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# SEASONAL MOVEMENTS OF ADULT FEMALE POLAR BEARS IN THE BERING AND CHUKCHI SEAS

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**Abstract:** Ten adult female polar bears (*Ursus maritimus*) were fitted with satellite telemetry collars during March 1986 in the Kotzebue Sound area of the Chukchi Sea. During March-April 1987, 2 of these bears were refitted with satellite telemetry collars and an additional 10 adult females were collared in the northern Bering and eastern Chukchi seas. Data for 1,560 point locations recorded through May 1988 indicated that female polar bears in the Bering and Chukchi seas were resident in western Alaskan waters from November through March, then moved northward with the receding pack ice during April and May. They remained in the northern and northwestern Chukchi Sea during June through September, often adjacent to the Soviet coastline. Satellite telemetry data indicated that 4 females marked in Alaskan waters of the Chukchi Sea apparently denned in the vicinity of Wrangel Island during winter 1987/1988. Denning in American territory of bears marked in the Chukchi and Bering seas has not been documented using satellite telemetry data. Some polar bears moved from the Chukchi Sea into the western Beaufort Sea during summer and fall, then returned to the Chukchi and Bering seas the following winter. Movements of bears from the Chukchi Sea into the central or eastern Beaufort Sea were not documented through spring 1988. These data document that polar bears occurring in the Bering and Chukchi seas are shared internationally between the United States and the Soviet Union.

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Polar bears are circumpolar in their distribution and were once believed to be circumpolar wanderers (Pederson 1945, as cited in Lentfer 1983). Currently, it is thought that there are 6 distinct populations of polar bears in the polar basin (DeMaster and Stirling 1981) and tagging data indicate limited exchange of individuals between these hypothesized populations (Taylor 1982). Movement information during the 1970's was primarily limited to mark/recapture data (Schweinsburg et al. 1982a, Lentfer 1983). Use of conventional radio-telemetry was first used during the late 1970's and became more common during the 1980's (Amstrup 1986a, Calvert et al. 1986). However in northern Alaska, the cost and size of the area surveyed limited the number of locations per marked bear to 3-6 locations per year (S.C. Amstrup, pers. commun.).

With the advent of satellite telemetry, the study of polar bear movements, which cover extensive areas, became more feasible (Garner et al. 1989). Satellite telemetry technology was first used on elk (*Cervus canadensis*) in 1970 (Craighead et al. 1972), on polar bears in 1977 (Kolz et al. 1980), and became generally available for use on wildlife in the mid-1980's (Fancy et al. 1988). In western Alaska, the use of satellite telemetry was mandatory because polar bears inhabiting that region were thought to move between American and Soviet territory (Lentfer 1983).

Polar bear research in western Alaska was initiated by the Alaska Fish and Wildlife Research Center during spring 1986 to determine population size and status in the Bering and Chukchi seas. The primary management concern is what effects the current harvest by Alaskan coastal natives have upon the bear population. Population bounds are currently being established by analyzing

movement data from females fitted with satellite telemetry collars. Data presented in this paper summarize movements of female polar bears instrumented during 1986-1987 and demonstrate the international nature of the polar bear population in western Alaska. Collars were not placed on males because neck configuration is larger than the head and neck collars could be readily shed.

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## STUDY AREA

The study area was the seasonal and permanent polar pack ice in the Bering and Chukchi seas and included both American and Soviet regions separated by the international boundary at 169° W longitude (Fig. 1). The climate is harsh and winter temperatures below -30 C are common. Northerly winds exceeding 30 km/hr are typical during winter and are responsible for the southerly flow of the ice pack during winter and spring (Burns et al. 1981). The southern edge of the ice pack extends south of the Bering Straits to near 55° N latitude in winter and recedes to approximately 72° N latitude in summer (Fig. 1).

