146.362428	69.998299	16 Jun 93	14:52:04	2	2	ca	4	0	0	3	7
146.372580	69.989051	16 Jun 93	14:53:02	2	3	ca	1	0	0	0	1
146.371946	69.965459	16 Jun 93	14:54:31	2	4	ca	0	3	0	0	3
146.395090	69.962543	16 Jun 93	14:54:39	2	5	ca	4	0	0	0	4
146.385367	69.949723	16 Jun 93	14:55:14	2	6	ca	1	1	1	0	3
146.439126	70.000888	16 Jun 93	15:01:55	2	7	ca	0	4	0	1	5
146.397502	70.106318	16 Jun 93	15:07:56	2	8	ca	0	0	0	3	3
146.440124	70.112814	16 Jun 93	15:08:14	2	9	ca	1	0	0	0	1
146.397844	70.115532	16 Jun 93	15:08:22	2	10	ca	0	5	4	0	9
146.423456	70.160338	16 Jun 93	15:12:05	2	11	ca	0	2	2	0	4
146.459345	70.173971	16 Jun 93	15:14:42	2	12	ca	1	0	0	0	1
146.460242	70.163043	16 Jun 93	15:15:12	2	13	ca	0	1	1	0	2
146.461427	70.124924	16 Jun 93	15:16:53	2	14	ca	0	6	6	0	12
146.450966	70.067011	16 Jun 93	15:21:04	2	15	ca	0	9	5	0	14
146.483058	69.936247	16 Jun 93	15:28:16	2	16	ca	2	0	0	3	5
146.484082	69.930011	16 Jun 93	15:30:52	2	17	ca	4	0	0	0	4
146.507567	70.014350	16 Jun 93	15:34:52	2	18	ca	0	1	0	0	1

Table C-2. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
146.514808	70.019828	16 Jun 93	15:35:08	2	19	ca	0	9	7	0	16
146.493600	70.115259	16 Jun 93	15:40:41	2	20	ca	0	2	2	0	4
146.482497	70.129097	16 Jun 93	15:41:22	2	21	ca	0	7	6	0	13
146.482702	70.130709	16 Jun 93	15:42:58	2	22	ca	1	1	1	0	3
146.525405	70.085923	16 Jun 93	15:51:18	2	23	ca	1	0	0	0	1
146.562242	70.024076	16 Jun 93	15:54:06	2	24	ca	1	0	0	0	1
146.566496	69.982426	16 Jun 93	15:56:01	2	25	ca	0	5	4	0	9
146.582670	69.990957	16 Jun 93	15:57:12	2	26	ca	6	34	23	0	63
146.570307	69.972884	16 Jun 93	15:59:25	2	27	ca	8	54	27	0	89
146.592554	69.970118	16 Jun 93	16:00:29	2	28	ca	0	6	2	0	8
146.555747	69.980028	16 Jun 93	16:01:25	2	29	ca	0	2	0	0	2
146.544172	69.975227	16 Jun 93	16:01:55	2	30	ca	1	4	1	0	6
146.553380	69.973130	16 Jun 93	16:02:01	2	31	ca	1	18	6	0	25
146.526456	69.957420	16 Jun 93	16:02:45	2	32	ca	0	0	0	3	3
146.614494	69.998675	16 Jun 93	16:13:56	2	34	ca	0	2	1	0	3
146.598783	69.998675	16 Jun 93	16:13:56	2	35	ca	1	41	40	0	82
146.619572	70.103586	16 Jun 93	17:41:36	2	1	ca	1	16	8	0	25
146.633816	70.053535	16 Jun 93	17:44:52	2	2	ca	0	1	1	0	2
146.631293	69.962358	16 Jun 93	17:48:52	2	3	ca	1	1	5	1	8
146.675054	69.931643	16 Jun 93	17:55:02	2	5	ca	0	0	0	2	2
146.656923	69.931438	16 Jun 93	17:56:36	2	6	ca	2	3	2	2	9
146.672689	69.971279	16 Jun 93	18:00:29	2	7	ca	0	104	89	0	193
146.668827	70.018093	16 Jun 93	18:08:21	2	8	ca	0	46	31	0	77
146.668062	70.041985	16 Jun 93	18:09:41	2	9	ca	0	23	13	0	36
146.686255	70.116489	16 Jun 93	18:18:40	2	10	ca	0	3	1	0	4
146.675781	70.124575	16 Jun 93	18:19:07	2	11	ca	0	1	1	0	2
146.674268	70.176109	16 Jun 93	18:22:05	2	12	ca	0	3	2	0	5
