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THE EFFECTS OF OCEAN CURRENTS AND ICE MOVEMENT ON POLAR BEAR ACTIVITY

by
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FINAL REPORT (RESEARCH)

State: Alaska

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SUMMARY

Polar bears are more numerous in the drifting pack ice zone of the north polar basin than in the shore fast ice or polar pack ice; probably because of the presence of more leads and seals in the drifting pack ice. Bears are more numerous along the coast of Alaska in years when winds bring heavy ice to the coast earlier than usual in the fall. There is evidence that long term warming and cooling trends occur in the Arctic; these probably affect polar bear distribution and numbers. Ice drift could perhaps tend to isolate groups of bears north and west of Alaska, or it could tend to cause mixing of animals from the two areas, depending on the pattern of travel by individual animals. Ice movements should be considered when assessing polar bear distribution, density, and hunter harvest. Climatic trends should be considered when assessing bear distribution and population data on a long term basis.

CONTENTS

BACKGROUND

The population status of polar bears (Ursus maritimus Phipps) throughout their circumpolar range is unknown. Scientists and informed laymen differ in their estimates of relative abundance, expressing opinions ranging from the possibility of extirpation because of over hunting, to the assumption of near normal abundance. Unfortunately, little effort has been directed at determining the influence of climatic change on potential polar bear habitat, and in turn the bear population. Climatic change is directly manifested by sea ice conditions. This study relates polar bear occurrence and patterns of movement to occurrence and movements of the different types of sea ice, with emphasis on observations made off the west and north coasts of Alaska.

OBJECTIVES

To describe the different types of sea ice in the north polar basin and relative abundance of polar bears in the different ice types.

To determine how changes in ice movement and formation from year to year might affect abundance of bears along the Alaska coast.

To describe movement patterns of ice throughout the polar basin with emphasis on those movements which would have the most effect on bears off the Alaska coast.

To describe long-term climatic changes which might affect polar bears.

PROCEDURES

Data on relative abundance of bears, as determined by sightings of tracks and/or animals, within different types of ice were obtained each year since 1965. Observations were made incidental to surveys for polar

bear dens, attempts to develop a census technique, tagging, radio-tracking, and accompanying hunters on guided hunting flights. Information from guides supplemented these observations. Most observations were made in March and April, although some were also made in February, May, October and November.

Eskimo hunters provided information on relationships between bears and the formation and movements of ice along the Alaska coast.

Literature on ice and climate was reviewed to determine possible effects of ice movements and climatic changes on bears.

FINDINGS

Characteristics and Movements of Sea Ice

Arctic sea ice can be classified into three types--land fast ice, drifting seasonal pack ice, and polar pack ice.

Land fast or fast ice is ice which is anchored to the shore. In protected bays, fast ice generally forms in place along the shore in the fall. Along open shorelines, ice which eventually becomes land fast ice generally forms at sea and is brought to the coast by currents and winds. In some areas, fast ice is mainly newly frozen ice that forms with a smooth surface. Along other shorelines, including the north coast of Alaska, old ice is interspersed with the newly formed ice causing the surface in some areas to be quite rough. Fast ice occurs in a narrow belt along coasts with deep water and offshore winds and currents, and extends offshore the farthest where shallow water permits ice to freeze or pile up to the bottom, and where prevailing winds and currents do not tend to move ice offshore.

Along the Alaska coast, the first fast ice forms during the fall in the area to the east of Point Barrow and then from Point Barrow southwestward toward Cape Lisburne. Most fast ice melts during the summer or breaks loose from shore to become part of the drifting seasonal pack ice.

Drifting seasonal pack ice extends as a belt of ice, in motion, between shore fast ice and the heavier ice of the polar pack in the central polar basin. There is more open water in the drifting pack ice zone, especially in early winter, than in the polar pack zone. This open space allows winds and currents to move ice masses relative to one another. Openings in the ice and pressure ridges are formed as the ice moves within the confines of the slower moving polar pack ice and the stationary fast ice. During winter, leads freeze over as they are formed.