Ice conditions in the Bering and Chukchi seas follow a cyclic pattern that influences polar bear distributions (Burns et al. 1981). The winter ice pack in the Bering and Chukchi seas is very dynamic as the southerly flow in the Chukchi Sea is compressed between the Seward Peninsula of Alaska and the Chukchi Peninsula of the U.S.S.R. This compression creates large flaw zones characterized

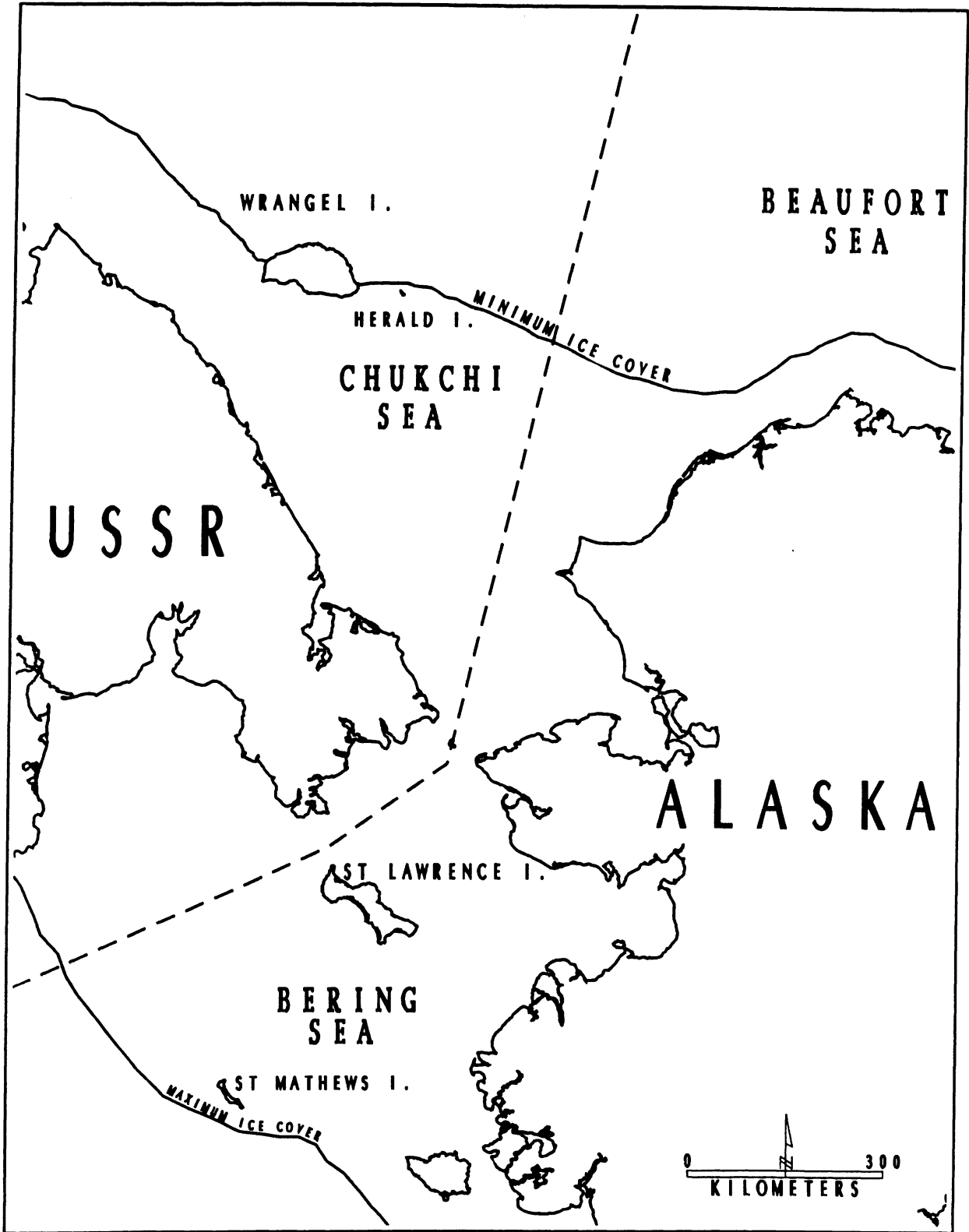


Fig. 1. Study area for western Alaska polar bear research project showing the international boundary and the maximum and minimum extent of the polar ice.