146.729104	69.987453	16 Jun 93	18:30:33	2	13	ca	0	3	2	0	5
146.724058	69.972208	16 Jun 93	18:31:11	2	14	ca	0	3	1	0	4
146.708346	69.972208	16 Jun 93	18:31:11	2	15	ca	0	71	46	0	117
146.705796	69.971409	16 Jun 93	18:31:13	2	16	ca	0	73	35	0	108
146.695376	69.962263	16 Jun 93	18:31:36	2	17	ca	0	0	0	2	2
146.770000	69.920000	16 Jun 93		2	1	ca	0	2	0	0	2
146.759191	69.930093	16 Jun 93	18:39:18	2	19	ca	0	1	1	0	2
146.760107	70.049279	16 Jun 93	18:45:37	2	20	ca	0	2	2	0	4
146.737004	70.119412	16 Jun 93	18:49:05	2	22	ca	0	4	3	1	8
146.779597	70.053316	16 Jun 93	18:58:28	2	23	ca	0	7	7	0	14

Table C-2. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
146.812090	70.010552	16 Jun 93	19:01:34	2	25	ca	0	3	1	3	7
146.785905	70.010552	16 Jun 93	19:01:34	2	26	ca	0	11	6	3	20
146.794598	69.981019	16 Jun 93	19:02:54	2	27	ca	0	2	0	0	2
146.806912	69.961867	16 Jun 93	19:03:45	2	28	ca	0	28	17	0	45
146.849242	69.952455	16 Jun 93	19:10:48	2	29	ca	0	2	0	0	2
146.862175	69.959708	16 Jun 93	19:11:11	2	30	ca	0	1	1	0	2
146.843858	70.067414	16 Jun 93	19:18:46	2	32	ca	0	1	1	0	2
146.835893	70.100690	16 Jun 93	19:20:22	2	33	ca	0	1	0	0	1
146.837983	70.174402	16 Jun 93	19:23:57	2	34	ca	0	1	0	0	1
146.861996	70.102644	16 Jun 93	19:28:14	2	35	ca	0	0	0	1	1
146.903893	70.102644	16 Jun 93	19:28:14	2	36	ca	0	19	16	0	35
146.879674	70.076976	16 Jun 93	19:31:03	2	37	ca	1	0	0	0	1
146.879193	70.013838	16 Jun 93	19:33:49	2	39	ca	0	25	11	0	36
146.891169	69.991899	16 Jun 93	19:34:46	2	40	ca	0	2	0	0	2
146.893679	69.991134	16 Jun 93	19:34:48	2	41	ca	0	28	10	0	38
146.889755	69.987890	16 Jun 93	19:36:31	2	43	ca	1	13	4	0	18
146.863922	69.965111	16 Jun 93	19:38:00	2	44	ca	0	0	0	1	1
146.858950	69.936226	16 Jun 93	19:42:23	2	45	ca	0	37	13	0	50
146.894819	69.910654	16 Jun 93	19:44:04	2	46	ca	0	4	0	0	4
146.929223	69.914882	16 Jun 93	19:44:26	2	47	ca	0	1	1	0	2
146.899207	69.916029	16 Jun 93	19:44:30	2	48	ca	0	2	1	0	3
146.909581	70.077673	16 Jun 93	19:54:36	2	49	ca	0	5	1	0	6
146.953686	70.062086	16 Jun 93	20:03:42	2	50	ca	0	39	25	0	64
146.920340	70.050126	16 Jun 93	20:04:19	2	51	ca	0	6	2	0	8
146.954656	69.954797	16 Jun 93	20:13:27	2	53	ca	0	40	20	0	60
146.951340	69.925995	16 Jun 93	20:14:39	2	54	ca	0	1	0	0	1
146.990008	69.980540	16 Jun 93	20:20:45	2	57	ca	0	1	0	0	1
146.025768	70.135067	22 Jun 93	11:10:12	3	1	ca	0	0	0	2	2
146.183545	70.028755	22 Jun 93	11:52:42	3	6	ca	0	9	8	0	17
146.179697	70.099495	22 Jun 93	11:57:44	3	7	ca	0	7	7	5	19
146.221516	70.157388	22 Jun 93	12:03:52	3	8	ca	0	4	4	1	9
146.253648	70.149178	22 Jun 93	12:31:12	3	13	ca	0	7	7	2	16
146.323127	70.167879	22 Jun 93	12:58:18	3	16	ca	0	6	4	0	10
