

**Aerial Surveys of Polar Bears Along the Coast and Barrier Islands of the Beaufort Sea,  
Alaska, September-October 2000**

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## INTRODUCTION

The Northstar Project includes construction of the first off-shore oil production facility incorporating sub-sea pipeline technology in Arctic North America. It is operated by BP Exploration and located approximately six miles off-shore from Point Storkersen in the Alaskan Beaufort Sea, northwest of Prudhoe Bay. In February 1999, the U.S. Army Engineer District, Alaska, completed the *Final Environmental Impact Statement, Beaufort Sea Oil and Gas Development/Northstar Project* (Northstar EIS). The Northstar EIS identified potential effects of development and production of the Northstar Unit on the surrounding environment, as well as stipulations to mitigate for potential effects on biological resources, including polar bears (*Ursus maritimus*). Lease stipulation # 7 states: "Operators [are] required to conduct resource surveys if biological populations or habitats that may require additional protection are identified...". Special condition # 14 of the U.S. Army Corps of Engineers permit for the Northstar Project states:

"The permittee shall conduct or support studies to address the following:...(c) conduct aerial surveys to determine the distribution of polar bears on barrier islands and along the coast within the Project Area during August through October. Study objectives, design and methods will be developed by the U.S. Fish and Wildlife Service (Marine Mammals Management), the U.S. Geological Survey (Biological Resources Division), and the permittee, in coordination with the Corps of Engineers."

The use of barrier islands and coastlines by polar bears in the Alaska Southern Beaufort Sea has increased in the last 10 years. Bowhead whale remains at Barter Island and Cross Island are believed to serve as attractants for polar bears visiting coastal areas in the fall although other factors such as ice conditions and trends in weather may also influence polar bear distributions. Distribution of polar bears is primarily related to sea ice and prey availability (Lentfer 1972). During the fall and winter months polar bears often travel along the Beaufort Sea coast and barrier islands between feeding locations or to search for denning areas.

Kaktovik hunters report that polar bears usually arrive on the Beaufort Sea coast in September (Kalxdorff 1997); however, in more recent years polar bears have been sighted in August (pers comm. Dave Marinucci, Vice President, Fairweather Incorporated, August 1999). Anecdotal information from local North Slope residents and workers indicate that polar bear use of coastal areas during the fall open water season is increasing. Amstrup and Gardner (1994) and Stirling and Andriashek (1992) noted increased use of mainland terrestrial denning habitat by female polar bears over the last decade.

Polar bear aggregations may occur in areas of high seal availability (Stirling et al. 1981, Stirling 1980). The presence of marine mammal carcasses may also attract polar bears (U.S. Fish and Wildlife Service 1995, Shideler 1993). Aggregations of polar bears at bowhead whale carcass sites at Barter Island and Cross Island have been observed recently (pers comm. George Durner, pers comm. Anne Morkill).

Whether polar bears present on land during the open water period in the late fall are primarily females preparing to den remains unanswered, along with other questions regarding the movements of individuals, fidelity of animals to specific sites, patterned learning behavior in visitation of specific sites and the transmission of this behavior to offspring, as well as questions concerning the significance to the ecology of polar bears in this area during the fall. Ongoing and future research could provide a better understanding of the ecology of bears using coastal areas and of the importance of these areas to polar bears. Telemetry and ground based studies of movements, use, and inter and intra-annual use and fidelity of individual animals are in the planning phase and progress on these studies should be integrated by reference into future progress or final reports of this project.

## **OBJECTIVES**

The purpose of conducting aerial coastal surveys is to determine the spatial and temporal distribution and abundance of polar bears using coastal habitats and barrier islands during the open water period prior to freeze-up in the fall. Documenting the number, sex, and age classes of polar bears using coastal habitat will: 1) increase understanding of the ecological significance of these areas to polar bears; 2) provide information useful for assessing the effects of various on- and off-shore exploration and production activities on polar bears; and 3) provide information for developing oil spill contingency plans, bear/human interaction plans, and for implementing better strategies related to human activities in polar bear habitat.

## **METHODS**

The survey area identified for this study is the coastline and barrier islands between Cape Halkett and Jago Spit (located east of Kaktovik, Barter Island) (Figure 2). Aerial surveys were initiated when polar bears arrived in the survey area and were continued weekly until freeze-up occurred and polar bears began to disperse to off-shore marine habitat.

A Shrike Aero Commander aircraft operated by Commander Northwest, Limited was used for all survey flights. Surveys were flown parallel to and slightly off set from barrier islands and the mainland shoreline at a speed of 90-110 knots, at approximately 70-170 m (200-500 ft) elevation. The crew consisted of two pilots and four observers. Pilots were responsible for navigation and did not participate in data collection. Two front seat observers and two rear seat observers were responsible for data collection; the front left seat observer was the primary observer. Pilots flew along the coast until notified of a polar bear sighting. Observers attempted to identify the number, age, and sex of polar bears observed. Sightings of more than one animal (= group) included females with dependent young, and any combination of adult, sub-adult, or unknown age/sex bears within 50 m of each other. Animals were circled to ensure accurate counts.

The right front (or rear) seat observer recorded all survey data, e.g. wildlife sightings, changes in weather conditions, flight start/end points, and time of each event, on data sheets (Appendix 1). These data were time-linked to a Global Positioning System that recorded the location of the aircraft at 15 second intervals. At the end of each survey, flight tracks and survey data were entered into a database using Microsoft Access 2000 software. Maps were created using Arc View version 3.1 software.

## RESULTS

Surveys were flown along the coastline and barrier islands of the Beaufort Sea between Cape Halkett and Jago Spit on September 21, September 28, October 5, and October 12, 2000. Flight distances varied among surveys due to presence of fog, shore-fast ice, and slight deviations in the survey routes. During all flights, the larger barrier islands were circled to obtain full survey coverage. Each survey was completed in one day. Good survey conditions were encountered during all flights, with the exception of some fog patches encountered during the first three surveys.

On September 21, 2000, the survey was initiated in Prudhoe Bay and flown west along the mainland coast to Cape Halkett, with return to Prudhoe Bay via Thetis, Spy, Leavitt, Pingok, Bodfish, Cottle, Long, Egg, and Stump islands. After refueling, a second leg was initiated off-shore from Prudhoe Bay at Reindeer Island and flown east along the barrier islands (Argo, Cross, Narwhal, Jeanette, Karluk, Pole, Challenge, Alaska, Duchess, North Star, and Flaxman) to Jago Spit (east of Barter Island) with return to Prudhoe Bay along the mainland coast. Since no barrier islands are present in the pelagic area between Brownlow Point and the west side of Barter Island, it was not surveyed.

For the remaining three surveys, the east leg of the survey was flown first to ensure that the area with the highest likelihood of polar bears presence was surveyed, in anticipation of poor weather conditions or other flight limitations. All flights were initiated off-shore from Prudhoe Bay at Reindeer Island and flown east to Jago Spit along the barrier islands with return to Prudhoe Bay along the mainland coast. The west leg of the survey was truncated from Cape Halkett to Atigaru Point because of fuel, weather, and time constraints. On September 28 and October 5, 2000, the west leg was flown from Prudhoe Bay to Atigaru Point along the mainland with return to Prudhoe Bay via the barrier islands. On October 12, 2000, the barrier islands were flown first with return to Prudhoe Bay along the mainland.

The distribution of polar bears observed during each survey is illustrated in Figures 3-6 and described in Tables 1-4. A total of 232 polar bears were observed over 2,772 survey km. The age and sex composition of polar bears encountered during surveys is described in Table 5. Of the total number of bears observed ( $n = 232$ ), 23% were adult females  $> 5$  years old ( $n = 53$ ), 3% were adult males  $> 5$  years old ( $n = 8$ ), 5% were sub-adult bears 2.5-5 years old ( $n = 11$ ), and 30% were dependent young, including cubs-of-the-year  $< 1$  year old ( $n = 48$ ) and yearlings 1-2.5 years old ( $n = 22$ ). Thirty-nine percent of the bears observed were of unknown sex and age ( $n = 90$ ); 11% of these were identified as adults ( $n = 25$ ).