Polar pack ice covers the central part of the polar basin. It is a year or more old, and pressure ridges have been eroded so the surface is fairly smooth. Thickness is relatively uniform with freezing on the bottom in winter generally in equilibrium with destruction of the upper

ice surface in summer. Polar ice is packed together so there is not much movement of ice masses relative to one another, and leads and pressure ridges are not formed to the extent that they are in drifting pack ice. North of the Alaska coast there does not appear to be a sharp delineation between drifting pack ice and polar pack ice. Some areas of heavy, unbroken, flat ice occur within the drifting pack ice zone; the extent of these large ice fields varies from year to year.

Off the coast of Alaska, ice cover is at its maximum in February and March and at its minimum in August and September (Wittman and MacDowell, 1964; Fig. 1). Ocean currents and winds cause both the drifting pack ice and the polar pack ice to move in fairly well defined patterns. The earliest comprehensive reports on ice movements are from the drift of the Norwegian ship "FRAM" as reported by Nansen (1902) and the drift of the Russian ship "SEDOV" as reported by Zubov (1943). More recent information has come from Soviet and United States drifting ice stations. Fig. 2 shows the most widely accepted pattern of surface current movement.

Changes in ocean currents and climate affect sea ice. Vibe (1967) states that the relative strengths of the Canadian, the East Greenland, and the Irminger Currents in Davis Strait off the southwest coast of Greenland determine sea ice distribution which in turn influences climatic conditions and the composition, distribution, and stability of plant and animal communities on and adjacent to Greenland. He distinguished three different climatic periods, each about 50 years long, between 1810 and 1960, reflecting three stages of penetration of East Greenland ice into Davis Strait. Vibe believes that conditions of 1810-1860 are now repeating themselves. He designates this as a drift ice stagnation stage where the Canadian current has a dominating influence, and East Greenland ice does not penetrate far north into Davis Strait. The climate is cold, dry, and stable.

Several authors have presented data indicating that sections of the Arctic have experienced warming trends prior to about 1950 and have experienced cooling trends since that time. Zubov's (1943) data show a warming of the Arctic for approximately 100 years prior to publication in 1943. He shows that Arctic glaciers have receded and the southern boundary of Siberian permafrost has moved northward. Zubov also presents comparative data obtained during the drift of the "FRAM" and the drift of the "SEDOV," 43 years later, over similar tracks in the Eurasian sector of the Arctic Ocean. The mean ice thickness was one-third less and the mean air temperature 4°C higher in 1937-40 than in 1893-96. Dorf (1960) quotes Willett (1950) who stated that in Spitsbergen, mean winter temperatures rose about 8°C between 1910 and 1950. Dorf (1960) also quotes Ahlmann (1953) who reported ice free ports in Spitsbergen were open to navigation about 7 months of the year as compared with only 3 months 50 years earlier. Mitchell (1965) states that world climate during the past century has been characterized by a warming trend from the 1880's to the 1940's. Thereafter, the warming trend appears to have given way to a cooling trend that has continued to at least 1960 with some evidence that it was continuing in 1965. Budyko (1966) says that polar ice cover is so sensitive to temperature that a summer anomoly of plus 4°C would cause