by extensive pressure ridges, shear zones, and numerous lead systems (Burns et al. 1981). Part of the Chukchi ice pack is extruded through the Bering Straits during winter and accumulates along the northern shoreline of St. Lawrence Island (Shapiro and Burns 1975). Strong northerly winds also move the ice sheet away from the southern edges of land masses, and polynyas are common in the Bering Sea (Burns et al. 1981). In late summer when the ice pack is at a minimum, the entire Bering Sea and a major portion of the Chukchi Sea are ice free.

## METHODS

### Capture

Polar bears were captured in selected areas of the American portions of the Bering and Chukchi seas to obtain a more representative sample of polar bears using the area (Fig. 2). Field operations were located at St. Lawrence Island and along the western Alaska coastline at Shishmaref, Kotzebue, and Cape Lisburne. Bears were captured during March-April each year when they were most accessible due to the ice pack's proximity to the Alaskan coast. Helicopter and remote injection of immobilizing drugs were used to capture bears (Lentfer 1968, Larsen 1971, Schweinsburg et al. 1982b). Bears were

immobilized with M99 and its antagonist M50/50 (Miller and Will 1976) in 1986 and with Telazol (Haigh et al. 1985; Stirling et al. 1985, 1989) in 1987. Tranquilized bears were measured, weighed, and blood and a vestigial premolar tooth were collected. Bears were aged by counting cementum annuli (Hensel and Sorensen 1980).

All adult females were fitted with satellite telemetry collars (Telonics Inc., Mesa, AZ) that transmitted for 12 hours every third day. Expected transmitter life was 13.8 months, based upon battery capacity, although realized life ranged from 1 to 18 months. Premature failure of satellite collars (<75% expected life) was 53% in 1986 and 35% in 1987 (Garner et al. 1989). Transmissions were timed to coincide with the period of maximum number of overpasses of polar-orbiting TIROS-N satellites. Each transmission included sensor data on internal temperature of the transmitter, and short- and long-term bear activity counts. The mean locational error for land-based satellite collars was 829 m (SE = 26 m) (Fancy et al. 1988). No data are available for determining locational error of satellite collars deployed on polar bears using sea ice habitats.

### Movement and Home Range Analyses

Locational data were transformed from latitude/longitude format to x,y coordinates using the Alber's equal area projection with 55° and 65° N latitude standards. This projection adjusts the x,y grid for differences due to the earth's curvature at high latitudes so that distances and areas are accurately represented.

The 24-hr rate of movement was based on the minimum straight-line distance between 2 consecutive locations spaced 3 days apart. Individual movement rates were averaged for winter (January to March), spring (April to May), summer (June to September), and fall (October to December) periods. Movements derived from the above data are more sensitive to directed movement (i.e., travel) than undirected travel (i.e., local movements) due to the minimum time interval of 72 hours between consecutive locations. The total distance traveled during a year was a minimum estimate based upon the sum of consecutive straight-line distances between 3-day locations.

The size of the annual area used by an individual bear was determined by minimum convex polygon (Mohr 1947, Hayne 1949) using the program Home Range (Samuel et al. 1985). Size of a composite activity area for all marked bears was determined using the ARC/INFO geographic information system. The proportion of the composite range, number of locations, and total time that bears were in American and Soviet regions were calcu-

