CALVING DISTRIBUTION OF THE PORCUPINE CARIBOU HERD IN THE 1002 AREA OF THE ARCTIC NATIONAL WILDLIFE REFUGE, ALASKA, 1991

FINAL REPORT

to

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EXECUTIVE SUMMARY

Aerial surveys were conducted in the 1002 area of the Arctic National Wildlife Refuge (ANWR) on 4 June 1991. The objectives were:

1. To estimate the numbers, composition, and distribution of the Porcupine Caribou Herd (PCH) in the 1002 area of Arctic National Wildlife Refuge near the peak of calving.

2. To compare results obtained from a systematic transect survey to results obtained from a non–systematic census.

The systematic survey covered about 18 percent of the 1002 study area using 1.6–km wide transects spaced 9.6 km apart. In the non–systematic census, as many caribou as possible were located and counted by flying over areas where concentrations were expected, such as the major river drainages and the rolling foothills of the coastal plain. Areas immediately to the south and east of the 1002 area were also surveyed to determine the extent of calving outside of the 1002 area.

There were approximately 25,000 adult and yearling caribou observed in the study area during the non–systematic survey and an additional 5,000 caribou were seen outside of the 1002 area. Most of the caribou observed in the census were adult females. There were 3,072 caribou, including calves, observed on sample transects in the study area during the systematic survey. Based on the 18 percent survey coverage, this equates to a total of 17,203 caribou (including calves) in the 1002 area. Excluding calves, the estimate was only 12,398 animals (roughly 50 percent of the animals counted in the non–systematic survey). The systematic survey underestimated the total numbers present mainly because the area surveyed was too small to obtain an accurate estimate for the total area.

Based on the counts obtained in the non–systematic survey, about 26 percent of the cow component of the PCH calved in the 1002 area in 1991. This compares to a historical range of 5 to 82 percent. Both types of surveys conducted in 1991 showed concentrations of calving in the 1002 area between the Hulahula and Tamayariak rivers, from the foothills of the Sadlerochit Mountains north to within a few kilometers of the Beaufort Sea coast. Concentrated calving in this area has not been observed since 1977. The majority of calving sites were on broad ridges and gently sloping river terraces which were snow–free or had mottled snow.

There is considerable annual variation in the numbers of PCH cows that calve in the 1002 area. In two of every three years, on the order of only 25 percent of the PCH cows calve in the 1002 area; most calving occurs elsewhere in these years. While an average of 75 percent of the PCH cows may calve in the 1002 area during one out of every three years, the specific location of concentrated calving varies greatly among years.

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INTRODUCTION

In 1980, the Alaska National Interest Lands Conservation Act (ANILCA) established the 7.7–million–hectare Arctic National Wildlife Refuge (ANWR) in Alaska (Fig. 1). Section 1002 of ANILCA authorized oil and gas exploration on a 0.6–million–hectare area on the coastal plain of ANWR. During 1983–85, surface exploration occurred in the "1002 area", including field observations, seismic activities, surface measurements, and gravity surveys. These investigations showed that the 1002 area has the highest potential for major recoverable oil resources of any other currently developed onshore area in the United States.

The potential environmental effects of oil exploration and development in the 1002 area of ANWR have been intensively debated for many years. One major issue is the effect of development on the Porcupine Caribou Herd (PCH). In 1989, this herd was estimated to be about 178,000 animals (Fancy et al. 1990). The calving range of this herd includes the 1002 area. Many biologists believe that the area in the vicinity of the upper Jago River may constitute a calving area critical to the well–being of the herd (Clough et al. 1987, Fancy et al. 1990, Whitten et al. 1991). The entire 1002 area is used as post–calving habitat (Whitten 1991).

Caribou of the Central Arctic Herd (CAH) also use the 1002 area but calve primarily in two areas west of the 1002 area. However, scattered, low–density calving by this herd does occur during most years within the western section of the 1002 area. CAH caribou also use western portions of the 1002 area during the post–calving period for insect relief, and some winter there in most years (Clough et al. 1987, Whitten 1991).

Agency biologists are concerned that oil development might result in a decrease in herd productivity due to displacement of PCH caribou from their calving grounds in the 1002 area (Clough et al. 1987, Fancy et al. 1990, Whitten et al. 1991). Biologists have collected information on PCH movements and distributions in what is now known as the 1002 area since 1972. Emphasis has been placed on distribution during the calving period, and pre– and post–calving movements.

Industry–sponsored studies on PCH calving distribution were conducted from 1972–77 as part of the Arctic Gas Studies (Roseneau and Stern 1974, Roseneau et al. 1975, Roseneau and Curatolo 1976). From 1978–81, the Canadian Wildlife Service (CWS) and Yukon Territory Wildlife Branch studied the PCH in response to concerns about potential effects from oil and gas developments in northwestern Canada. As mandated by section 1002