146.357382	70.094953	22 Jun 93	13:03:28	3	17	ca	0	0	0	1	1
146.464004	70.126987	22 Jun 93	13:28:26	3	18	ca	0	6	5	0	11
146.453475	70.078103	22 Jun 93	13:30:29	3	19	ca	0	6	4	0	10
146.471413	69.934191	22 Jun 93	13:36:58	3	20	ca	0	0	0	1	1

Table C-2. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
146.510277	69.990506	22 Jun 93	13:42:34	3	21	ca	0	15	15	5	35
146.521134	70.045755	22 Jun 93	13:45:12	3	22	ca	0	8	8	4	20
146.542970	70.014821	22 Jun 93	14:01:35	3	23	ca	0	8	6	2	16
146.582452	70.156172	22 Jun 93	14:19:58	3	25	ca	0	1	1	0	2
146.634532	70.164546	22 Jun 93	15:27:31	3	1	ca	0	7	4	0	11
146.617340	70.042395	22 Jun 93	15:32:45	3	2	ca	0	1	1	0	2
146.648380	69.943890	22 Jun 93	15:37:09	3	3	ca	0	1	0	0	1
146.701324	70.100567	22 Jun 93	15:57:36	3	4	ca	0	3	3	0	6
146.717035	70.100192	22 Jun 93	15:57:37	3	5	ca	0	1	1	0	2
146.693987	70.084387	22 Jun 93	15:59:20	3	6	ca	0	1	1	0	2
146.699443	70.032648	22 Jun 93	16:01:44	3	7	ca	0	2	2	0	4
146.695991	69.927279	22 Jun 93	16:06:18	3	8	ca	0	6	4	2	12
146.770003	69.931083	22 Jun 93	16:09:50	3	9	ca	0	0	4	0	4
146.734340	69.929123	22 Jun 93	16:10:46	3	10	ca	0	30	25	3	58
146.740274	70.156247	22 Jun 93	16:23:35	3	11	ca	0	7	5	0	12
146.769078	70.156247	22 Jun 93	16:23:35	3	12	ca	0	1	1	0	2
146.783847	70.163309	22 Jun 93	16:26:21	3	13	ca	0	13	12	0	25
146.868517	69.981456	22 Jun 93	16:41:40	3	14	ca	0	90	80	5	175
146.850170	69.991387	22 Jun 93	16:43:45	3	15	ca	0	35	30	0	65
146.831840	69.991387	22 Jun 93	16:43:45	3	16	ca	0	1	1	0	2
146.904713	70.075603	22 Jun 93	16:59:46	3	17	ca	0	3	1	0	4
146.905492	70.001011	22 Jun 93	17:02:51	3	18	ca	0	1	0	0	1
146.911598	69.929703	22 Jun 93	17:10:16	3	20	ca	0	30	30	10	70
146.946487	70.053501	22 Jun 93	17:18:10	3	21	ca	0	4	4	0	8
146.947538	70.126461	22 Jun 93	17:21:53	3	22	ca	0	0	0	1	1
146.908260	70.126461	22 Jun 93	17:21:53	3	23	ca	0	2	0	0	2
146.971169	70.113565	22 Jun 93	17:26:32	3	24	ca	0	3	3	0	6
146.983337	70.050734	22 Jun 93	17:29:02	3	25	ca	0	2	0	0	2
146.952716	69.998579	22 Jun 93	17:31:16	3	26	ca	0	5	5	0	10
146.946595	69.948439	22 Jun 93	17:33:25	3	27	ca	0	0	0	1	1
146.988132	70.014698	22 Jun 93	17:40:53	3	29	ca	0	15	11	0	26
146.706725	70.122943	06 Jul 93	15:28:13	4	2	ca	38	1000	480	80	1598
146.748436	70.098436	06 Jul 93	15:36:22	4	3	ca	10	200	40	10	260
146.664514	70.101401	06 Jul 93	15:55:07	4	4	ca	38	325	300	70	733
146.679037	70.113538	06 Jul 93	16:04:58	4	5	ca	50	900	850	80	1880
146.578263	70.048521	06 Jul 93	16:29:15	4	6	ca	420	200	105	30	755
146.549336	70.082645	06 Jul 93	16:41:21	4	7	ca	5	36	20	0	61

Table C-2. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