The frequency rate of polar bears encountered along the survey route is described in Table 6. Frequencies were compared among the following four segments: 1) Atigaru Point to Prudhoe Bay; 2) Prudhoe Bay to Brownlow Point; 3) Brownlow Point to (the western tip of) Barter Island; and 4) Barter Island to Jago Spit. The segment with the highest encounter rate ( $x = .65$  polar bears/km) was between Barter Island and Jago Spit; the lowest was between Atigaru Point and Prudhoe Bay ( $x = .01$  polar bears/km). Polar bears were most frequently encountered on September 28, 2000 ( $x = .11$  polar bears/km), and least frequently encountered on October 12, 2000 ( $x = .05$  polar bears/km), when sufficient shore-fast ice probably allowed polar bears access to off-shore habitat.

Table 7 compares habitat use among barrier islands, the mainland coast, open water, and shore-fast ice. Barter Island was included as "mainland" for purposes of these analyses because of its proximity and physical similarity to mainland, versus the barrier islands which typically occur further off-shore, and are long and narrow in form. During all surveys combined, 72% ( $n = 166$ ) of polar bears observed were found on barrier islands; 17% ( $n = 40$ ) were found on mainland, 9% ( $n = 21$ ) on shore-fast ice (includes ice attached to both the mainland coast and barrier islands), and 2% ( $n = 5$ ) were observed in open water. One should note that the amount of open water to ice varied among surveys; namely, the amount of open water decreased and the amount of shore-fast ice increased within the survey tract over the survey period. Some newly formed lagoon ice (between mainland coast and barrier islands) was encountered during all but the first survey and was heaviest and most extensive during the last survey. Little or no ice was encountered north of the barrier islands except on the last survey.

While polar bear distribution did vary among surveys, some areas were consistently used by polar bears. Cross Island, Jago Spit, and Barter Island had animals present during all surveys. Polar bears were sighted at Bernard Spit and Manning Point (both near Kaktovik) on three of four surveys. In addition, polar bears were present at or near (on shore-fast ice or in open water) Flaxman Island and Konganevik Point during three of four surveys. Narwhal Island and Bullen Point had polar bears present during two of four surveys. No method was employed to determine whether individual animals were present in subsequent surveys.

Additional wildlife observed during surveys included: ringed, bearded and spotted seals; bowhead and beluga whales; Arctic and red foxes; caribou; and one brown bear (Table 8).

## DISCUSSION

The distribution and abundance of polar bears varied among surveys. Survey results confirm that large numbers of polar bears aggregate near Barter Island, possibly due to the presence of hunter-harvested bowhead whale remains which provide an alternate food source for polar bears. The age and sex composition of large aggregations of bears is more difficult to assess by air, especially when animals are laying down. Many of the unidentified animals seen near Barter Island were believed to be females with cubs or yearlings, but actual composition remains unquantified. The U.S. Fish and Wildlife Service intends to initiate a ground-based study in Kaktovik during the fall of 2001 to obtain a better estimate of the age and sex composition of polar bears around Barter Island.

Managers need to determine whether the same polar bears are seen among surveys, or whether a high degree of migration occurs in and out of the survey area. A mark and recapture study or way of identifying individual animals would be useful to address this issue. We do know that two of the polar bears observed on October 12, 2000, were marked by researchers who later confirmed that those bears denned in proximity of where they were observed (personal communication with Anthony Fischbach, Research Scientist for the U.S. Geological Survey Biological Resources Division, December 2000). Additional surveys are needed to compare distribution, abundance, sex composition, and habitat use of polar bears among years. Surveys are planned for 2001 and 2002; summary and final reports will be prepared.

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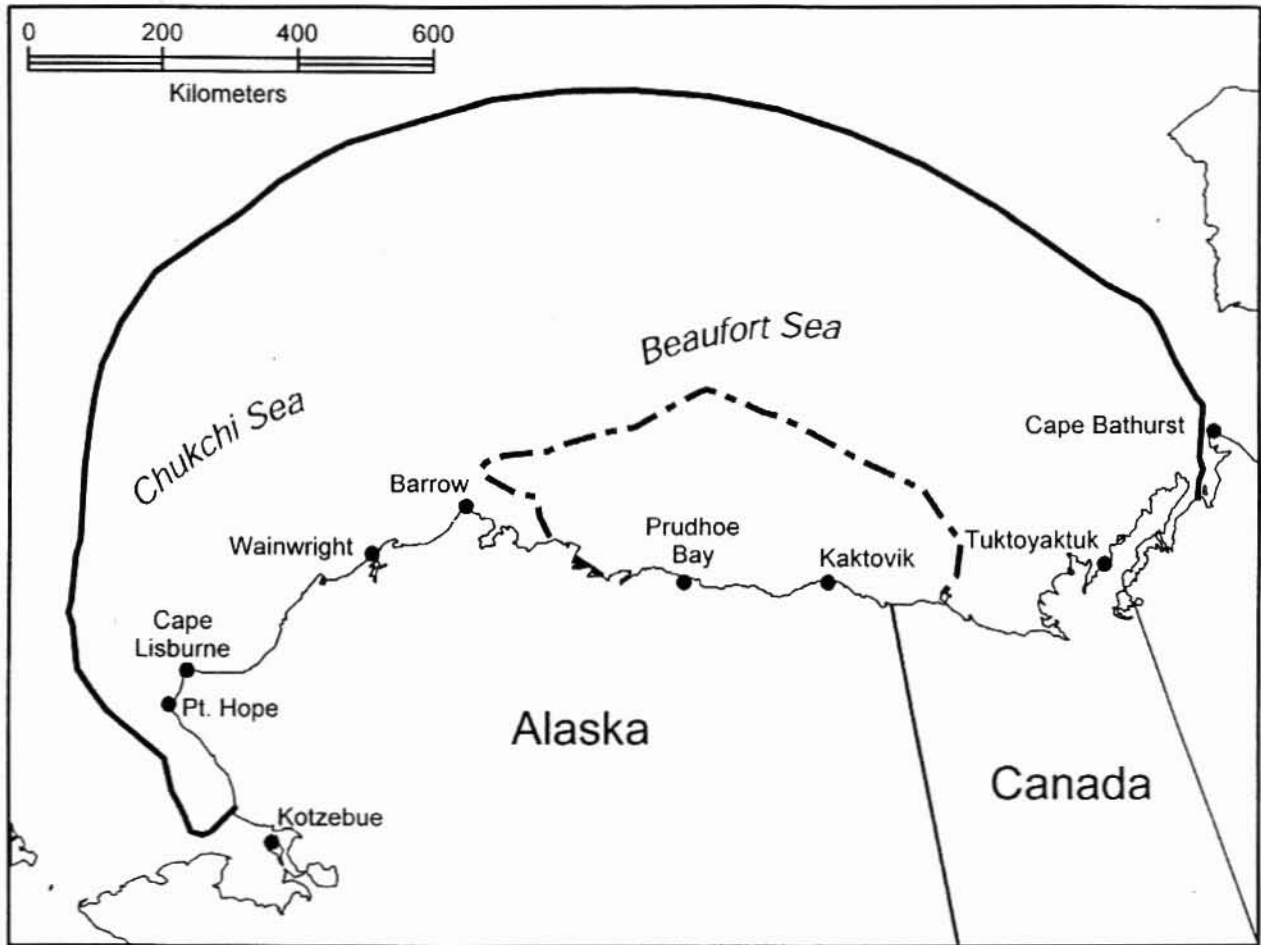


Figure 1. Approximate boundary of the Beaufort Sea polar bear population (solid line) and core activity area (dotted line) as determined by harmonic mean analysis of satellite radiotelemetry data collected during 1985-1993 (Amstrup 2000).