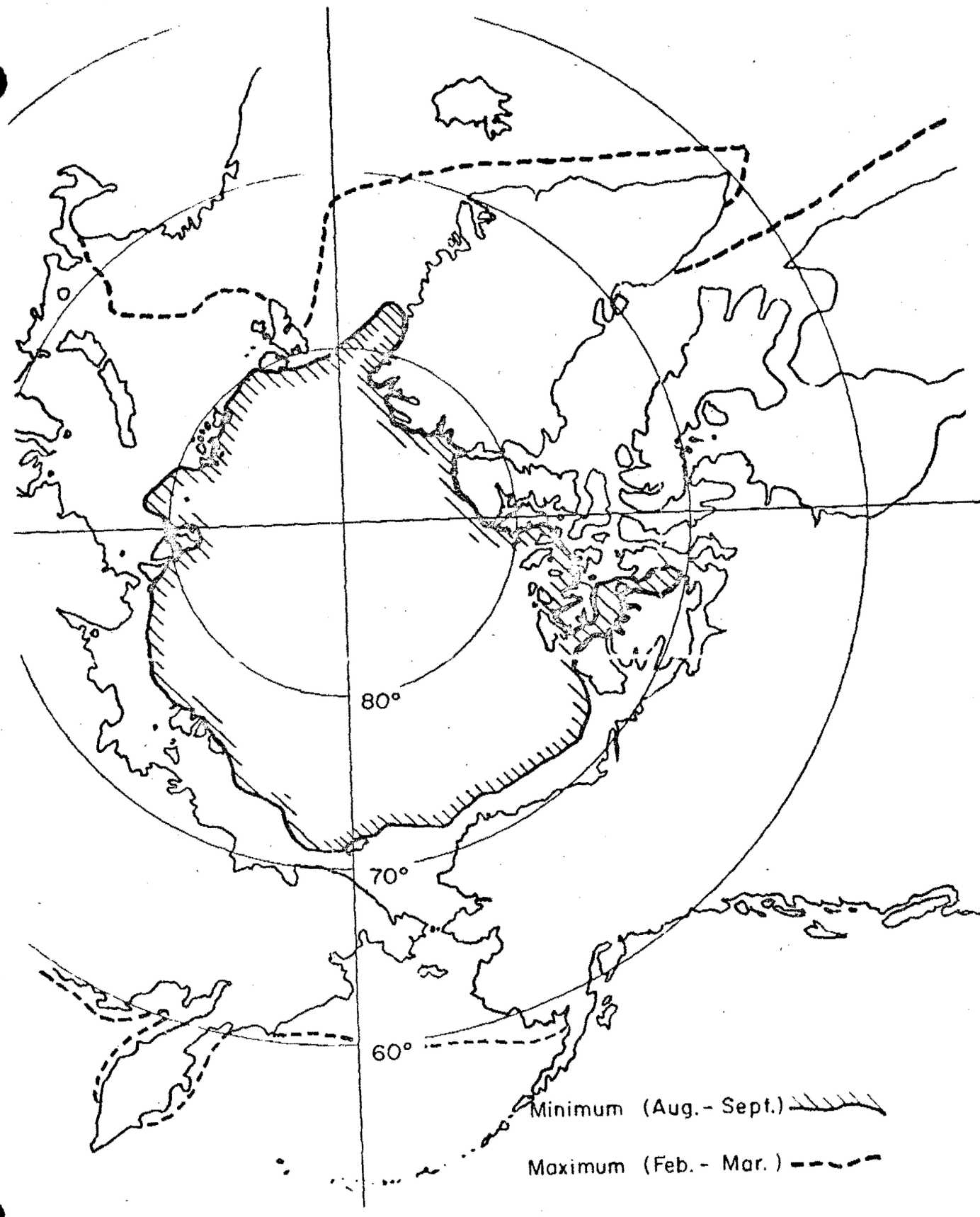

Figure 1. Pack Ice Cover, North Polar Basin.