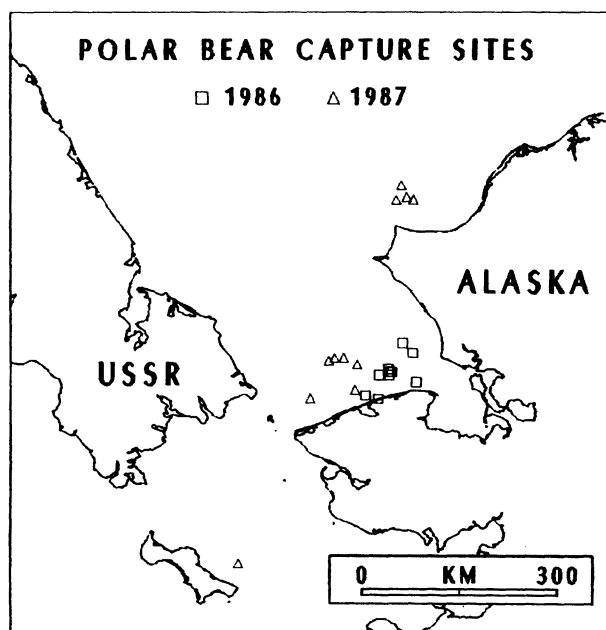


Fig. 2. Capture locations for 20 female polar bears in western Alaska, 1986-1987 (includes 2 recaptures in 1987).

lated using the international boundary as the separation line.

Temperature and location data were used to determine denning status of bears. Internal temperature of the transmitter for bears within dens was higher than for free-ranging bears. Consistent point locations were recorded for bears in dens on land and shore-fast ice, whereas continuing movements were recorded for bears that denned on drifting sea ice.

### Ice Information

The extent of ice coverage and the position of the leading edge of the pack ice was determined using weekly ice summaries prepared by the National Climate Data Center (1986).

## RESULTS

Ten female polar bears were captured during March 1986 and fitted with satellite telemetry collars. An additional 10 females were captured and marked during March/April 1987, and 2 females marked in 1986 were recaptured in 1987 and fitted with new satellite telemetry collars. Capture of polar bears extended to 149 km offshore, with average offshore distance of captures being 52 km.

### Movements

Marked bears ranged between 59° 27' N latitude in the Bering Sea to 74° 40' N latitude in the Chukchi Sea. East-west movements by instrumented bears ranged in extremes from 155° 00' W longitude in the Beaufort Sea to 162° 54' E longitude in the East Siberian Sea.

Spring movements of instrumented bears were northward from the northern Bering Sea into the southern Chukchi Sea (Fig. 3A). Further movements north were in advance of the receding ice pack, and appear to have followed 2 divergent routes, although some bears did move through the central Chukchi Sea. An eastern route led into the northeastern Chukchi and western Beaufort seas and a western route went into the western Chukchi and eastern East Siberian seas (Fig. 3A). Movements throughout this period were against the general southerly flow of the ice pack, which can average 15.5 km/day during March-April in the Bering Sea (Muench and Ahlnas 1976). Spring movement rates, uncorrected for ice movements, of instrumented bears averaged 14.1 km/day  $\pm$  11.6 SD (range 0 - 41 km/day).

Movements during summer were less extensive than spring movements (Fig. 3B) and occurred in 2 areas. Bears in the northeastern Chukchi and western Beaufort

seas moved by oscillating along the front zone of the ice pack near the offshore polar gyre. Webster (1954) noted that movement rates for the summer ice pack near this gyre varied between 2.0 and 2.5 km/day in a westerly direction. Bears in the western Chukchi Sea confined their movements to the sea ice between Wrangel Island and the Soviet mainland to the south. Some of the northwesterly movements near the Soviet mainland were a continuation of the northerly movements associated with the receding ice pack observed during spring. Movement rates for instrumented bears in both areas averaged 12.6 km/day  $\pm$  12.9 SD (range 0 - 65 km/day).

Polar bears moved southeast along the Chukchi Peninsula during fall (Fig. 3C). Movements were offshore and passed through the Bering Strait into the northern Bering Sea. Rates of movement averaged 16.8 km/day  $\pm$  12.9 SD (range 0 - 65 km/day).