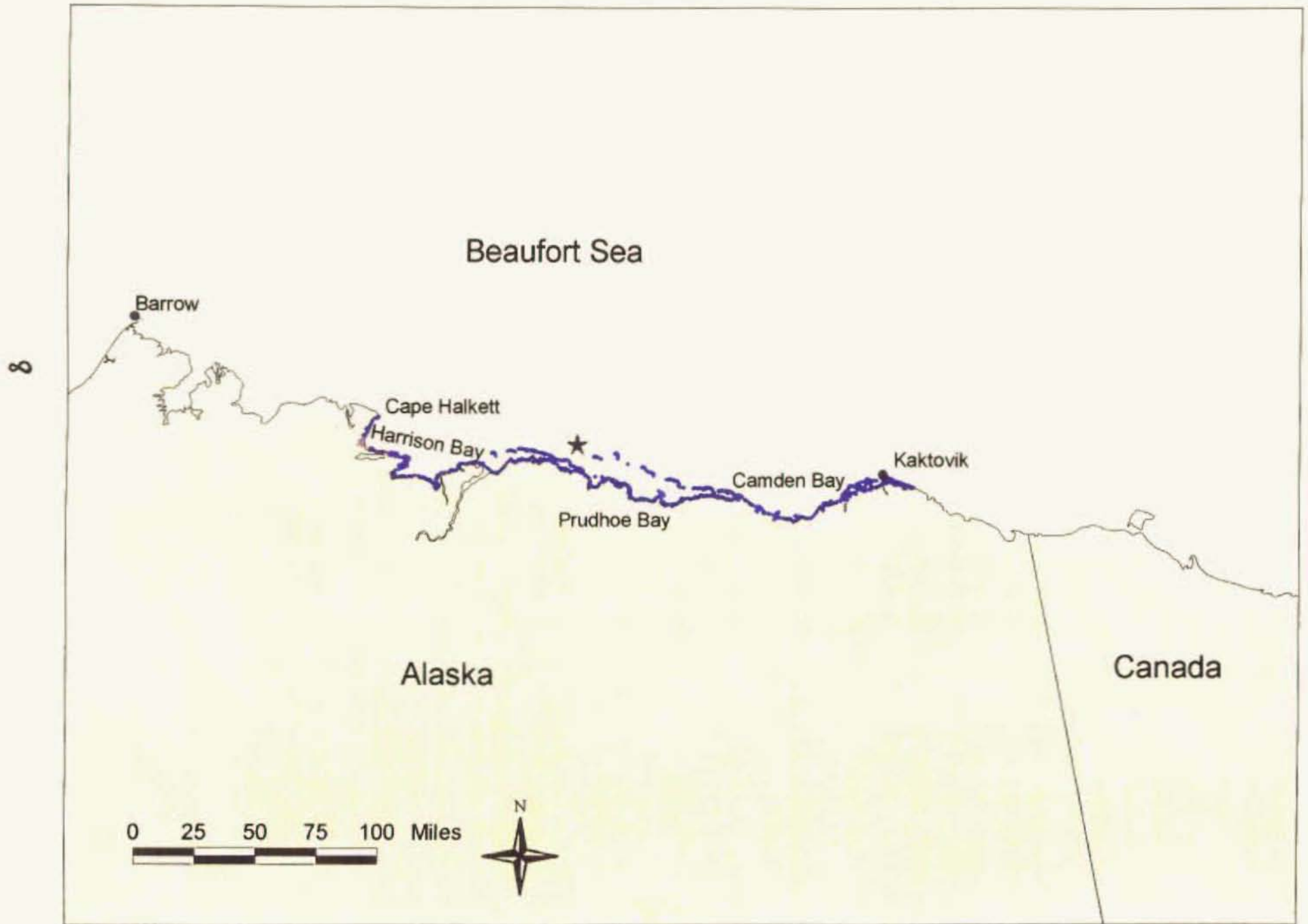


Figure 2. Survey area for conducting aerial surveys of polar bears, September-October 2000.

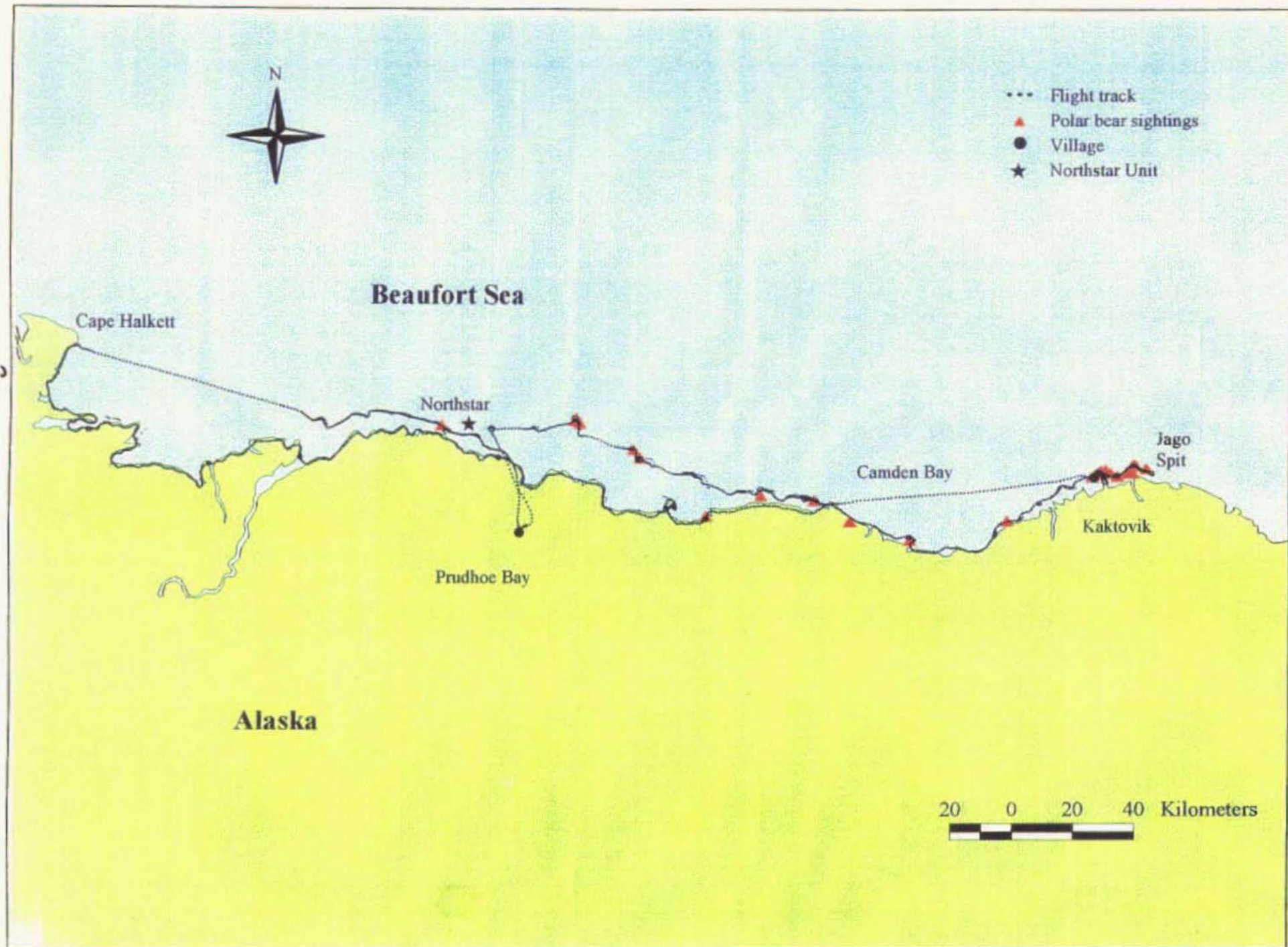


Figure 3. Polar bears observed during an aerial survey conducted along the coast and barrier islands of the Beaufort Sea, Alaska, September 21, 2000.