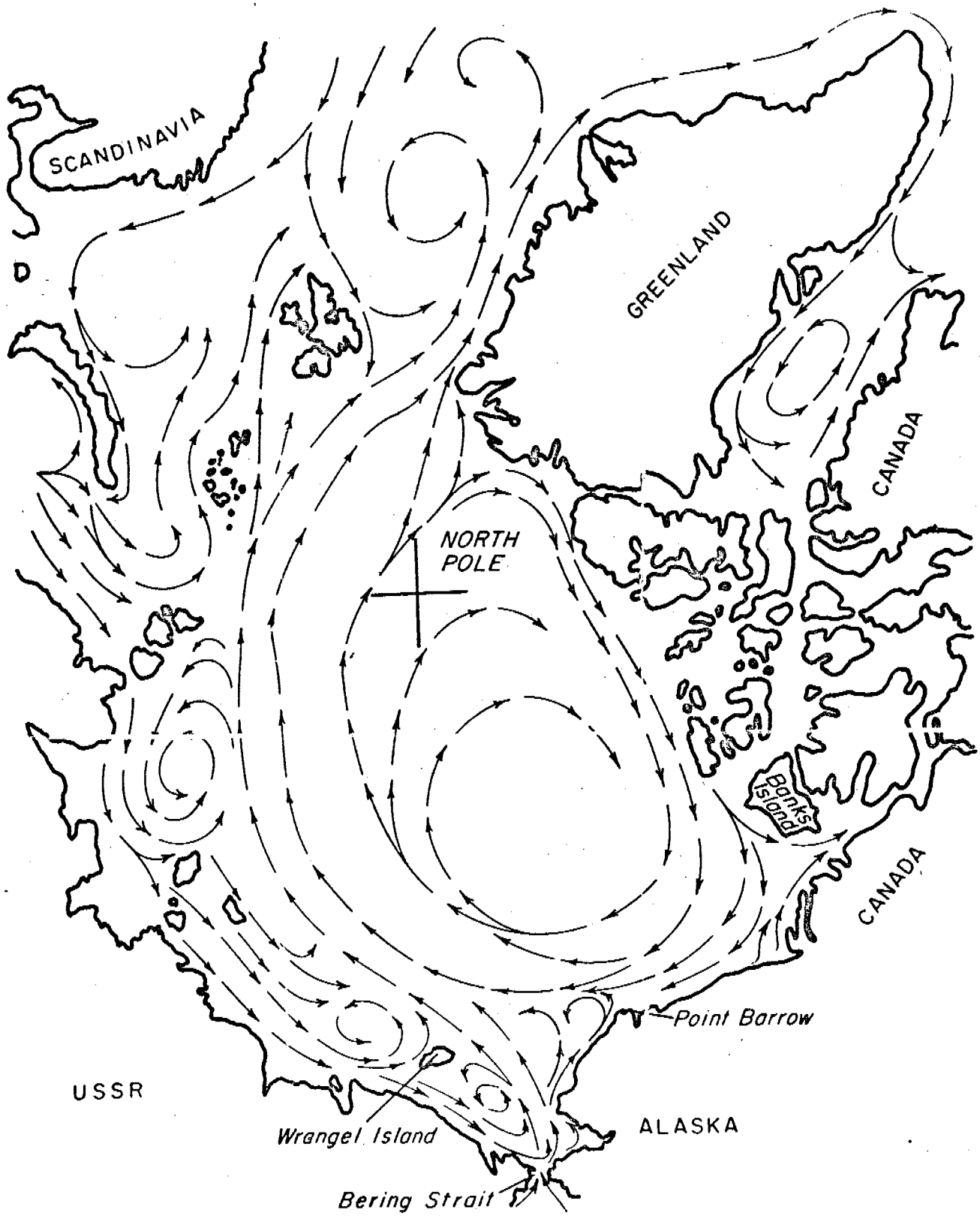

Figure 2. General Surface Circulation, North Polar Basin. (From Oceanographic Atlas of the Polar Seas. 1958. U. S. Navy Hydrographic Office, Washington, D. C.)

the entire ice pack to melt in 4 years; an anomoly of plus 2°C would produce the same effect in a few decades. Once the ice pack had disappeared, negative temperature anomolies could re-establish it.

Polar Bear Distribution in Relation to Type of Ice

Polar bears first appear along Alaska's north coast, generally in October, when shore fast ice enables them to travel from drifting pack ice to the beach. The first bear sightings are reported to the east of Point Barrow and then to the southwest in the same sequence that fast ice forms. Eskimos indicate that polar bears travel from northeast to southwest in the fall, along the coast between Point Barrow and Cape Lisburne. Considering the two most productive bear hunting areas along this section of coast, bears are first taken by Eskimos in the northernmost Point Franklin area and then in the Icy Cape area to the south. Eskimos also report that, traditionally, bears are more numerous along the coast in years when winds from the north and west bring old ice to the coast than in years when newly frozen ice drifts in. Bailey and Hendee (1926) verify this and report that in the fall of 1921, old ice failed to come in, and new ice formed for miles out from the shore. Consequently, few polar bears were killed between Barrow and Point Hope. In the fall of 1967, winds brought more heavy ice further south than usual, and there were more bears along the coast than usual as far south as St. Lawrence Island. In late summer and fall of 1970, heavy ice came to the north Alaska coast earlier than usual, and there were more bears along the coast than usual.

Several things attract polar bears to shore fast ice. One is beach carrion which includes carcasses of walrus (Odobenus rosmarus), bowhead whales (Balaena mysticetus), beluga whales (Delphinapterus leucas), ringed seals (Pusa hispida), and bearded seals (Erignathus barbatus). Ringed seal pupping dens in fast ice attract bears in the spring. Bears also travel on fast ice to find suitable denning sites. Polar bear dens have been reported along river banks in northeast Alaska and on fast ice close to the islands east of the mouth of the Colville River. Quantitative data on the number of dens along the north coast of Alaska have not been obtained, but dens are less concentrated than in many denning areas elsewhere in the polar basin.