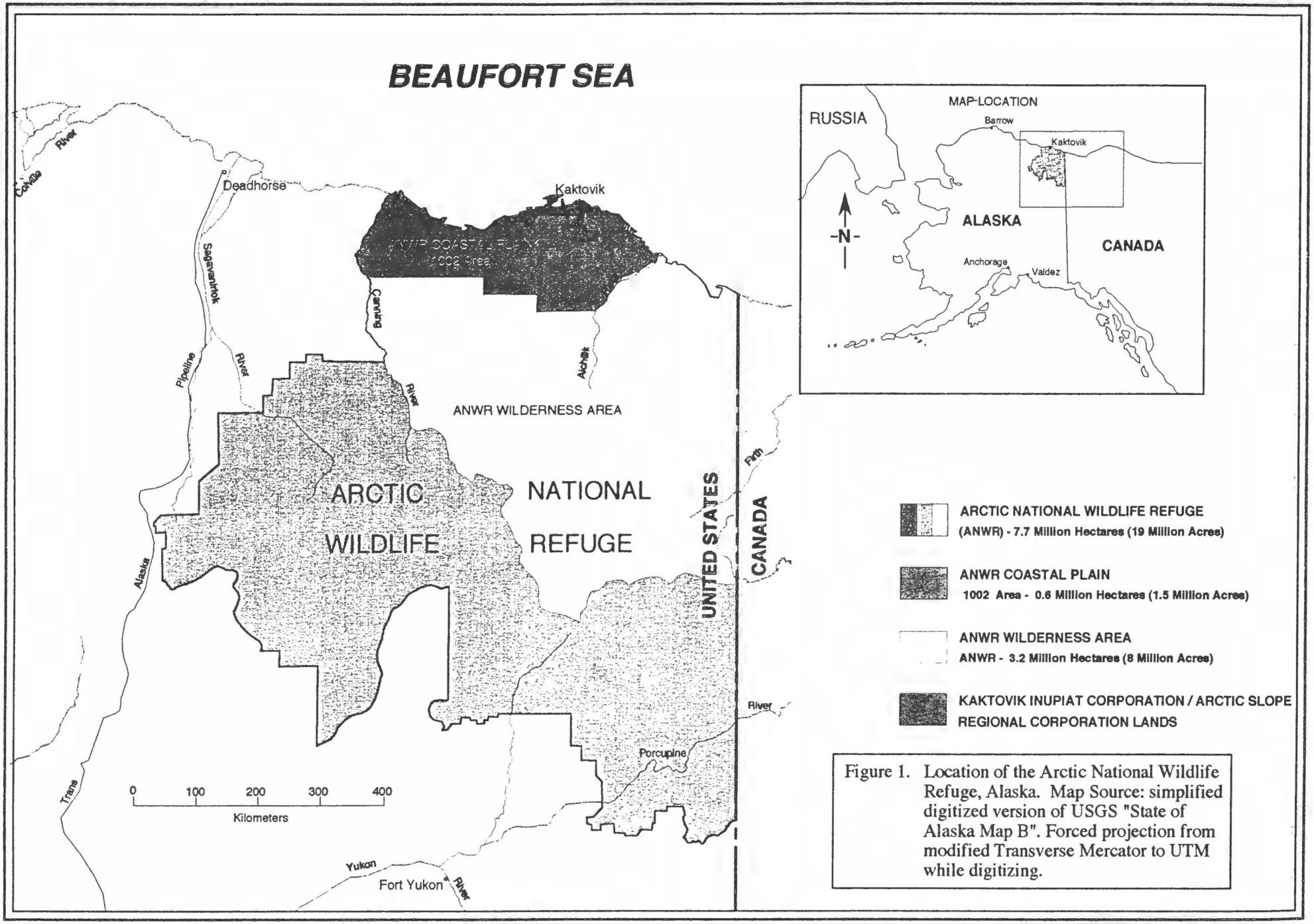

Figure 1. Location of the Arctic National Wildlife Refuge, Alaska. Map Source: simplified digitized version of USGS "State of Alaska Map B". Forced projection from modified Transverse Mercator to UTM while digitizing.

of ANILCA, the U.S. Fish and Wildlife Service (USFWS), in cooperation with the Alaska Department of Fish and Game (ADF&G) and Canadian wildlife biologists, studied the PCH from 1981–85. These studies concentrated on caribou distribution and movements, habitat use, predator–prey relationships, and on the potential impacts of development (Garner and Reynolds 1986).

These studies identified potential impacts of development on the PCH. These potential impacts were evaluated in the Final Legislative Environmental Impact Statement (LEIS), Resource Assessment of the Coastal Plain of ANWR (Clough et al. 1987). It was concluded in this document that displacement of the PCH from calving grounds in the upper Jago River area would constitute a "major" impact. However, the authors state that "It is unlikely, though possible, that such displacement would result in any appreciable decline in herd size" (Clough et al. 1987:187).

The importance of the calving grounds in the upper Jago River is central to the debate about potential effects of development on the PCH. Long–term study of movements and year–to–year variation in distribution during the calving period is in order. A cooperative government program to gather such information was initiated in 1988. Participants in this program included the USFWS Alaska Fish and Wildlife Research Center, ADF&G, Arctic National Wildlife Refuge, the University of Alaska–Fairbanks (UAF), CWS, and the Yukon Territory and Northwest Territories Departments of Natural Resources.

In addition to these government studies, BP Exploration (Alaska), Inc. has sponsored annual surveys in the ANWR area during the calving period since 1987 (Roseneau 1991). The goal of the program has been to document the numbers, composition and distribution of caribou in the 1002 area of ANWR at the peak of calving. These data can be used to evaluate the concentrated calving area concept. This report provides the results of the 1991 survey. Below we present some of the recent findings concerning calving and post–calving use of the 1002 area by the PCH.

Like most other caribou herds in North America, the PCH exhibits seasonal migrations between winter and summer ranges (Fancy et al. 1989). From their wintering grounds south of the Continental Divide in Alaska and Canada, the PCH begins spring migration to the calving grounds in April and May (Clough et al. 1987, Duquette and Klein 1987, Fancy et al. 1990). The routes of travel and progression of migration are influenced by weather, snow conditions, winter distribution, and the proximity to parturation of adult females (Garner and

Reynolds 1986, Clough et al. 1987). These factors act in concert to produce annual variations in the timing of and the routes used in spring migration.

Typically, PCH caribou begin to arrive on their calving grounds in mid– to late May (Clough et al. 1987). Groups comprised predominately of pregnant females arrive first. Groups comprised mainly of bulls and juveniles lag behind the cow segment of the population during migration and are generally found in areas peripheral to the calving grounds during the calving period (Garner and Reynolds 1986, Clough et al. 1987). Calving generally occurs over a 2–3 week period commencing during the last week of May. Peak calving (defined as the point in time when 50 percent of pregnant females have given birth) usually occurs between June 4–8 (Clough et al. 1987).

The PCH calving grounds extend throughout the arctic foothills and coastal plain from the Canning River in Alaska to the Babbage River in Canada and encompass the entire 1002 area. The 1002 area represents about 17 percent of the total calving area (Fig. 2). The area between the Hulahula River (Alaska) and the Canadian border is where most calving generally occurs (Clough et al. 1987, Fancy et al. 1990, Fancy and Whitten 1991). However, data collected between 1972–90 shows substantial variation in calving distribution within this overall area (Garner and Reynolds 1986, Clough et al. 1987, Fancy et al. 1990, BP Exploration (Alaska), Inc. 1991, Whitten et al. 1991). The percentage of cows calving in Alaska ranged from 65–90 percent during six of the years between 1982–90 when the most rigorous and detailed studies were conducted (Roseneau 1991). There is also annual variation in the percentage of of cows calving in the 1002 area. For example, 20 percent of PCH cows calved in the 1002 area in 1987 (BP Exploration 1991), 5 percent in 1988 (Fancy et al. 1989), 38 percent in 1989 (Fancy et al. 1990) and 70 percent in 1990 (BP Exploration 1991).

Recent research has shown that a variety of factors influence calving site selection by caribou. It is generally agreed that PCH caribou calve in areas that have undergone earlier snowmelt and forage green–up than surrounding non–selected areas (Lent 1980, Clough et al. 1987, Truett et al. 1989, Fancy and Whitten 1991). Using satellite imagery, Lent (1980) documented that the arctic foothills and southern coastal plain from Herschel Island in Canada to the Canning River in Alaska are characterized by early snowmelt. Furthermore, Eastland et al. (1989) found that much of the coastal plain east of the Aichilik River was already snow–free or had only patchy snow conditions during the early part of the calving season.