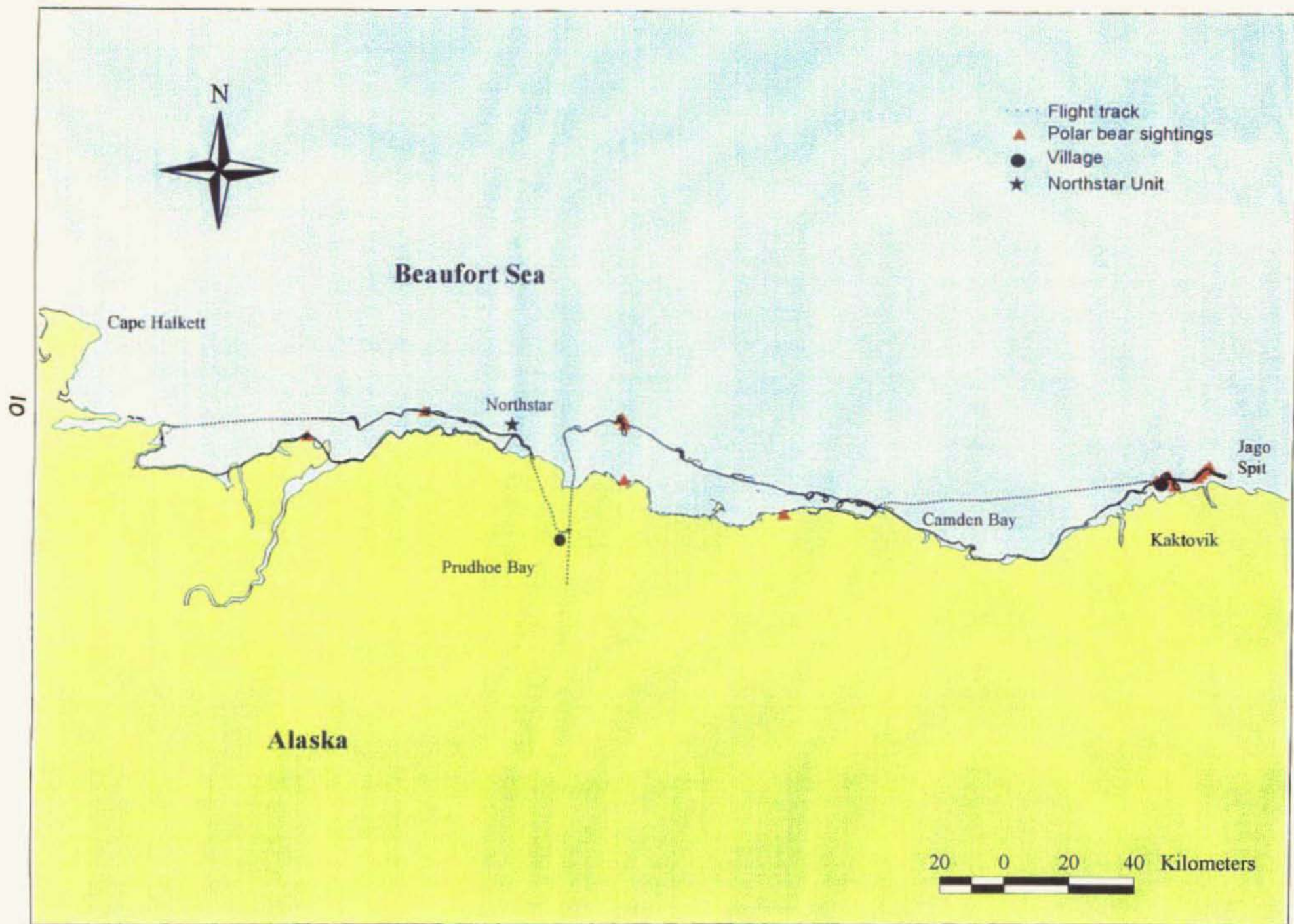


Figure 4. Polar bears observed during an aerial survey conducted along the coast and barrier islands of the Beaufort Sea, Alaska, September 28, 2000.

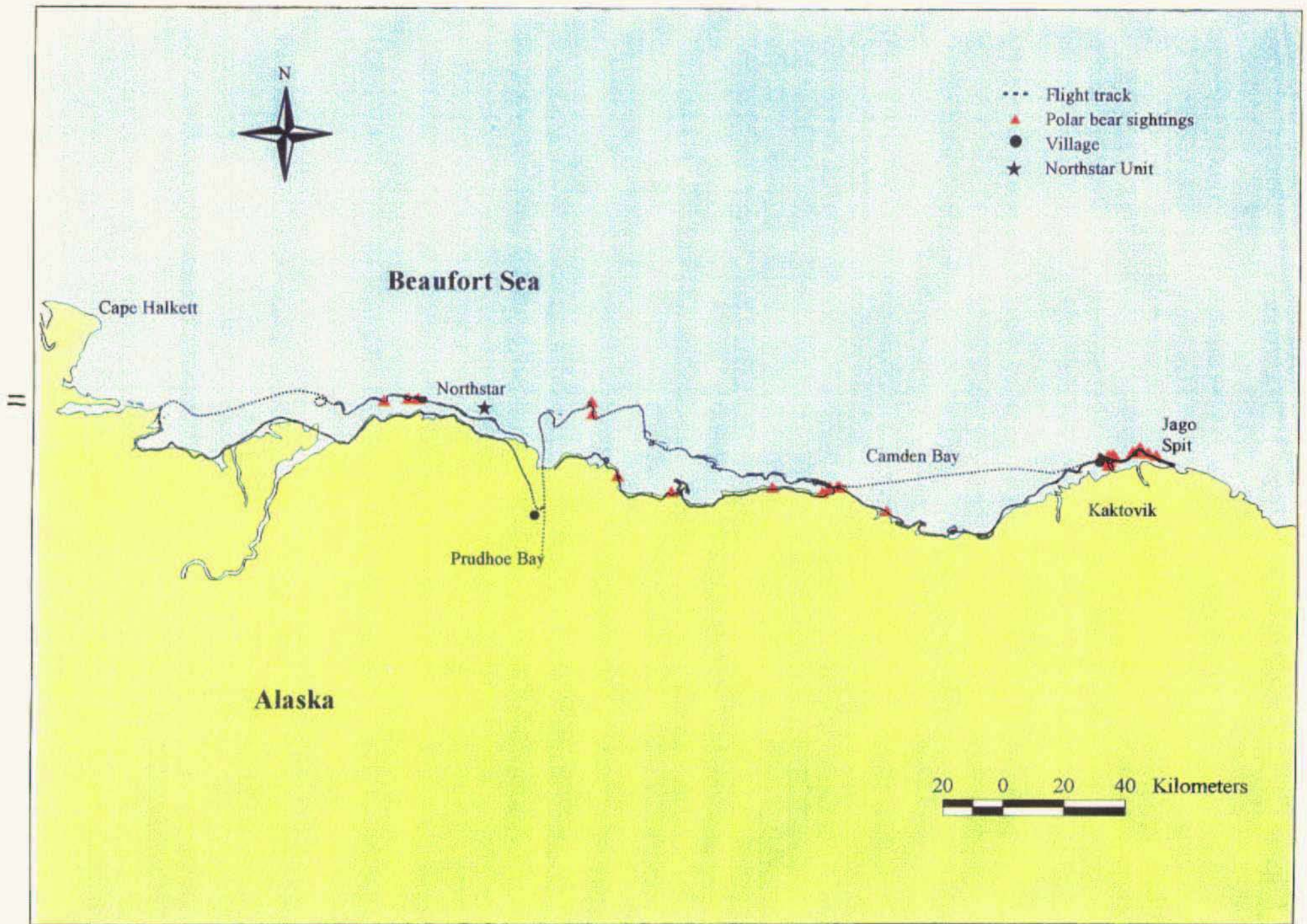


Figure 5. Polar bears observed during an aerial survey conducted along the coast and barrier islands of the Beaufort Sea, Alaska, October 5, 2000.