146.483781	70.094277	07 Jul 93	12:02:49	4	1	ca	0	130	90	0	220
146.354582	69.963820	07 Jul 93	12:37:18	4	2	ca	0	130	90	0	220
146.353912	69.965910	07 Jul 93	12:37:23	4	3	ca	0	0	3	0	3
146.947060	70.069620	20 Jul 93	13:31:32	5	3	ca	2	0	0	0	2
146.569829	69.955364	20 Jul 93	16:09:22	5	1	ca	1	0	0	0	1
146.989694	69.963042	27 Jul 93	13:02:32	6	30	ca	1	0	0	0	1
146.988669	70.029957	27 Jul 93	13:04:42	6	31	ca	1	0	0	0	1
146.988977	70.155011	27 Jul 93	13:09:02	6	34	ca	12	0	0	0	12
146.989312	70.127492	27 Jul 93	13:10:06	6	35	ca	1	0	0	0	1
146.979626	70.068554	27 Jul 93	13:12:04	6	36	ca	1	0	0	0	1
146.985915	70.048487	27 Jul 93	13:12:46	6	37	ca	0	0	0	2	2
146.950785	70.019042	27 Jul 93	13:13:46	6	38	ca	1	0	0	0	1
146.904139	69.993306	27 Jul 93	13:21:20	6	39	ca	0	0	0	1	1
146.917973	70.034219	27 Jul 93	13:22:38	6	40	ca	0	1	0	0	1
146.947661	70.048200	27 Jul 93	13:23:06	6	41	ca	2	0	0	0	2
146.936787	70.062154	27 Jul 93	13:23:32	6	42	ca	1	0	0	0	1
146.912755	70.089154	27 Jul 93	13:24:26	6	43	ca	0	0	1	0	1
146.907331	70.111284	27 Jul 93	13:25:10	6	44	ca	1	0	0	0	1
146.868900	70.064709	27 Jul 93	13:31:12	6	45	ca	1	0	0	0	1
146.899312	69.995335	27 Jul 93	13:33:36	6	46	ca	1	0	0	0	1
146.904126	69.929567	27 Jul 93	13:35:54	6	47	ca	0	0	0	1	1
146.818884	69.941164	27 Jul 93	13:38:26	6	48	ca	1	0	0	0	1
146.837419	70.008442	27 Jul 93	13:40:36	6	49	ca	0	0	0	1	1
146.824936	70.163924	27 Jul 93	13:47:18	6	51	ca	1	0	0	0	1
146.811480	70.009084	27 Jul 93	13:52:38	6	52	ca	0	1	0	0	1
146.782011	69.990178	27 Jul 93	13:53:18	6	53	ca	1	0	0	0	1
146.779310	69.967570	27 Jul 93	13:54:06	6	54	ca	1	0	0	0	1
146.753781	69.990540	27 Jul 93	13:59:12	6	55	ca	1	0	0	0	1
146.738557	70.064791	27 Jul 93	14:01:32	6	56	ca	0	0	0	1	1
146.755921	70.176970	27 Jul 93	14:05:10	6	57	ca	2	0	0	0	2
146.718903	70.136050	27 Jul 93	14:07:20	6	58	ca	1	0	0	0	1
146.735133	70.031405	27 Jul 93	14:10:56	6	59	ca	1	0	0	0	1
146.695012	70.008421	27 Jul 93	14:11:44	6	60	ca	1	0	0	0	1
146.730347	69.951307	27 Jul 93	14:13:42	6	61	ca	0	0	0	1	1
146.682708	69.998729	27 Jul 93	14:18:46	6	62	ca	1	0	0	0	1
146.651913	70.015866	27 Jul 93	14:19:20	6	63	ca	0	0	0	1	1
146.664150	70.053542	27 Jul 93	14:20:30	6	64	ca	0	1	0	0	1

Table C-2. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
146.632218	70.184756	27 Jul 93	14:25:32	6	65	ca	25	0	0	15	40
146.646263	70.092118	27 Jul 93	14:28:42	6	66	ca	0	0	0	1	1
146.640579	70.058978	27 Jul 93	14:29:50	6	67	ca	1	0	0	0	1
146.597604	69.943268	27 Jul 93	14:36:36	6	68	ca	0	1	0	0	1
146.582324	69.985533	27 Jul 93	14:38:00	6	69	ca	0	2	2	0	4
146.569186	70.008018	27 Jul 93	14:38:44	6	70	ca	1	0	0	0	1
146.608870	70.026945	27 Jul 93	14:39:20	6	71	ca	1	0	0	0	1