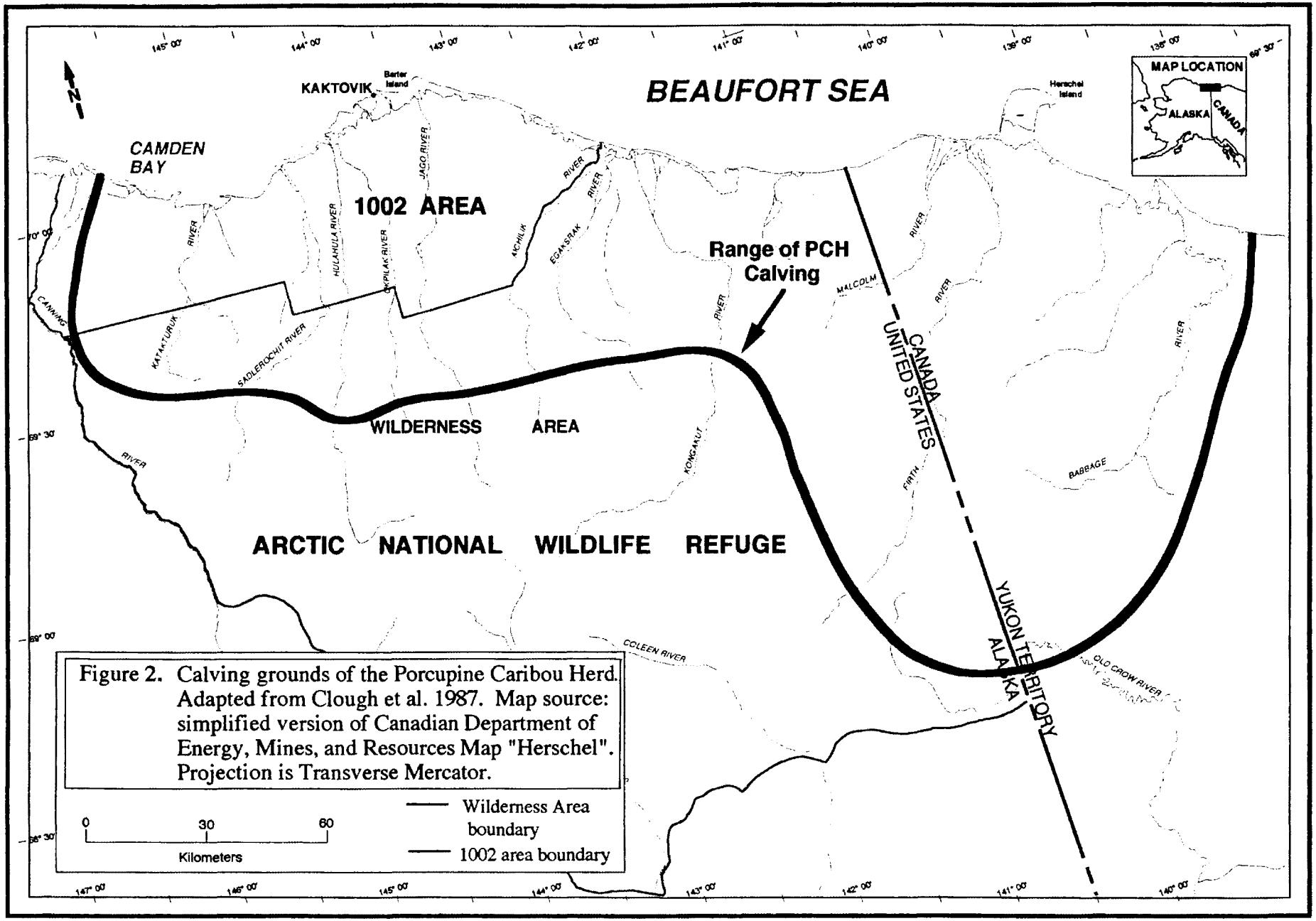

Figure 2. Calving grounds of the Porcupine Caribou Herd. Adapted from Clough et al. 1987. Map source: simplified version of Canadian Department of Energy, Mines, and Resources Map "Herschel". Projection is Transverse Mercator.

Fancy and Whitten (1991) analyzed calving sites used by radio–collared PCH cows between 1983 and 1990. They found that in years of early snowmelt, a consistently higher concentration of calving sites were located in Alaska west of the Aichilik River. In contrast, calving sites were concentrated east of the Aichilik River or in the foothills during all years of study when snowmelt was late. These authors also found a high correlation between calving sites and areas characterized by *Eriophorum* tussock tundra. *Eriophorum* (cottongrass) is highly nutritious and highly digestible (Fancy et al. 1989). Therefore, it may be an important forage species during calving when parturient cows may experience an energy deficit. However, Fancy and Whitten (1991) contend that the selection for tussock tundra types is not based on any nutritional advantage it may afford, but rather is an "artifact" of tussock tundra's association with areas of mottled snow. They state, "The microtopography of *Eriophorum* tussocks promotes melting, evaporative loss of snow cover, and early growth of vegetation, and in most years when cows arrive on the coastal plain, the northernmost patches of bare ground are associated with tussock tundra landcover types" (Fancy and Whitten 1991:1741).

Weather and snow conditions encountered during spring migration may also affect the location of calving. In some years, such as 1972 and 1982, deep snow along migration routes resulted in significant levels of calving occurring enroute to the calving grounds (Garner and Reynolds 1986). In 1982, the PCH calved almost entirely in Canada (Mauer et al. 1983).

Another factor that may influence PCH calving location is predator abundance. Wolves (*Canus lupus*) and brown bears (*Ursus arctos*), which are the major predators on caribou calves, occur in lower densities on the Arctic Coastal Plain than in mountainous areas to the south (Truett et al. 1989, Young et al. 1990, Fancy and Whitten 1991). Thus cows may select coastal plain areas to bear their young because predation risk in this region would be lower as compared to more southerly areas (Eastland et al. 1989, Fancy et al. 1990).

Following calving, cows with young calves form small "nursery bands" (Garner and Reynolds 1986). These groups commonly use river terraces and vegetated gravel bars associated with riparian areas within the Arctic Coastal Plan, including the 1002 area (Garner and Reynolds 1986). The post–calving season, which begins about June 15 and extends until early August, is characterized by nursery bands aggregating with groups of bulls, yearlings and barren cows (Garner and Reynolds 1986). Movements by these sometimes large aggregations are directed by insect harassment during July to mid–August. To escape insects, these groups generally move into the wind and may seek relief on high ridges, mud–flats, aufeis, river deltas, barrier islands, and along coastlines (Garner and Reynolds 1986, Clough et al. 1987).

Post–calving movement patterns of the PCH vary annually although most caribou groups usually move in the same direction. In some years, post–calving groups have shifted westward across the coastal plain, forming large aggregations in the foothills south of Camden Bay (Garner and Reynolds 1986). The 1002 area is usually vacated by the PCH by mid–July, although in some years as many as 15,000 animals have remained in this area and adjacent foothills through August (Clough et al. 1987).

Objectives

In June 1991, LGL Alaska Research Associates and Biosystems Alaska, under contract to BP Exploration (Alaska), Inc., conducted aerial surveys in the 1002 area of ANWR with the following objectives:

1. To estimate the numbers, composition and distribution of the PCH over the 1002 area of ANWR near the peak of calving.

2. To compare caribou survey results obtained using a systematic survey technique and GPS–assisted navigation with a non–systematic survey technique.