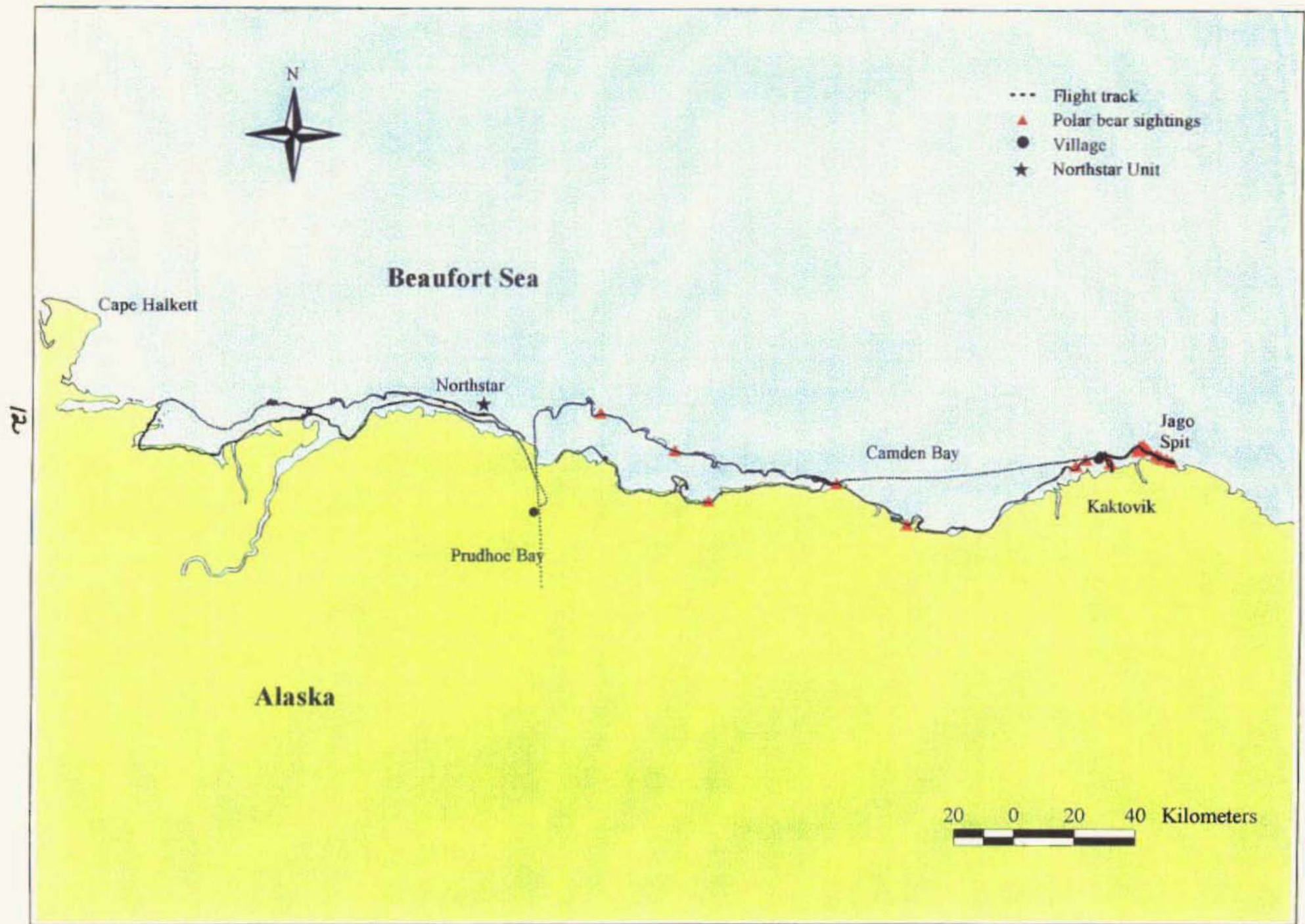


Figure 6. Polar bears observed during an aerial survey conducted along the coast and barrier islands of the Beaufort Sea, Alaska, October 12, 2000.

Table 1. Distribution of polar bears observed during 9-21-00 survey. AF = Adult Female; AM = Adult Male; SA = Sub-Adult (2.5-5 year-old); YEAR = Yearling (1-2.5 year-old); COY = cub of the year (<1 year old); UA = Unidentified Adult (>5 years old); and Unknown = unknown age or sex animal.

Sighting Number	Number of Polar Bears	Age/Sex Composition	Location
1	1	1 UA	Cottle Island
2	3	1 AF with 2 COYs	Cross Island
3	3	1 AF with 2 COYs	Cross Island
4	2	1 AF with 1 YEAR	Cross Island
5	2	1 AF with 1 COY	Cross Island
6	1	1 UA	Narwhal Island
7	3	1 AF with 2 YEAR	barrier island (McClure Island group)
8	1	1 UA	Dutchess Island
9	1	1 Unknown	Flaxman Island
10	3	1 AF with 2 COYs	Bernard Spit
11	1	1 UA	Bernard Spit
12	2	1 AF with 1 COY	Bernard Spit
13	3	1 AF with 2 COYS	Jago Spit
14	2	1 AF with 1 YEAR	Jago Spit
15	2	1 AF with 1 YEAR	Jago Spit
16	2	1 AF with 1 COY	Jago Spit
17	1	1 UA	Jago Spit
18	4	1 AF with 2 YEAR; 1 Unknown	Jago Spit
19	1	1 Unknown	Bernard Spit
20	1	1 Unknown	Bernard Spit
21	3	1 AF with 2 COYs	Bernard Spit
22	1	1 UA	Barter Island
23	2	1 AF with 1 COY	barrier island near Anderson Point
24	2	1 AF with 1 COY	mainland near Konganevik Point
25	1	1 UA	barrier island between Canning River and Brownlow Point
26	1	1 UA	mainland near Bullen Point
Total	49		



Table 2. Distribution of polar bears observed during 9-28-00 survey. AF = Adult Female; AM = Adult Male; SA = Sub-Adult (2.5-5 year-old); YEAR = Yearling (1-2.5 year-old); COY = cub of the year (<1 year old); UA = Unidentified Adult (>5 years old); and Unknown = unknown age or sex animal.