During the winter, drifting pack ice off the Alaska coast supports greater concentrations of polar bears than either shore fast or polar pack ice. Immature ringed seals and bearded seals, the bears' main food, are more numerous in drifting seasonal pack ice than in fast or polar pack ice. Seals probably prefer drifting pack ice because of open water and the relative ease of keeping breathing holes open where leads have recently frozen over. Intensive studies have not been conducted off the Alaska coast in the summer, but it is assumed that seals and therefore bears are more numerous in drifting pack ice than in the more stable polar pack ice. Bears may be more concentrated in drifting seasonal or polar pack ice in the summer than in the winter because there is less ice on which to disperse during the summer. ~~Torger~~ Thor Larsen, Norwegian Polar Institute, found bears quite concentrated in the drifting pack ice east of Spitsbergen in the summer (personal communication).

There is not much information on polar bear abundance and distribution on polar pack ice. Bears have been sighted close to the North Pole, and at several locations on polar pack ice between Alaska and the North Pole, by personnel of United States drifting ice stations and the British Transarctic Expedition (data on file at Naval Arctic Research Laboratory, Barrow, Alaska). The number of sightings, however, suggests that bears are sparsely distributed. The area where drifting pack ice occurs north of Point Barrow sometimes has extensive heavy ice without open leads or thin ice, and observations here might give some insight into bear abundance on polar pack ice. Some bears travel through these areas, but they apparently do not spend appreciable amounts of time in them. This was especially evident in March 1971. Bears were present on shore fast ice and the immediate drifting pack ice along the entire north coast of Alaska in greater numbers than usual in October and November 1970. The next observations in March 1971 revealed extensive areas of heavy, unbroken ice with relatively few bears and few seals in evidence in the drifting pack ice zone in the Point Barrow-Wainwright area. Bears at this time were reported to be fairly abundant in the Cape Lisburne area and in the mid-Chukchi Sea area west of Point Hope. It is believed that bears moved to the southwest in midwinter because of the difficulties of obtaining seals in heavy ice with few leads. Bears became more numerous and seals became evident after storms in early April disturbed the heavy ice, and leads opened and refroze.

Harvest of Polar Bears Related to Ice Movements

The pattern of ice formation and movement in a given year can affect the Alaskan harvest of polar bears for that year. More bears occur and are taken by Eskimo hunters along the coast in years when winds bring drifting pack ice close to the beach and when shore fast ice forms early in the fall. Nearly all hunting by Eskimos is on the beach or on fast ice. The present mode of travel is snow machine or dog team. Nearly all trophy hunting of bears is with the aid of aircraft on the drifting seasonal pack ice. Hunter selectivity for trophy bears, in years when there is much rough ice and relatively few areas suitable for landing an airplane, is low. The differing degrees of selectivity can affect the total kill and contribute to variations in sex and age structure of the harvest from year to year. In Greenland, Vibe (1967) relates changes in distribution of the polar bear harvest to changes in ice conditions.

Denning Related to Ice Movements and Climate

In polar bears, the pregnant females appear to be the only animals that routinely go into dens in the fall for extended periods. Young are born in the den. Most known areas that have high concentrations of denning animals around the polar basin are on large offshore islands. There are few data on fluctuations in the numbers of denning females from year to year in these areas, but there are reports that numbers of bears visiting islands where denning occurs vary from year to year, depending on ice conditions (Harington, 1968; Kishchinsky, 1969; Lønø, 1970). In years when relatively few pregnant females reach denning areas on land, some may be forced to den on sea ice. It is quite possible that ice provides

a less stable platform for denning than does land. This could cause the segment of the population denning on the ice to be less successful in raising cubs and therefore to have a lower reproductive rate than the segment denning on land.

A general warming of the Arctic could adversely affect denning. Changing ice conditions because of a warming climate could result in fewer bears reaching some of the more favorable denning areas. Also, Vibe (1967) has pointed out that bears and ringed seals, their principal food, require a relatively stable Arctic or sub-Arctic climate without periods of thawing and melting of snow during winter, in order to successfully den and produce offspring. Warming of the Arctic would reduce the extent of such favorable areas. Disappearance of the ice cover because of air temperature anomolies, a possibility described by Budyko (1966), would have a severe impact on denning and, in fact, the food chain supporting the polar bear. Periods of cooling trends, during which the ice cover increased, should make more land areas (especially further south) accessible for denning.