This report describes the methodology used and results of these surveys.

STUDY AREA

The study area is the 627,530 hectare 1002 area of ANWR and is bordered on the west by the Canning River, on the east by the Aichilik River, and the Beaufort Sea coast on the north (Fig. 3). The southern boundary follows township lines and approximates the 3280 m (1000 ft) elevation contour. The 1002 area is within the tundra region of the Arctic Coastal Plain Province, is characterized by moderately wet to dry habitats, and is vegetated with low–growing plants (Clough et al. 1987).

Six distinct terrain types are contained within the 1002 area (Clough et al. 1987). Foothills comprise 45 percent of the 1002 area between the Canning and Sadlerochit rivers. These rivers run from the Sadlerochit Mountains, 29–54 km from the seacoast to Camden Bay. The foothills east of the Sadlerochit River are farther from the coast. River flood plains make up 25 percent of the 1002 area and are comprised of barren deltas, braided channels of the larger rivers, river terraces, alluvial areas, and deltaic formation at the base of foothills. Hilly

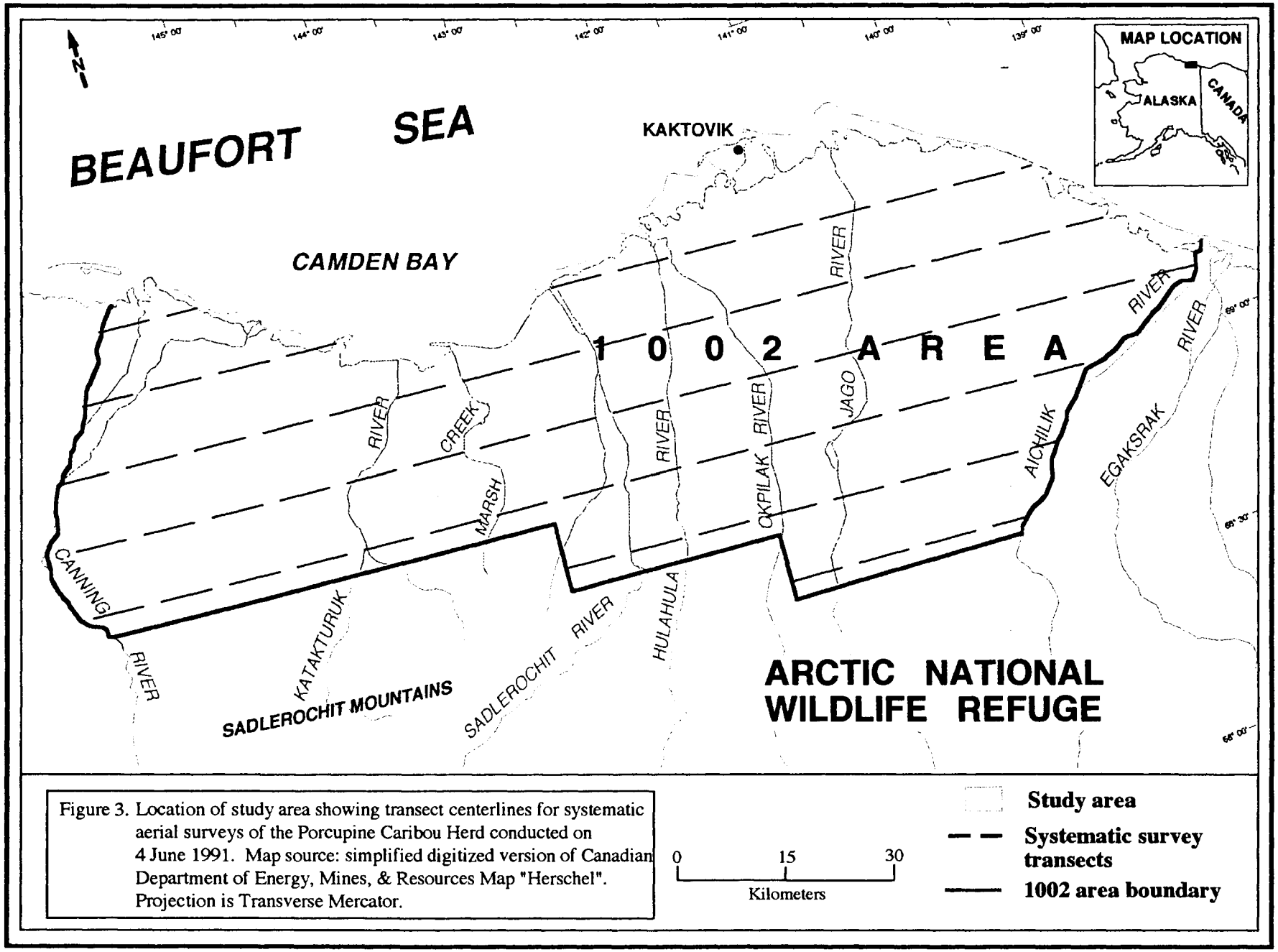

Figure 3. Location of study area showing transect centerlines for systematic aerial surveys of the Porcupine Caribou Herd conducted on 4 June 1991. Map source: simplified digitized version of Canadian Department of Energy, Mines, & Resources Map "Herschel". Projection is Transverse Mercator.

coastal plains represent 22 percent of the 1002 area and are characterized by gently rolling topography. Thaw–lake plains, 3 percent of the 1002 area, occur primarily near braided–river deltas and are comprised of low–centered polygons and shallow pond complexes. Ocean water, 5 percent of the 1002 area, is contained within the boundary of the 1002 area. Mountains, about 0.05 percent, are located west of Sadlerochit Spring (Clough et al. 1987).

The climate of the 1002 area is classified as arctic marine (Clough et al. 1987). Summers on the coastal plain are short and cool with little precipitation. The prevailing winds during most of the year are from the east–northeast. More detailed descriptions of the biological environment and the physical geography of the 1002 area are found in Walker et al. (1982) and Clough et al. (1987).

METHODS

On 3 June 1991, a three and one–half hour reconnaissance flight was conducted over the 1002 area in ANWR to determine the general distribution of caribou. During the flight, altitude averaged about 152 m above ground level (AGL) and air speed varied between 144–208 km/h. Prior to this flight, ADF&G informed us that calving was approximately 70 percent complete as of the evening of 2 June. Our observation on the reconnaissance flight confirmed that calving was past its peak. Our aerial survey scheduled for 4 June was appropriately timed for observing the distribution and number of calving females in the 1002 area.

Two simultaneous aerial surveys of the 1002 area were flown on 4 June 1991. One survey was flown with two observers and a Global Positioning System (GPS) for flight navigation along systematically–spaced transects across the 1002 area. The other survey was flown over the study area using a non–systematic survey technique with the goal of obtaining a census of the animals present. Both surveys were flown in approximately 8 hours.