Sighting Number	Number of Polar Bears	Age/Sex Composition	Location
1	3	1 AF with 2 COYs	Cross Island
2	2	1 AF with 1 YEAR	Cross Island
3	3	1 AF with 2 YEAR	Cross Island
4	3	1 AF with 2 COYs	Barter Island
5	2	1 AF with 1 YEAR	Barter Island
6	1	1 Unknown	Bernard Spit
7	8	1 AF with 1 COY; 6 Unknown	Bernard Spit
8	19	19 Unknown (mainly females with cubs)	Bernard Spit
9	2	1 AF with 1 YEAR	Barter Island
10	2	2 Unknown	Jago Spit
11	2	1 AF with 1 COY	Jago Spit
12	6	6 Unknown	Jago Spit
13	3	1 AF with 2 COYS	in water off Jago Spit
14	1	1 Unknown	Jago Spit
15	3	1 AF with 2 COYs	Jago Spit
16	3	1 AF with 2 COYs	Jago Spit
17	2	1 AF with 1 YEAR	mainland near Manning Point
18	3	1 AF with 2 COYs	mainland between Bullen and Gordon Points
19	1	1 Unknown	mainland 3 miles south of Endicott
20	3	1 AF with 2 COYs	shore-fast ice; Colville River Delta
21	1	1 Unknown	in water near Pingok Island
Total	73		

Table 3. Distribution of polar bears observed during 10-05-00 survey. AF = Adult Female; AM = Adult Male; SA = Sub-Adult (2.5-5 year-old); YEAR = Yearling (1-2.5 year-old); COY = cub of the year (<1 year old); UA = Unidentified Adult (> 5 years old); and Unknown = unknown age or sex animal.

Sighting Number	Number of Polar Bears	Age/Sex Composition	Location
1	4	1 AM; 1 AF with 1 YEAR; 1 Unknown	Cross Island
2	1	1 AM	Cross Island
3	1	1 AF	shore-fast ice near Flaxman Island
4	1	1 AF	in water near Flaxman Island
5	7	2 AF with 2 COYS; 3 UA	Barter Island
6	2	2 UA	Bernard Spit
7	11	1 AF with 1 COY; 9 UA	Bernard Spit
8	3	1 AF with 1 COY; 1 SA	Jago Spit
9	2	2 Unknown	shore-fast ice near Jago Spit
10	3	3 UA	Jago Spit
11	3	1 AF with 2 YEAR	Jago Spit
12	8	1 AF with 2 YEAR; 3 SA; 2 AM	Jago Spit
13	3	1 AF with 1 YEAR; 1 Unknown	Jago Spit
14	1	1 Unknown	shore-fast ice near Jago Spit
15	3	1 AF with 1 COY; 1 Unknown	Barter Island
16	3	3 Unknown	Jago Spit
17	2	1 AF with 1 COY	mainland near Manning Point
18	1	1 AM	mainland near Manning Point
19	1	1 Unknown	barrier island near Konganevik Point
20	1	1 Unknown	mainland near Brownlow Point
21	1	1 Unknown	mainland near Brownlow Point
22	1	1 Unknown	mainland near Point Thompson
23	3	1 AF with 2 COYS	shore-fast ice in Mikkelsen Bay
24	1	1 SA	mainland near Sagavanirktok River
25	2	1 AF with 1 YEAR	shore-fast ice near Spy Island
26	1	1 Unknown	Leavitt Island
27	2	2 SA	shore-fast ice near Pingok Island
Total	72		

Table 4. Distribution of polar bears observed during 10-12-00 survey. AF = Adult Female; AM = Adult Male; SA = Sub-Adult (2.5-5 year-old); YEAR = Yearling (1-2.5 year-old); COY = cub of the year (<1 year old); UA = Unidentified Adult (> 5 years old); and Unknown = unknown age or sex animal.

Sighting Number	Number of Polar Bears	Age/Sex Composition	Location
1	1	1 SA	Cross Island
2	2	1 AF with 1 YEAR	Narwhal Island
3	1	1 AF	shore-fast ice near Flaxman Island
4	6	1 AF with 3 COYs; 1 AF with 1 COY	Jago Spit
5	2	1 AF with 1 COY	Jago Spit
6	4	1 AM; 3 SA	Jago Spit
7	3	1 AF with 1 COY; 1 Unknown	Jago Spit
8	3	1 AF with 2 COYs	shore-fast ice near Jago Spit
9	2	2 Unknown	shore-fast ice near Jago Spit
10	2	2 Unknown	Jago Spit
11	2	1 AF with 1 YEAR	Jago Spit
12	1	1 Unknown	Jago Spit
13	2	2 Unknown	mainland near Manning Point
14	2	2 Unknown	Barter Island
15	1	1 AM	Barter Island
16	2	1 AF with 1 COY	Arey Island
17	1	1 AM	shore-fast ice near Konganevik Point
18	1	1 AF	mainland near Bullen Point
Total	38		

Table 5. Age and sex composition of polar bears sighted during aerial surveys along the coast and barrier islands of the Beaufort Sea, Alaska, September-October, 2000. Adult animals = > 5 years old; Sub-Adult = 2.5-5 years old; Yearling = 1-2.5 years old; Cub-of-the-Year = <1 year old; Other Unknown = unknown age or sex.

Survey Date	Age Class							Total Observed
	Adult Females	Adult Males	Sub-Adults	Yearlings	Cubs-of-the-Year	Adults of Unknown Sex	Other Unknown	
09-21-00	15	0	0	7	15	8	4	49
09-28-00	14	0	0	6	16	0	37	73
10-05-00	14	5	7	7	8	17	14	72
10-12-00	10	3	4	2	9	0	10	38
Total	53	8	11	22	48	25	65	232

Table 6. Frequency rate of polar bears observed during aerial surveys along the coast and barrier islands of the Beaufort Sea, Alaska, September-October, 2000. Flight distances varied due to presence of fog, shore-fast ice, and slight deviations in survey routes.

Survey date	Number of Polar Bears Observed/Survey Kilometer				
	Atigaru Point to Prudhoe Bay	Prudhoe Bay to Brownlow Point	Brownlow Point to Barter Island	Barter Island to Jago Spit	Average/survey
09-21-00	1/245 = .00	17/261 = .07	5/106 = .05	26/64 = .41	49/676 = .07
09-28-00	4/229 = .02	12/259 = .05	0/106 = .00	57/64 = .89	73/658 = .11
10-05-00	5/280 = .02	14/254 = .06	1/106 = .01	52/64 = .81	72/704 = .10
10-12-00	0/293 = .00	5/269 = .02	1/106 = .01	32/66 = .49	38/734 = .05
Average/segment	10/1,047 = .01	48/1,043 = .05	7/424 = .02	167/258 = .65	

Table 7. Habitat types used by numbers of polar bears observed during aerial surveys along the coast and barrier islands of the Beaufort Sea, Alaska, September-October 2000. Barter Island was included as "mainland" for purposes of these analyses because of its proximity and physical similarity to mainland, versus the barrier islands which typically occur further off-shore, and are long and narrow in form.

Survey Date	Barrier Island	Mainland	Shore-fast Ice	Open Water
09-21-00	45	4	0	0
09-28-00	53	13	3	4
10-05-00	43	17	11	1
10-12-00	25	6	7	0
Total	166	40	21	5

Table 8. Additional wildlife observed during aerial surveys along the coast and barrier islands of the Beaufort Sea, Alaska, September-October 2000.