Discreteness of Polar Bear Populations

Discreteness of bear populations is of primary concern from the standpoint of polar bear management. Effects of sea ice movements on distribution of bears must be considered in an analysis of tag return and related data to determine if there are discrete sub-populations of bears. Possible effects of ice movements are considered here primarily as they relate to bears off the Alaska coast. Fig. 2 shows that moving ice could transport bears in various ways. Bears could reach the northern Bering Sea, normally the southern limit of their range off Alaska, by drifting on ice carried by the current moving to the southeast from the vicinity of Wrangel Island. Bears could then be carried north and northwest toward Wrangel Island, or north and northeast past Point Hope and Cape Lisburne and then along the Alaska coast toward Point Barrow. Bears north of Point Barrow could drift west toward Wrangel Island, or north and then in a clockwise movement to the east and then to the south past the west side of the Canadian archipelago, finally moving northwest from the vicinity of Banks Island back toward Point Barrow.

Drifting ice could thus transport bears to a degree which would prevent formation of isolated geographic groups off the coast of Alaska. Bears from the vicinity of Wrangel Island could be carried to Bering Strait and then past Cape Lisburne to Point Barrow and the Canadian archipelago. Bears from the northwestern section of Canada could drift past northeastern Alaska on their way toward Wrangel Island.

On the other hand, currents could very well tend to isolate subpopulations west and north of Alaska. Bears west of Alaska could drift back and forth between Wrangel Island and Bering Strait. Bears north of Alaska could be part of a population that remains in the area north of Alaska east to the Canadian islands. At the present time the actual influence of ice movements is unknown.

Active movements of the bears themselves will have to be considered as well as their passive movements on drifting ice. Polar bears travel in their search for feeding areas, denning sites, mates, and suitable ice at the time of spring breakup. Bears travel on their own, independently of ice movement, northward from the southern Chukchi Sea in March prior to ice breakup. Along the north coast of Alaska there is a pronounced movement of bears to the east during the spring. This appears to be from an area where ice is breaking up, to an area where the ice is still quite solid.

It is interesting that bears tend to travel against the direction of prevailing ice drift along the north coast of Alaska in the spring and thereby tend to remain in a fixed position relative to the land. Recovery data have been obtained by recapture and hunter harvest for 34 of 283 bears marked off the Alaska coast prior to 1971. Animals have been recovered 1 to 4 years after tagging, most in the same general area where they were tagged. However, there have also been some recoveries a considerable distance from the tagging site. If bears can selectively navigate on changing sea ice with no constant reference points, the mechanisms for doing so would be most interesting to study.

Influence of Human Activity

With the expanding human population and attendant exploitation of natural resources, man will have a greater impact in the Arctic. The most immediate concern with regard to sea ice and polar bears is oil exploration, offshore drilling, and the transport of oil by ships through ice covered seas.

Consideration should be given to limiting oil extracting activities in known polar bear denning areas throughout the polar basin. Human activity, including the use of large vehicles and explosive seismic charges, could keep bears away from denning areas. The effects of such activities when bears are in dens or emerging is unknown. Seismic exploration and drilling activities on fast ice could also affect seals; especially ringed seals when they are denning and pupping in the spring.

Oil spills would probably result if wells were drilled offshore and oil were transported by ship. From documentation of oil activity in Cook Inlet in southcentral Alaska (Evans, 1970), it appears that spills would be inevitable. Moving ice would pose a threat to offshore drilling platforms, pumping facilities, and transport ships. In the case of a leaking transport ship, ice would hamper or prevent repairs at sea and might delay travel to a docking area. Ice would hinder or prevent a mopping-up or containing of a spill, and currents could spread a large spill over a considerable area. Oil spills would affect polar bears by reducing the insulative value of their fur and adversely affecting species in the food chain below them.

RECOMMENDATIONS

Sea ice movements and patterns of ice formation along the coast should be considered when assessing polar bear distribution and densities and the hunter harvest each year, and when assessing results of movement patterns as indicated by recapture of marked bears. Long term climatic trends should be considered when assessing long term polar bear distribution and population data.

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