Non–systematic Survey

In the non–systematic aerial survey, an observer (in addition to the pilot) in a Cessna 206 fixed–wing aircraft used experience, information from others in the field, and trails to locate groups of calving caribou. Air speed varied between 144–208 km/h and altitude averaged about 152 m AGL. Surveys were in and around the 1002 area. A large number of animals was encountered west of the Aichilik River (Fig. 2) and counting them took

considerable time. As a result, there was insufficient time to fly east of the Kongakut River and into Canada.

The aircraft flew along major drainages within the study area and the flight course was altered, as caribou groups were sighted, for counting and recording composition and location of the group. Caribou were counted directly or estimated by groups of ten's, hundred's, or thousand's depending on group sizes and densities. Only adults and yearlings (not calves) were counted; because of time constraints, a complete account of the sex/age composition of each group was not attempted. This information was recorded on USGS 1:250,000 topographic maps of the study area and later transferred to a digital basemap of the study area.

Systematic Survey

This survey was done using a Cessna 206 fixed–wing aircraft flying 152 m AGL at about 150 km/h airspeed. Seven strip–transects (Caughley 1977), 1.6 km wide and spaced 9.6 km apart, were surveyed (Fig. 3). This transect spacing provides for an 18 percent overall coverage of the study area. Transect lines were oriented in an east west direction along latitude lines to avoid running lines parallel to ridges (Eberhardt 1978). Past studies have shown that PCH caribou often use ridge tops which have been blown free of snow for calving (Clough et al. 1987). Therefore, this survey was designed to minimize bias of surveying clumped groupings along the transects (Burnham et al. 1980). The survey was flown with a pilot and two observers, one seated on the right and the other on the left. The observers surveyed an 800 m–wide swath on their respective sides of the transect centerline. Streamers attached to the aircraft wing struts enabled visual control of transect strip–width (Pennycuick and Western 1972).

Data collected during the survey included numbers and sex/age classification of all caribou observed. Caribou were counted and classified into sex and age categories (bulls, cows, calves, yearlings, unclassified) on the basis of body size, antler development, pelage, and calf presence. "Unclassified" caribou were adults (or possibly large yearlings) that could not be classified with confidence. Where large groups of caribou were encountered, the survey aircraft left the transect centerline and circled the group to facilitate counting and classification. Because the survey covered only 18 percent of the study area, the total number of caribou observed on all transects was multiplied by 5.6=(100÷18) to derive an estimated total of all caribou in the study area.

A Trimble *Pathfinder*™ Global Positioning System (GPS) was used to navigate the aircraft during surveys. The GPS consisted of three components—an antenna, a receiver, and a polycorder. Signals from orbiting satellites, which are components of the U.S. Department of Defense NAVSTAR GPS, were relayed from the antenna to the receiver in the aircraft. Based on these signals, the receiver determined the aircraft's altitude, speed, and position in latitude and longitude. This information was displayed on the liquid–crystal–display (LCD) screen of the polycorder, which was mounted in front of the pilot. This "real–time" display of position information enabled the pilot to navigate accurately along transect centerlines because each transect was associated with a fixed line of latitude. Locations of caribou were determined by using the GPS in combination with visual estimation. At the time of sighting, all count and classification data were entered directly into a lap–top computer that was linked to the GPS receiver in the airplane. For each caribou sighting, a GPS–determined position (latitude and longitude of the survey aircraft) was automatically associated with attributes (e.g., number of individuals in the group, sex/age classification) and entered into the computer by the observer. Lateral distances of caribou from the aircraft (i.e., from the transect centerline) were visually estimated in 100 m increments to the transect margin (800 m from centerline) and were entered into the computer. The method resulted in all individuals of a group of caribou assigned the approximate position of the group's center. The above process was facilitated using Geolink®, a computer software program that builds digital maps and databases with real–time input of GPS satellite data.

The GPS–assisted survey technique has been successfully used in caribou distribution studies of the CAH (Pollard et al. 1992a, 1992b). Automated positioning by GPS alleviates the need for observers to assist in navigation, thereby maximizing the amount of time observers can search for caribou. It also allows for accurate repeatability among surveys. These advantages of GPS are particularly valuable in the Arctic where surveys are often flown over relatively featureless or snow–covered terrain.

Inclusion of Data in a Geographic Information System

Caribou data collected during the systematic survey were combined with digital base–map data in an ARC/INFO® (Environmental Systems Research Institute, Inc., Redlands, California) Geographic Information System (GIS). ARC/INFO® is an interactive database management program that stores spatial data and corresponding attribute data. Within the caribou GIS, data such as caribou numbers and sex/age classification (attribute data) are associated with point locations of caribou (spatial data). Sets of base–map data in the GIS include locations of lakes, rivers, and coastline.

RESULTS

Distribution of Caribou within the 1002 area

On 4 June, a relatively large amount of standing water from snowmelt was present in many lowland areas north of about the 122 m (400 ft) contour interval east of the Canning River. In some localized areas of coastal lowlands, snow cover was estimated to be at 20–30 percent. However, the snow that remained in these areas was shallow. South of about the 122–152 m (400–500 ft) contour intervals, the terrain was estimated to be about 90–95 percent snow-free, and most of the residual snow cover consisted of melting drifts along river and stream banks and small patches in some of the lower, more sheltered valleys. As described below, caribou were generally more abundant at the higher elevations than at the lower elevations where standing water was prevalent.

Non-systematic Survey

During the survey of 4 June, approximately 24,807 adult and yearling caribou were observed in the 1002 study area. This constitutes about 14 percent of the total PCH, assuming the herd is about the same size (178,000 caribou) as it was in 1989 (Fancy et al. 1990). Most of the animals were in the Sadlerochit uplands between the Katakturuk and Sadlerochit rivers (Fig. 4, a folded map found at the end of this report). Specifically, these occurred from the slopes overlooking Camden Bay southward to the southern boundary of the 1002 area. Practically all of the caribou seen during the 4 June survey were either cows with calves or pregnant cows. The relatively low number of barren cows, yearlings, and bulls that were observed were located predominately south of the 1002 area at elevations above 335 m (1100 ft) and a few were along the east bank of the Kongakut River (Note: the Kongakut River is approximately 20–35 km east of the 1002 area and is not depicted on Fig. 4).

Approximately 1,268 caribou (5 percent of the total) were west of the Katakturuk River in the uplands between the Katakturuk and Canning rivers. It is possible that some of these animals belonged to the CAH (Fig. 4). There were approximately 22,695 individuals (about 92 percent of the total), observed between the Katakturak and Sadlerochit rivers (Fig. 4). Most of these animals were found in groups of between 500 and 2,000 individuals. Approximately 844 individuals (about 3 percent of the total) were observed between the Sadlerochit and Aichilik rivers.

Systematic Survey

Seven 1.6 km–wide transects were surveyed covering approximately 18 percent of the study area. Because time permitted and we were interested in obtaining information on caribou distribution along the northern flanks of the Sadlerochit Mountains, the survey along transect 6 was extended outside of the 1002 area boundary (Fig. 5, a folded map found at the end of this report).