During winter, instrumented bears spread into the southern Chukchi Sea in the Kotzebue Sound area and further into the Bering Sea south of Saint Lawrence Island (Fig. 3D). Based upon sensor data received from their collars, 3 bears stayed in the northern Chukchi Sea and denned during winter 1987/1988. Two bears denned on or near Wrangel Island, and 1 bear denned on or near the Soviet mainland at Cape Netan. A fourth female denned on drifting pack ice 300+ km offshore in the northern Chukchi Sea, then drifted into the East Siberian Sea before emerging from the den during spring. No females instrumented in western Alaska ( $n = 20$ ) have denned in American territory as of May 1988. Movement rates of non-denning females during winter averaged 10.9 km/day  $\pm$  13.0 SD (range 0 - 65 km/day).

The total annual distance moved by 6 non-denning female polar bears having locational data >300 days was estimated using the sum of the consecutive 3-day distances for each bear (Table 1). This estimate is considered a minimum value and does not compensate for concurrent ice movements. The mean annual total distance moved per bear was 5,542 km  $\pm$  634 SD for the 6 bears.

### Range Size

Marked polar bears ranged over large areas of the Bering and Chukchi seas during the April 1986 to May 1988 study period (Figs. 3A-D). The 6 marked females with locational data >300 days occupied an average area of 244,463 km<sup>2</sup>  $\pm$  80,038 SD (Table 1). Cumulative area occupied by the 20 satellite-collared females was 865,000 km<sup>2</sup> (Table 2).

Distribution of the 20 marked females between American and Soviet portions of the Bering and Chukchi