146.580175	70.037190	27 Jul 93	14:39:40	6	72	ca	1	0	0	0	1
146.554505	70.012424	27 Jul 93	16:01:58	6	1	ca	0	1	0	0	1
146.563836	69.994283	27 Jul 93	16:02:35	6	2	ca	0	0	0	1	1
146.556295	69.985527	27 Jul 93	16:02:53	6	3	ca	1	0	0	0	1
146.485089	69.983361	27 Jul 93	16:08:32	6	4	ca	0	0	0	2	2
146.493136	69.987808	27 Jul 93	16:08:41	6	5	ca	1	0	0	0	1
146.483408	70.115751	27 Jul 93	16:13:03	6	6	ca	1	0	0	0	1
146.495272	70.184770	27 Jul 93	16:15:22	6	7	ca	0	2	2	0	4
146.479005	70.121160	27 Jul 93	16:18:09	6	8	ca	1	0	0	0	1
146.478149	70.045769	27 Jul 93	16:20:48	6	9	ca	1	0	0	0	1
146.443807	70.038884	27 Jul 93	16:21:02	6	10	ca	1	0	0	0	1
146.480276	70.007349	27 Jul 93	16:22:06	6	11	ca	0	0	0	1	1
146.456394	69.998456	27 Jul 93	16:22:24	6	12	ca	1	0	0	0	1
146.469310	69.992097	27 Jul 93	16:22:37	6	13	ca	1	0	0	0	1
146.481228	69.938193	27 Jul 93	16:24:28	6	14	ca	0	0	0	1	1
146.397366	70.007991	27 Jul 93	16:29:19	6	15	ca	0	0	0	1	1
146.421589	70.179620	27 Jul 93	16:35:08	6	16	ca	0	1	0	0	1
146.394114	70.179688	27 Jul 93	16:35:46	6	17	ca	1	0	0	0	1
146.399229	70.175638	27 Jul 93	16:35:55	6	18	ca	1	0	0	0	1
146.396824	70.007014	27 Jul 93	16:41:49	6	19	ca	0	0	0	1	1
146.352852	70.175802	27 Jul 93	16:54:43	6	21	ca	1	0	0	0	1
146.245178	70.022041	27 Jul 93	17:10:01	6	25	ca	0	1	1	0	2
146.271732	70.067646	27 Jul 93	17:11:33	6	26	ca	0	0	0	1	1
146.236425	70.172264	27 Jul 93	17:15:03	6	27	ca	40	0	0	5	45
146.220460	70.038939	27 Jul 93	17:21:18	6	28	ca	1	0	0	0	1
146.143529	70.027437	27 Jul 93	17:30:04	6	32	ca	1	0	0	0	1
146.143105	70.090254	27 Jul 93	17:32:09	6	33	ca	1	0	0	0	1
146.144855	70.156391	27 Jul 93	17:35:13	6	34	ca	2	0	0	0	2
146.129699	70.035728	27 Jul 93	17:39:21	6	35	ca	15	0	0	5	20
146.060091	70.056745	27 Jul 93	17:50:34	6	37	ca	1	0	0	0	1

Table C-2. Continued.

Longitude °W	Latitude °N	Date	TimeAST	Flight	Attribute	Species	Bulls	Cows	Calves	Unclass	Total
146.059654	70.101291	27 Jul 93	17:52:03	6	38	ca	1	0	0	0	1
146.055670	70.093314	27 Jul 93	17:55:56	6	39	ca	1	0	0	0	1
146.059190	70.075651	27 Jul 93	17:56:32	6	40	ca	1	0	0	0	1
146.054704	70.069674	27 Jul 93	17:56:44	6	41	ca	1	0	0	0	1
146.907900	69.925195	05 Aug 93	12:20:06	7	2	ca	1	0	0	0	1
146.945626	70.020319	05 Aug 93	12:23:05	7	4	ca	0	1	1	0	2
146.776346	69.953377	05 Aug 93	12:58:59	7	7	ca	2	0	0	0	2
146.441895	70.041268	05 Aug 93	14:06:57	7	8	ca	1	0	0	0	1
146.439673	70.073158	05 Aug 93	14:17:12	7	9	ca	2	0	0	0	2
146.362984	70.070583	05 Aug 93	14:24:41	7	10	ca	0	1	1	0	2
146.988601	69.964715	18 Aug 93	15:00:33	8	2	ca	0	0	0	1	1
146.860649	69.986776	18 Aug 93	15:39:18	8	2	ca	1	0	0	0	1
146.552911	69.979769	18 Aug 93	16:52:46	8	3	ca	0	1	0	0	1