Table 1 provides a summary of the results obtained from the systematic survey, including the area of each transect. The total number of caribou observed on all transects within the 1002 area was 3,072. Of this total, 67 percent were cows, 28 percent calves, 4 percent yearlings, and about 1 percent unclassified. Extrapolating from the 18 percent survey coverage, an estimated total of 17,203 caribou (12,398 adults and yearlings and 4,805 calves) was present in the study area.

The majority of caribou observed (2,130 animals, 69 percent of the total) were located between the Katakturuk and Sadlerochit rivers as in the non–systematic survey (Fig. 5). Comparable to the non–systematic survey, these animals were predominately cow/calf groups that were found on broad ridges in gently sloping terrain that were snow–free or had mottled snow. Several groups were located along river terraces and creek drainages, as is common during the period following calving (Garner and Reynolds 1986).

About 366 (12 percent of the total) caribou were observed between the Canning and the Katakturuk rivers, primarily on bluffs and ridges. Approximately 576 (19 percent of the total) animals were observed between the Sadlerochit and Aichilik rivers (Fig. 5). Few caribou were seen in the northeast and northwest portions of the study area, presumably because of the generally wet conditions in these areas.

Distribution of Caribou Outside the 1002 area

No adult bulls were observed within the 1002 area during the systematic survey. A few bulls were seen during the non–systematic survey, primarily outside of the 1002 area in the foothills of the Sadlerochit Mountains. This is consistent with observations that bulls normally lag behind the cows during migration to the calving grounds and they are usually located in peripheral areas around concentrated calving areas (Garner and Reynolds 1986, Clough et al. 1987). It must be noted that male and female yearlings were not differentiated during either survey and certainly some of the yearlings were male.

Table 1. Numbers and classes of caribou observed along systematically-spaced,1.6 km-wide, survey transects on 4 June 1991, in the 1002 area of the Arctic National Wildlife Refuge, Alaska.

		Number of Caribou				Observed	Estimated*
Transect	Area (hectares)	Cows	Calves	Yearlings	Unclassified	Total	Total
1	2753.1	0	0	0	0	0	0
2	19777.8	1	0	0	0	1	5.6
3	24896.3	179	16	0	0	195	1092
4	27054.5	1043	490	65	4	1602	8971.2
5	23765.2	607	269	24	10	910	5096
6	12968	186	69	38	0	293	1640.8
7	4624.2	40	14	11	6	71	397.6
Total	115839.1	2056	858	138	20	3072	17203.2

*Total numbers estimated using the following extrapolation formula:
115,839.1 hectares (area of transects)/627,530.4 hectares (1002 area)=0.18 (or 18% of the 1002 area)
100/18=5.6; Observed Total x 5.6=Estimated Total.

Approximately 972 caribou (559 cows, 350 calves, 56 yearlings, and 7 unclassified individuals) were observed on the portions of transects 6 and 7 outside the 1002 area (Fig. 5). During the non–systematic survey, a total of about 4,790 caribou were observed outside of the 1002 area (Fig. 4). Most of the animals seen outside of the 1002 area during both surveys were in the foothills along the northern flanks of the Sadlerochit Mountains and along river terraces overlooking the Sadlerochit, Hulahula, and Okpilak rivers (Figs. 4 and 5). Only about 350 caribou were observed east of the Aichilik River during the non–systematic survey.

DISCUSSION

We estimate that about 26 percent of the PCH cows calved in the 1002 area in 1991 (Fig. 6). The estimate was derived from the following information and assumptions. First it was assumed that the PCH consists of 178,000 animals (Fancy et al. 1990) of which 49 percent (mean percentage calculated from 16 years of data collected during 1971–89), or 88,200, are cows (Fancy et al. 1991). Second, we assumed that there were 25,000 caribou in the 1002 area in 1991 based on the non–systematic census effort. Of these, 23,200 (93 percent) were cows based upon the ratio of cows to total animals (excluding calves) derived from the systematic surveys. Dividing 23,250 by 88,200 yields the estimate of 26 percent PCH cows in the 1002 area.

The distribution of calving areas used by the PCH has been mapped from 1972 to the present (e.g. Clough et al. 1987, BP Exploration (Alaska), Inc. 1991, this study). The data upon which these distributions are based have been used to estimate the proportion of the herd that calves in the 1002 area (e.g. Clough et al. 1987, Fancy et al. 1989, Fancy et al. 1990, BP Exploration (Alaska), Inc. 1991). Data gathered over the past nine years are generally believed to be more systematic and reliable than data obtained during earlier years. During this period (1983–1991), the proportion of the PCH cows which have calved in the 1002 area has ranged between 5 and 82 percent, averaging about 42 percent overall (Fig. 6). However, the proportion calving in the 1002 area has ranged between 5 and 38 percent in six of these nine years (mean for these six years was about 25 percent) and 70 percent or above has been observed in three of the nine years (mean was 75 percent, Fig. 6). Based upon these estimates, about 25 percent of the PCH calve in the 1002 area in two out of every three years, but a large proportion (about 75 percent) may be expected in the 1002 area in one out of every three years.