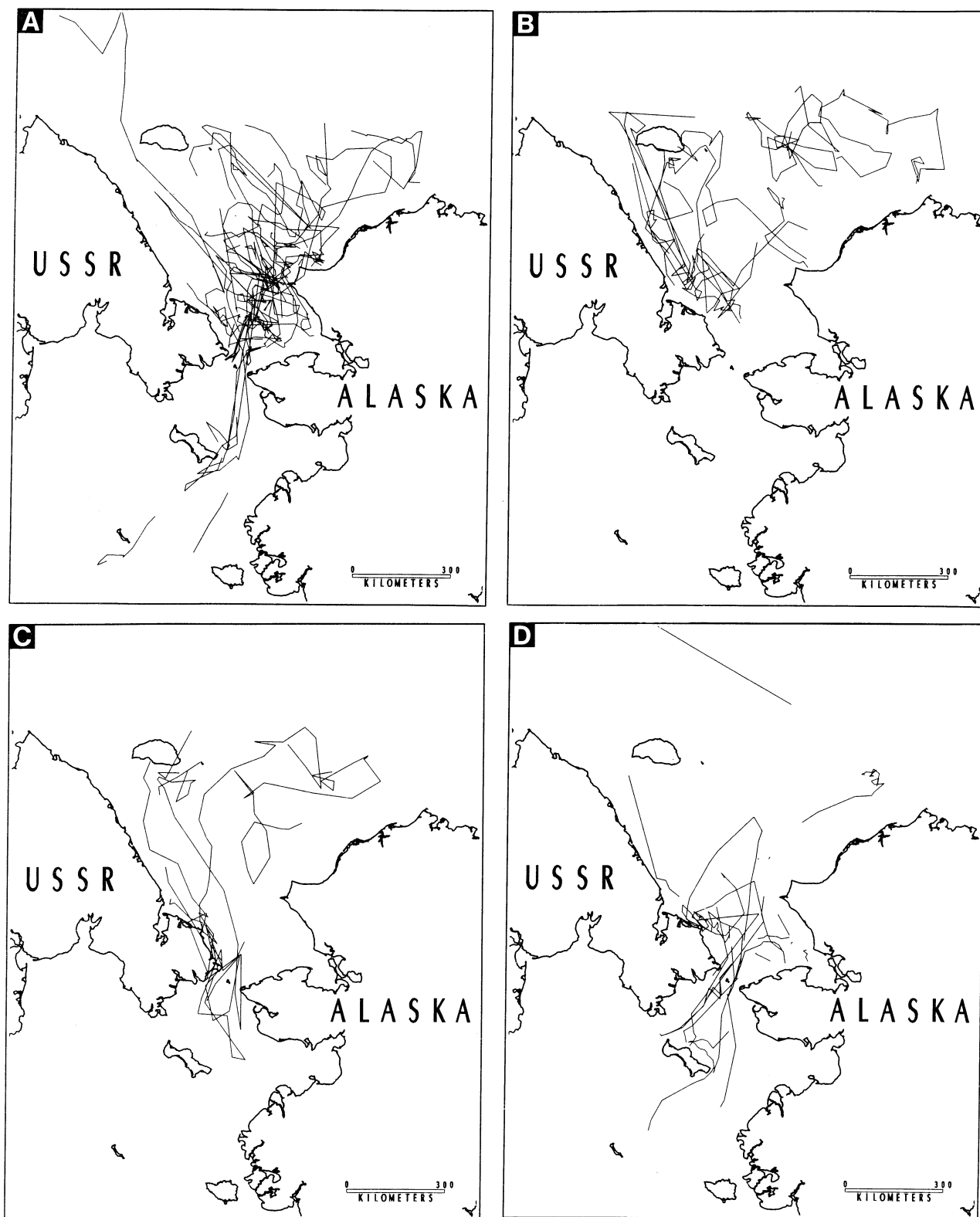


Fig. 3. Movements of female polar bears fitted with satellite telemetry transmitters in the Bering and Chukchi seas. A. Spring (Apr-May 1986-88), B. Summer (Jun-Sep, 1986-1987), C. Fall (Oct-Dec, 1986-1987), D. Winter (Jan-Mar, 1987-1988)

**Table 1.** Minimum distance traveled and area<sup>a</sup> occupied by 6 female polar bears, March 1986 through May 1988.

Bear number	Number locations	Time frame (days)	Minimum total distance (km)	Area (km <sup>2</sup> )
1	88	360	5,925	351,369
2	88	492	4,650	199,677
3	94	589	4,927	144,659
4	114	391	5,706	229,482
5	108	426	5,706	211,535
6	80	353	6,339	330,059

<sup>a</sup> Area calculated using minimum convex polygon (Hayne 1949) method in program Home Range (Samuel et al. 1985).

seas was examined using locations, time, and area (Table 2). Proportions of point locations, number of days, and area occupied indicated that marked bears used the Soviet territory more heavily than American areas. Polar bear use of the 2 portions of the international range was least disproportionate in total area used, and most disproportionate in time spent in each area.

## DISCUSSION

Movements of polar bears in the Bering and Chukchi seas were extensive and appeared to be influenced by seasonal ice distributions. Bears moved south with the advancing ice during fall and winter, then moved north in advance of the receding and melting ice pack. Extensive movements were reported for satellite-collared polar bears in the Greenland Sea (Larsen et al. 1983) and radio-collared polar bears in the Beaufort Sea (Amstrup 1986a). Both seas are open similar to the Bering and Chukchi seas in western Alaska, however, sea ice characteristics and dynamics differ. Shorefast ice was rarely used by western Alaska polar bears in contrast to bears monitored in Lancaster Sound, Northwest Territories, where 68.7% of the satellite locations were on shorefast ice (Schweinsburg and Lee 1982). The open physical character of the Bering Sea and particularly the Chukchi Sea are in contrast to the Canadian archipelago, where land masses interrupt and constrict sea ice habitats of polar bears.

Schweinsburg and Lee (1982) speculated that home ranges of polar bears in the Chukchi Sea would be the smallest of all polar bears world-wide because Chukchi bears were largest in physical size (Manning 1971) and probably had access to more abundant prey. Data from satellite-collared bears did not support this hypothesis. Individual polar bear ranges in western Alaska averaged approximately 250,000 km<sup>2</sup>, whereas individual home ranges of polar bears in Lancaster Sound ranged from

2,300-22,900 km<sup>2</sup> (Schweinsburg and Lee 1982). Polar bear ranges in the Beaufort Sea (Amstrup 1986a) averaged 96,924 km<sup>2</sup> (range 9,739-269,622 km<sup>2</sup>) and were intermediate in size between polar bear ranges in Lancaster Sound and western Alaska.