Species	09-21-00	09-28-00	10-05-00	10-12-00
Ringed Seal		1	23	4
Bearded Seal			1	
Spotted Seal			1	
Unknown Seal	1		21	2
Bowhead Whale		1		
Beluga Whale			1	
Brown Bear			1	
Arctic Fox			1	2
Red Fox			2	1
Caribou			40	65

## **APPENDIX 1. DATA SHEETS AND SURVEY CODES**

# FLIGHT DATA SHEET

FLIGHT: \_\_\_\_\_  
 yyyy-mm-dd [A/B/C][1/2]  
 A,B... = survey effort of day  
 1,2 = aircraft in survey  
 \*fill in when GPS is downloaded\*

Aircraft: \_\_\_\_\_ N \_\_\_\_\_  
 FAA# \_\_\_\_\_  
 Survey Type: Independent Inline  
 Aircraft Position: 1/1 1/2 2/2  
 Target Survey Altitude: \_\_\_\_\_ feet  
 Target Ground Speed: \_\_\_\_\_ knots

Departure Time: \_\_\_\_\_  
 Arrival Time: \_\_\_\_\_  
 Flight Summary: \_\_\_\_\_

Entered \_\_\_\_\_ Error Checked \_\_\_\_\_

PAGE \_\_\_\_\_ OF \_\_\_\_\_

Crew	Role	Data
_____	Pilot Right	
_____	Pilot Left	
_____	Mechanic	○
_____	RA RF LA LF	○
_____	RA RF LA LF	○
_____	RA RF LA LF	○

Time	Flight Mode	Observation	Count	Activity	Before	After	Ice Stage	Form	Observation Conditions
4:00:00	Fly	Polar Bear	1st	Inactive	OO		Open Water	New Brash	Good/Fair/Poor Mist
	Land	PB Track [old/new]	Full	Walk	OO		Nilas	Pancake	Glare? ○ Drizzle
	Circle	Seal _____	Full	Run	OO		Young	Cake	Fog? ○ Rain
	Hover	Walrus		Eat	OO		First-Year	Belt Strip	Snow/Sleet
	Transect	Other _____		Swim	OO		Multi-Year	Floe: [S M L V G]	
Transect id: _____		Zone: 1 2 3 4 5 6 7 _____°					____%Ice cover	____%Snow cover	Max. Zone Visible: R 1 2 3 4 5 6 7 L 1 2 3 4 5 6 7 _____% cloud C

	Fly	Polar Bear	1st	Inactive	OO		Open Water	New Brash	Good/Fair/Poor Mist
	Land	PB Track [old/new]	Full	Walk	OO		Nilas	Pancake	Glare? ○ Drizzle
	Circle	Seal _____	Full	Run	OO		Young	Cake	Fog? ○ Rain
	Hover	Walrus		Eat	OO		First-Year	Belt Strip	Snow/Sleet
	Transect	Other _____		Swim	OO		Multi-Year	Floe: [S M L V G]	
Transect id: _____		Zone: 1 2 3 4 5 6 7 _____°					____%Ice cover	____%Snow cover	Max. Zone Visible: R 1 2 3 4 5 6 7 L 1 2 3 4 5 6 7 _____% cloud C

	Fly	Polar Bear	1st	Inactive	OO		Open Water	New Brash	Good/Fair/Poor Mist
	Land	PB Track [old/new]	Full	Walk	OO		Nilas	Pancake	Glare? ○ Drizzle
	Circle	Seal _____	Full	Run	OO		Young	Cake	Fog? ○ Rain
	Hover	Walrus		Eat	OO		First-Year	Belt Strip	Snow/Sleet
	Transect	Other _____		Swim	OO		Multi-Year	Floe: [S M L V G]	
Transect id: _____		Zone: 1 2 3 4 5 6 7 _____°					____%Ice cover	____%Snow cover	Max. Zone Visible: R 1 2 3 4 5 6 7 L 1 2 3 4 5 6 7 _____% cloud C

	Fly	Polar Bear	1st	Inactive	OO		Open Water	New Brash	Good/Fair/Poor Mist
	Land	PB Track [old/new]	Full	Walk	OO		Nilas	Pancake	Glare? ○ Drizzle
	Circle	Seal _____	Full	Run	OO		Young	Cake	Fog? ○ Rain
	Hover	Walrus		Eat	OO		First-Year	Belt Strip	Snow/Sleet
	Transect	Other _____		Swim	OO		Multi-Year	Floe: [S M L V G]	
Transect id: _____		Zone: 1 2 3 4 5 6 7 _____°					____%Ice cover	____%Snow cover	Max. Zone Visible: R 1 2 3 4 5 6 7 L 1 2 3 4 5 6 7 _____% cloud C

Time	Flight Mode	Observation	Count	Activity	Before	After	Ice Stage	Form	Observation Conditions
24:00:00									Visibility / Wx / Precip
	Fly	Polar Bear	Ist	Inactive	OO		Open Water	New Brash	Good/Fair/Poor Mist
	Land	PB Track [old/new]		Walk	OO		Nilas	Pancake	Glare? O Drizzle
	Circle	Seal	Full	Run	OO		Young	Cake	Fog? O Rain
	Hover	Walrus		Eat	OO		First-Year	Belt Strip	Snow/Sleet
	Transect	Other		Swim	OO		Multi-Year	Floe: [S M L V G]	
Transect id: _____		Zone: 1 2 3 4 5 6 7 _____ °					%Ice cover _____	%Snow cover _____	Max. Zone Visible: R 1 2 3 4 5 6 7 L 1 2 3 4 5 6 7 _____ % cloud
		1 <sup>st</sup> Observer (seat) _____							

	Fly	Polar Bear	Ist	Inactive	OO		Open Water	New Brash	Good/Fair/Poor Mist
	Land	PB Track [old/new]		Walk	OO		Nilas	Pancake	Glare? O Drizzle
	Circle	Seal	Full	Run	OO		Young	Cake	Fog? O Rain
	Hover	Walrus		Eat	OO		First-Year	Belt Strip	Snow/Sleet
	Transect	Other		Swim	OO		Multi-Year	Floe: [S M L V G]	
Transect id: _____		Zone: 1 2 3 4 5 6 7 _____ °					%Ice cover _____	%Snow cover _____	Max. Zone Visible: R 1 2 3 4 5 6 7 L 1 2 3 4 5 6 7 _____ % cloud
		1 <sup>st</sup> Observer (seat) _____							

	Fly	Polar Bear	Ist	Inactive	OO		Open Water	New Brash	Good/Fair/Poor Mist
	Land	PB Track [old/new]		Walk	OO		Nilas	Pancake	Glare? O Drizzle
	Circle	Seal	Full	Run	OO		Young	Cake	Fog? O Rain
	Hover	Walrus		Eat	OO		First-Year	Belt Strip	Snow/Sleet
	Transect	Other		Swim	OO		Multi-Year	Floe: [S M L V G]	
Transect id: _____		Zone: 1 2 3 4 5 6 7 _____ °					%Ice cover _____	%Snow cover _____	Max. Zone Visible: R 1 2 3 4 5 6 7 L 1 2 3 4 5 6 7 _____ % cloud
		1 <sup>st</sup> Observer (seat) _____							

	Fly	Polar Bear	Ist	Inactive	OO		Open Water	New Brash	Good/Fair/Poor Mist
	Land	PB Track [old/new]		Walk	OO		Nilas	Pancake	Glare? O Drizzle
	Circle	Seal	Full	Run	OO		Young	Cake	Fog? O Rain
	Hover	Walrus		Eat	OO		First-Year	Belt Strip	Snow/Sleet
	Transect	Other		Swim	OO		Multi-Year	Floe: [S M L V G]	
Transect id: _____		Zone: 1 2 3 4 5 6 7 _____ °					%Ice cover _____	%Snow cover _____	Max. Zone Visible: R 1 2 3 4 5 6 7 L 1 2 3 4 5 6 7 _____ % cloud
		1 <sup>st</sup> Observer (seat) _____							

	Fly	Polar Bear	Ist	Inactive	OO		Open Water	New Brash	Good/Fair/Poor Mist
	Land	PB Track [old/new]		Walk	OO		Nilas	Pancake	Glare? O Drizzle
	Circle	Seal	Full	Run	OO		Young	Cake	Fog? O Rain
	Hover	Walrus		Eat	OO		First-Year	Belt Strip	Snow/Sleet
	Transect	Other		Swim	OO		Multi-Year	Floe: [S M L V G]	
Transect id: _____		Zone: 1 2 3 4 5 6 7 _____ °					%Ice cover _____	%Snow cover _____	Max. Zone Visible: R 1 2 3 4 5 6 7 L 1 2 3 4 5 6 7 _____ % cloud
		1 <sup>st</sup> Observer (seat) _____							