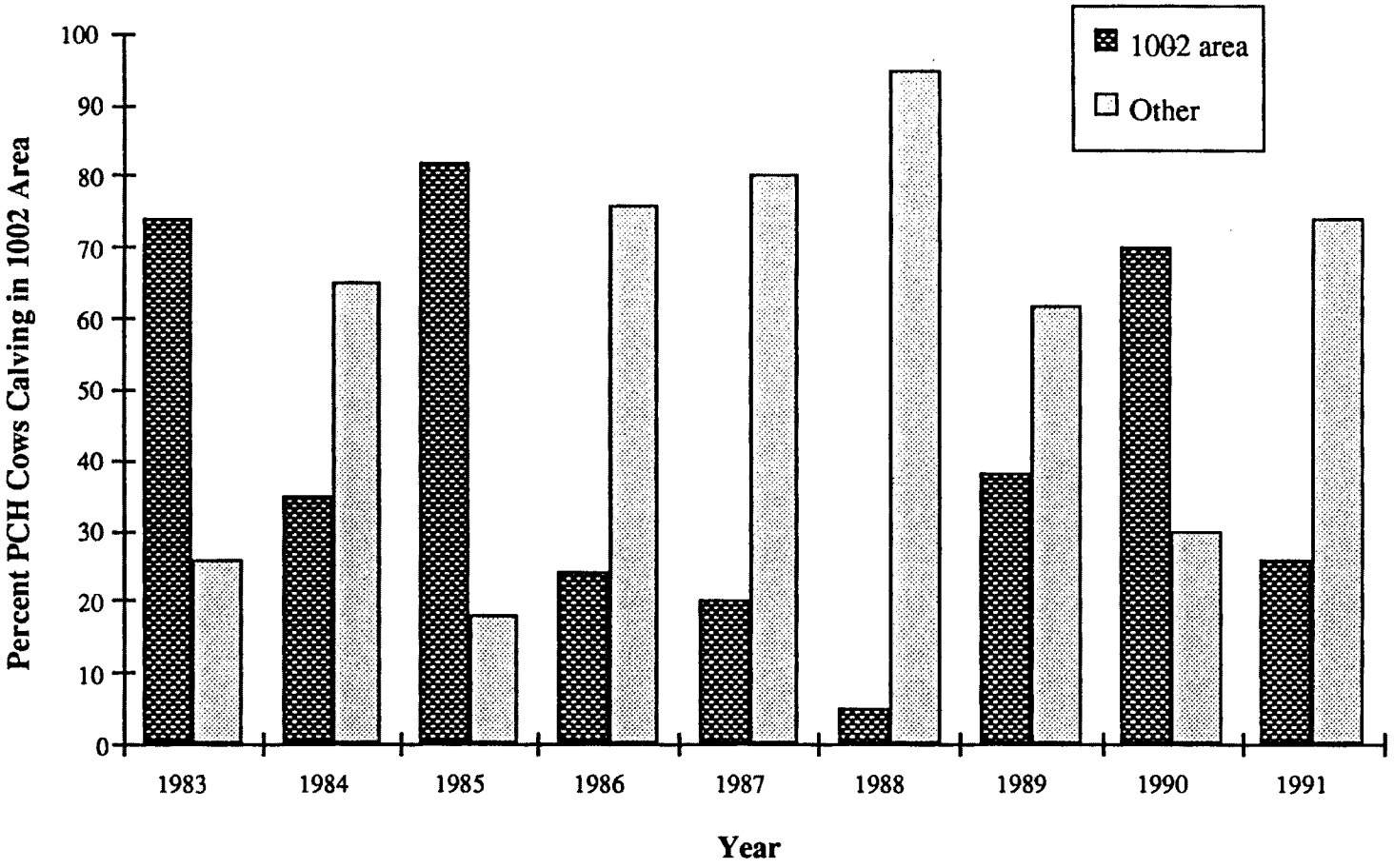

Figure 6. Percentage of PCH cows using the 1002 area for calving, 1983-1991. The sources for the estimates are 1983-1986 (Clough et al. 1987), 1987 (BP Exploration [Alaska] Inc. 1991), 1988 (Fancy et al. 1989), 1989 (Fancy et al. 1990), 1990 (BP Exploration [Alaska] Inc.) and 1991 (this study).

Caribou Distribution

Data from both surveys (systematic and non–systematic) were used to map calving distribution in Alaska in 1991. The overall boundary of calving (Fig. 7, yellow line) was based on trails and sightings of a few scattered cows with calves and a few pregnant cows. The boundary of the area where the majority of caribou calved (Fig. 7, green line) denotes a more restricted area, within which more concentrated calving occurred in the area between the Tamayariak River on the west and the Hulahula River on the east (Fig. 7, black line). Particularly heavy calving concentrations occurred in the Sadlerochit uplands between the Sadlerochit and Katakturuk rivers (Fig. 7, stippled area).

The western part of the 1002 area between the Tamayariak and Hulahula rivers has not been the site of concentrated PCH calving since about 1977 (Clough et al. 1987:22–23). The reasons for the concentrated calving there in 1991 are not entirely clear, but are probably related to the lack of snow cover in the area. Whitten et al. (1991) have suggested that the variation in snow cover on PCH calving grounds and on migration routes accounts for most of the variation in location of concentrated calving. During 1990, snowmelt was early and a high proportion of the PCH calved in the 1002 area (Fig. 6). In contrast, during 1987 and 1988, snowmelt was delayed and relatively little calving occurred in the 1002 area (Fig. 6, Whitten et al. 1991).

During 1972–1986, the peak of calving for the PCH has usually been between 4 to 8 June (Clough et al. 1987). Assuming that the ADF&G estimate of calving in 1991 was correct (that calving was 70 percent complete by the evening of 2 June), calving probably peaked sometime during about 30 May – 1 June in 1991. While calves were not recorded, estimates were made during the 3–4 June non–systematic surveys. Estimates of calf/cow ratios varied among groups from about 30 calves per 100 cows to as many as 60–70 calves per 100 cows.

Comparison of Non–systematic vs. Systematic Survey Results

The non–systematic survey was a census, a complete count of animals over a specified area at a specified point in time. The systematic survey was a sample census, a complete count of animals over a specified area (transects) at a specified point in time (Overton 1971). A complete census will give a more accurate count of the animals in the specified area, but a sample census can also be used to obtain an estimate for the entire study area.

Our sample census (systematic survey) underestimated the total numbers of caribou present by about 50 percent based upon comparison to the census data (non–systematic