A major difference in the 3 areas is the extent to which the ice pack recedes. In Lancaster Sound, polar bears go onto land or to ice-covered bays during late summer when the entire area becomes open water with scattered ice floes and unconsolidated ice (Schweinsburg and Lee 1982). In the Beaufort Sea, pack ice usually recedes to approximately 100-150 km from the coastline during late summer. The degree of ice retreat in the Bering and Chukchi seas from maximum to minimum ice cover is approximately 1,400 km in a normal year (National Climate Data Center 1986). Polar bears in western Alaska do not regularly over-summer on Alaskan land masses and over-summering has not been reported for the northeastern Soviet mainland. Therefore, bears must move extensively to maintain contact with the seasonally fluctuating pack ice.

The rarity of data on land-based denning of polar bears in western Alaska (Lentfer and Hensel 1980) indicates either unsuitable habitat, unsuitable ice distributions at the time of denning, or lack of successful denning caused by humans. Stirling et al. (1975) suggested that native hunters may have prevented polar bears from successfully denning on land in the eastern Beaufort Sea. Historically, polar bear distributions in the Bering Sea included St. Matthew and St. Lawrence islands (Elliot 1898, as cited by Amstrup 1986b; Hanna 1920). Polar bears commonly over-summered on both islands (Hanna 1920, Rausch 1950). Bears using St. Matthew Island were killed by commercial hunters in the late 1800's and early 1900's (Hanna 1920). Native hunters routinely kill any polar bear sighted on St. Lawrence Island during the summer months. Polar bears are currently harvested by coastal native hunters in Alaska, and land-based denning polar bears are vulnerable to harvest. In contrast, the highest densities of denning polar bears were recorded on

**Table 2.** Distribution of 20 satellite telemetry collared female polar bears between American and Soviet territory, March 1986-May 1988.

Parameter	Total	U.S.		U.S.S.R.	
		n	%	n	%
Locations	1,560	645	41	915	59
Time (days)	4,489	1,438	32	3,051	68
Area (km <sup>2</sup> )	865,000	385,000	44	480,000	56

Wrangel and Herald Islands and along the north coast of the Chukchi Peninsula in the Soviet Union (Stishov, in press), where polar bears have not been harvested since 1956. The only denning of bears marked with satellite transmitters in western Alaska occurred in Soviet territory; however, recent harvest data from western Alaska confirm that unsuccessful denning efforts have occurred on Little Diomedede Island and the Seward Peninsula in the Bering Straits (S. Schliebe, pers. commun.).

Movements of polar bears instrumented with satellite transmitters in western Alaska confirm Lentfer's (1983) hypothesis of a shared population between the U.S. and the Soviet Union. The primary management concern in Alaska is to determine the effects of the subsistence harvest on the polar bear population. However, the current effort to develop a population estimate for the western Alaska polar bear population is confounded by the verification of an internationally shared population. The International Agreement on the Conservation of Polar Bears in 1976 requires that shared populations be managed through consultation between the concerned nations. Efforts to census western Alaska polar bears without including the Soviet territory would be of limited value because annual and seasonal variation in habitat conditions and polar bear distribution would introduce unknown bias in the sampling design.

The degree that the Bering/Chukchi population is separated from adjacent polar bear populations in the Beaufort Sea and the East Siberian Sea also needs to be determined before establishing population estimates. Limited movement of marked bears into the East Siberian Sea and the Beaufort Sea was recorded during this study, but the extent of population interchange is unknown. Additionally, the origin of females that use the major denning areas on Wrangel and Herald islands is unknown and must be determined to estimate population size and monitor status effectively.

Data from the current study indicate cooperative research programs between scientists in the U.S. and the Soviet Union would be beneficial in understanding the ecology of polar bears that seasonally occur in Alaskan waters.

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