	Fly	Polar Bear	Ist	Inactive	OO		Open Water	New Brash	Good/Fair/Poor Mist
	Land	PB Track [old/new]		Walk	OO		Nilas	Pancake	Glare? O Drizzle
	Circle	Seal	Full	Run	OO		Young	Cake	Fog? O Rain
	Hover	Walrus		Eat	OO		First-Year	Belt Strip	Snow/Sleet
	Transect	Other		Swim	OO		Multi-Year	Floe: [S M L V G]	
Transect id: _____		Zone: 1 2 3 4 5 6 7 _____ °					%Ice cover _____	%Snow cover _____	Max. Zone Visible: R 1 2 3 4 5 6 7 L 1 2 3 4 5 6 7 _____ % cloud
		1 <sup>st</sup> Observer (seat) _____							



## SURVEY CODES

FLIGHT INFORMATION	SIGHTING INFORMATION		OBSERVER CONDITIONS
<p><b>Flight ID</b> Assign when the GPS tracklog is downloaded, using the format:</p> <p>yyyy-mm-dd-[A/B/C]-[1/2] where A, B, C ... = sequential survey effort of day 1 or 2 = aircraft position in survey.</p> <p><b>Aircraft</b> Note model of aircraft and FAA number.</p> <p><b>Departure and Arrival Time</b> Time of sighting in 24 hour clock (hh:mm:ss) synchronized with GPS in GMT -8 (summer), -9 (daylight savings time).</p> <p><b>Survey Type</b> Independent = one aircraft flying an independent survey effort In-line = two aircraft flying survey effort in line.</p> <p><b>Aircraft Position</b> 1/1 = aircraft flying independent survey 1/2 = first aircraft flying in-line survey 2/2 = second aircraft flying in-line survey.</p> <p><b>Crew</b> Last name of each participant, their role, and who maintained the datasheet</p> <p>Pilot (right and/or left) Mechanic LF = Left Forward Observer LA = Left Aft Observer RF = Right Forward Observer RA = Right Aft Observer.</p> <p>Check Data next to data recorder's name.</p>	<p><b>Time</b> Time of sighting in 24 hour clock (hh:mm:ss) synchronized with GPS in GMT -8 (summer) or -9 (daylight savings time).</p> <p><b>Flight Mode</b> Circle each change in flight mode:</p> <p>Fly = aircraft in flight, not on survey Land = aircraft lands on ground, ice or ship Circle = aircraft leaves transect line to circle polar bear group and verify count Hover = aircraft ceases forward movement while in the air Transect = aircraft begins survey transect (record transect number).</p> <p><b>Observation</b> Circle observation type. Note whether polar bears tracks are old or new. Note species as follows:</p> <p>ARFO = Arctic Fox BESE = Bearded Seal BEWH = Beluga Whale BOWH = Bowhead Whale GRWH = Gray Whale RBSE = Ribbon Seal RISE = Ringed Seal SPSE = Spotted Seal UNWH = Unidentified Whale</p> <p>Other = note kill sites and additional observations.</p> <p><b>Initial and Full Counts</b> Note number(s) of polar bears initially observed (1<sup>st</sup>) and number(s) observed at completion of circle (Full).</p> <p><b>Zone/Angle</b> Note zone in which polar bear(s) was observed. Record angle of sighting.</p>	<p><b>Activity</b> Check polar bear activity when first sighted and when circling of bear is completed.</p> <p><b>1<sup>st</sup> Observer</b> Note role of person who first made the observation. If only observed by video camera, make a new entry at the end of the flight datasheet and note "Video Camera" as the observer.</p> <p><b>Notes</b> Add additional information in the space below each event entry.</p> <p><b>ICE CONDITIONS</b></p> <p><b>Ice Stages and Forms</b> Circle stages and forms that are present (see attached definitions).</p> <p><b>Ice and Snow Cover</b> Record to nearest 10%.</p>	<p><b>Visibility</b> Note overall visibility as:</p> <p><b>Good</b> = 100% of survey area from aircraft to horizon is completely visible to both observers with no interference from glare, fog, precipitation, etc. <b>Fair</b> = 75-100% " " <b>Poor</b> = 50-75% " "</p> <p><b>Glare and Fog</b> Check if present.</p> <p><b>Precipitation</b> Note as follows:</p> <p><b>Mist</b> = water floating in the atmosphere as a fine spray <b>Drizzle</b> = water falling lightly in the atmosphere in small droplets <b>Rain</b> = water falling steadily in the atmosphere <b>Snow/sleet</b> = large droplets of precipitation in the form of crystals formed from freezing water.</p> <p><b>Zone</b> Note maximum zone of visibility for both right and left observers.</p>

## DEFINITIONS OF ICE STAGES

Modified from *Observer's Guide to Sea Ice*, prepared by the University of Alaska Anchorage, School of Engineering for the National Ocean and Atmospheric Administration. For copies of this document, send e-mail request to [library@hazmat.noaa.gov](mailto:library@hazmat.noaa.gov) or fax your request to 206 526-4442.

1. **New:** ice in one of the following stages of formation:
  - a) **Frazil:** separate fine needles or plates suspended in water
  - b) **Grease:** a thin soapy-looking surface layer of coagulated frazil ice
  - c) **Slush:** snow mixed with water in a viscous surface layer
  - d) **Shuga:** an accumulation of spongy white lumps
2. **Nilas:** a thin elastic crust of ice, less than 10 cm (4 in) thick; easily bends on waves, often has striped or chevron appearance
3. **Young:** Ice 10-30 cm (4-12 in) thick in one of the following stages:
  - a) **Gray:** young ice 10-15 cm (4-6 in) thick; less elastic than Nilas; breaks on swell and rafts (one layer over another) under pressure
  - b) **Gray-White:** young ice 15-30 cm (6-12 in) thick, that buckles to form ridges on its edges from pressure or collisions
4. **First-year ice:** sea ice that, in uniform level areas without ridges or other deformations, is 30 cm - 1.2 m thick (12 in - 4 ft)
  - a) **First-year thin:** Sea ice that, in uniform level areas without ridges or other deformations is 30-70 cm (12-27 in) thick
  - b) **First-year medium:** sea ice 70-120 cm (27-48 in) thick
  - c) **First-year thick:** sea ice over 1.2 m (4 ft) thick
5. **Old or multi-year:** sea ice 3 m (10 ft) thick or more that has survived at least one melting season; characterized by undulating, weathered ridges and a well-defined melt water drainage pattern.

## DEFINITIONS OF ICE FORMS

1. **New:** small thin newly formed dinner plate-sized pieces
2. **Brash:** broken pieces less than 2 m (6 ft) across
3. **Pancake:** rounded floes 30 cm - 3 m (1-10 ft) across with ridged rims
4. **Cake:** level piece 3-20 m (6-65 ft) across
5. **Floe Ice:** level pieces ranging in size from 20 m to > 10 km
  - a) **Small floe:** level piece 20-100 m (65-328 ft.) across
  - b) **Medium floe:** level continuous piece 100-500 m (328-1640 ft) across
  - c) **Big floe:** level continuous piece 500 m - 2 km (1/3-1 mi) across
  - d) **Vast floe:** level continuous piece 2-10 km (1-6 mi) across
  - e) **Giant floe:** level continuous piece greater than 10 km (6 mi) across
6. **Strip:** a linear accumulation of sea ice less than 1 km (0.6 mi) wide
7. **Belt:** a linear accumulation of sea ice from 1 km to over 100 km (0.6-60 mi) wide
8. **Beach Ice or Stamukhas:** irregular, sediment-laden blocks that are grounded on tidelands, repeatedly submerged, and floated free by spring tides
9. **Fast Ice:** ice formed and remaining attached to shore