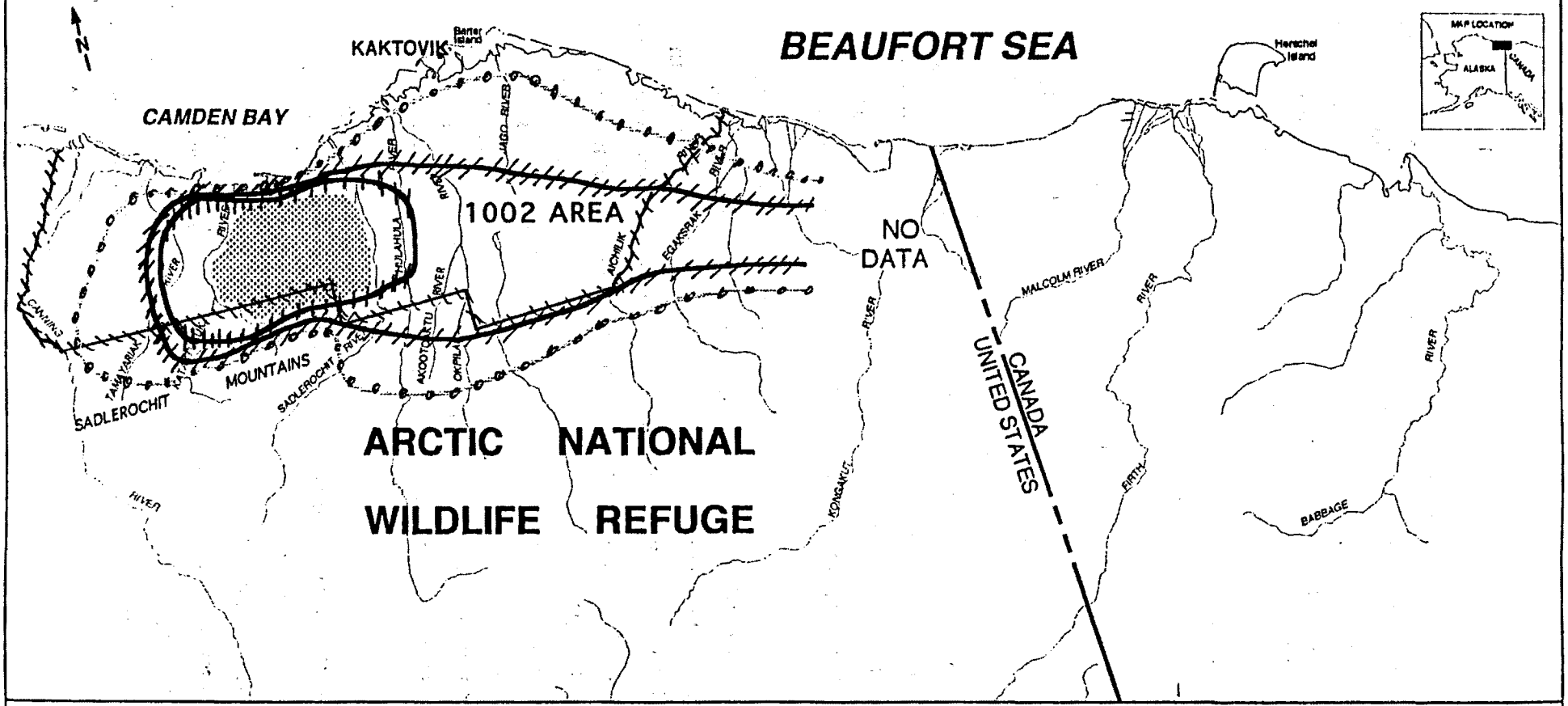

Figure 7. Porcupine Caribou Herd distribution in Alaska based on aerial surveys conducted on 4 June 1991. Map source: simplified digitized version of Canadian Department of Energy, Mines, & Resources Map "Herschel". Projection is Transverse Mercator.

0 30 60
Kilometers

Modified by hand to eliminate need for color copies. 1/31/96 BJP

LEGEND

- **Boundary of 1002 area**
- **General boundary of calving**
- **Boundary of area where majority of calving occurred**
- **Boundary of concentrated calving**
- **Area of greatest calving concentration**

survey). The discrepancy between the numbers of caribou censused versus the estimated number present based upon extrapolation from the transect data is probably related to the intensity of the transect coverage. Cameron et al. (1985) compared five years of systematic survey data on the CAH to total counts. Population estimates from four levels of partial survey coverage (17, 25, 33, and 50 percent) were compared with total counts based upon 100 percent coverage. They found a decreasing trend in mean errors related to estimated population counts with increasing survey coverage. Clearly, increased accuracy may be obtained with greater coverage, but costs increase accordingly.

The larger estimate for the non–systematic survey also reflects that a greater proportion of the higher–density calving areas was searched during this survey as compared to the systematic survey. The non–systematic surveys were directed towards counting the total numbers of caribou present within the 1002 area. Large groups of caribou seen at a distance were approached and counted. Altitude was not fixed during the survey which facilitated detection at long distance. While not all of the caribou present were counted, it is unlikely that any major groups were missed. During the systematic survey, altitude and survey transect strip–width were fixed and caribou that were observed beyond transect boundaries were not counted. This yielded a decided underestimate, largely because of the relatively small area surveyed (18 percent of the total area).

Other factors which can potentially affect the accuracy of aerial surveys include observer error and technical problems. Observer error during systematic strip–transect surveys has been shown to increase with increasing caribou density (Fong et al. 1985). Inaccuracies may also be associated with estimating numbers of animals in groups that are too large to count. One of the major technical problems in systematic surveys concerns banking of the survey aircraft. This may result in an inability to accurately define survey strip width on the ground (Pennycuick and Western 1972), thereby producing biased estimates. More discussion of biases which can occur in strip–transects can be found in Caughley (1977) and Heard (1985).

Comparison to USFWS and ADF&G Surveys

The results of the 1991 USFWS and ADF&G calving period surveys of radio–collared cows of the PCH in Alaska concur with our findings in terms of the distribution of calving within the 1002 area (K. R. Whitten, pers. comm.). However, the results obtained by the USFWS and ADF&G study suggest that virtually the entire herd calved in Alaska, and about 90 percent calved within the 1002 area, mainly between the Katakturuk and Hulahula rivers. If

this is true, then our surveys did not detect some 56,000 cows. Given the intensity of surveys we conducted in this area, we do not believe that this is likely. Our surveys were conducted on one day relatively close to the peak of calving. If considerable numbers of parturient cows and/or cows with calves moved out of the 1002 area into peripheral areas prior to our surveys, we probably would have detected these animals during our non–systematic survey. Moreover, cows with calves do not commonly move great distances shortly after calving. Fancy et al. (1991) tracked the movement of parturient PCH cows between 1985 and 1989. They found that cows moved <5 km/day during the 6–day period beginning at calving and that the daily distance traveled slowly increased one week after calving. In the same study, relocations of radio–collared cows showed that most cows remained in the general area where they calved for 1–2 weeks.

It is possible that, even though all or most of the collared cows tracked in the 1991 USFWS and ADF&G study may have calved in the 1002 area, their distribution was not representative of the herd in general. However, if supplementary count data confirm the estimates obtained from radio tracking pregnant cows, the interpretation would be that our surveys were too limited to accurately determine the extent of calving in the 1002 area. On the other hand, if the USFWS and ADF&G estimates are not supported by supplementary count data, the implication would be that companion census data are required for interpretation of the data obtained from collared animals. Much would be gained if the two studies were conducted as a coordinated effort rather than separate studies.

CONCLUSIONS

Our one day survey suggests that 26 percent of the total cow population of the PCH calved in the 1002 area in 1991. This compares to estimates of 5 to 82 percent present in the 1002 area during the 9–year period 1983 to 1991. The proportion of the herd which uses this area varies greatly and appears related to annual patterns of snowmelt and green–up.

During the non–systematic aerial surveys on 4 June, approximately 24,807 caribou (excluding calves) were observed in the 1002 area. Estimates derived from systematic aerial surveys conducted at the same time as the non–systematic surveys showed there to be approximately 17,203 caribou, including calves, in the same area. The non–systematic survey is believed to have provided a more accurate representation of the actual number of caribou within the study area because of the relatively low coverage (18 percent of the study area)

achieved during the systematic survey. However, the systematic survey was consistent with the non–systematic survey regarding caribou distribution.

The majority of calving in the 1002 area occurred in a broad area between the Hulahula and Tamayariak rivers, from the foothills of the Sadlerochit Mountains north to within a few kilometers of the Beaufort Sea coast. The area of greatest calving concentration was in the Sadlerochit uplands between the Sadlerochit and Katakturuk rivers. This area has not been the site of concentrated calving since about 1977.

Evaluation of potential calving displacement from oil and gas development in the 1002 area should take into consideration the proportion of the herd that might be affected. The data at present suggests that on the order of 25 percent of the PCH cows calve in the 1002 area during two out of every three years, but as much as 75 percent of the cows may calve there during one out of every three years. The distribution of calving within the 1002 area also varies greatly among years, apparently in response to snowmelt and green–up patterns.

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