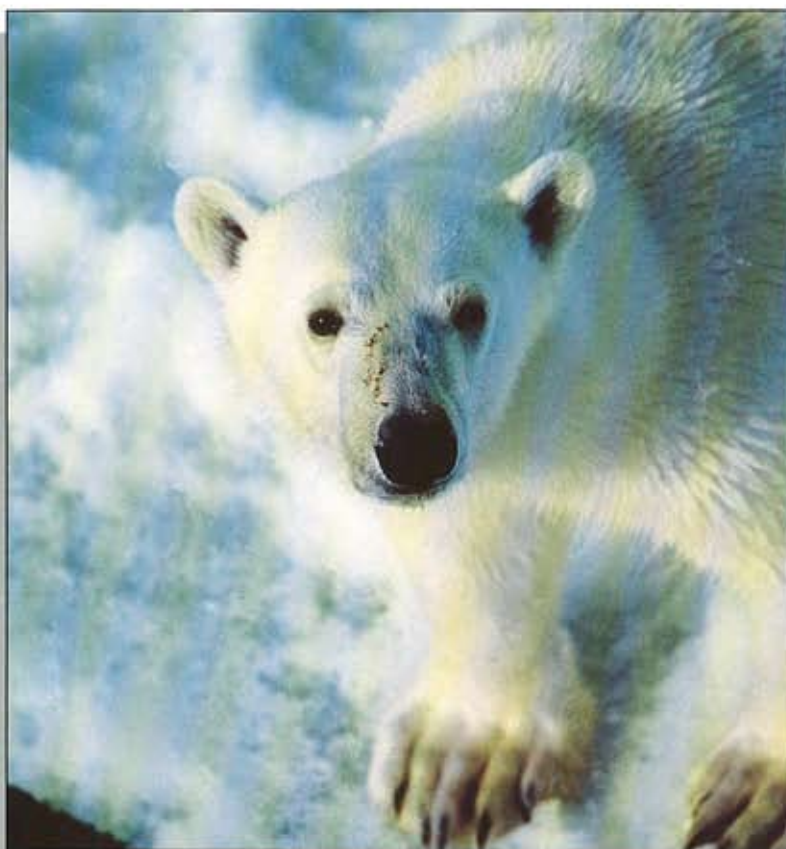


IUCN Species Survival Commission

Polar Bears

Proceedings of the Eleventh Working Meeting
of the IUCN/SSC Polar Bear Specialist Group
25–27 January 1993, Copenhagen, Denmark

Compiled and edited by
Øystein Wiig, Erik W. Born and Gerald W. Garner



Occasional Paper of the IUCN Species Survival Commission No. 10

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The World Conservation Union

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**IUCN – The World Conservation Union
1995**

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Foreword

The eleventh meeting of the IUCN/SSC Polar Bear Specialist Group was hosted by the Greenland Fisheries Research Institute in Copenhagen, 25–27 January 1993. One of the most notable features of this meeting was the participation of Inuit hunters and members of the Inuit Circumpolar Conference (ICC) as invited specialists.

The proceedings include a review of the world status of polar bears. Such a review has not been presented since the 1980 meeting of the group. It is, however, important to note that reviewing the population status is an ongoing process. The present summary will continue to be updated as new data are collected. During the 1988 meeting of the group the importance of the new developments in Russia was stressed. New cooperative projects between Russian, American and Norwegian scientists were recommended. The results from some of these projects are reported in the present proceedings. During the 1993 meeting, concern was expressed about possible detrimental effects of human activity on polar bears. Very high concentrations of toxic chemicals have been found in bears, particularly from the Svalbard and East Greenland areas. Nuclear waste in the Russian Arctic may affect the arctic ecosystem. Global warming may prolong the ice-free period and thereby alter the period during which polar bears are able to feed on seals, and so cause nutritional stress. Because the polar bear is at the top of the arctic marine food chain, it is an ideal species through which to monitor the cumulative effects of change in arctic marine ecosystems.

The proceedings contain an up-to-date review of present knowledge, management, and research on the polar bear populations of the world.

We are grateful to Ms Linette Humphrey at the IUCN/SSC, Gland, for help with preparing these proceedings for publication. The Canadian Wildlife Service, Edmonton, the Greenland Fisheries Research Institute, Copenhagen, the National Biological Survey, Anchorage, and the Norwegian Polar Institute, Oslo, have all contributed to meet the printing costs.

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Agenda

Monday 25 January 1993

- 10.00
1. Introductory remarks/comments from the hosts
 2. Election of the meeting chairman
 3. Selection of secretary for recording notes from the meeting
 4. Suggestions of additional topics for the meeting, adoption of final agenda
 5. Production and format of published proceedings from the meeting.
- 11.00 Election of ad hoc "editors" for compilation of information on status of different populations for the minutes of the meeting.
Election of group to draft press release.
- 11.30 Summary of research: Canada, Norway.
- 12.30 Lunch
- 13.15 Summary of research (continued): Greenland/Denmark, Russia, USA.
- 14.45 Present status of polar bear populations: Canada.
- 15.30 Coffee break
- 15.45 Present status of polar bear population (continued): Norway.
- 16.30 Greenland/Denmark

Tuesday 26 January

- 9.00 Present status of polar bear populations (continued): Russia.
- 9.45 USA
- 10.30 Coffee break
- 10.45 Presentation: "Effect of sex-selective harvest" (Mitchell Taylor, Wildlife Division, Department Renewable Resources, NWT). Discussion.

- 11.45 Lunch
- 13.45 Discussion and evaluation of how management of polar bears in different countries complies with the intentions of the articles of international "Agreement on the Conservation of Polar Bears".
- 12.45 Sports hunts (regulations for sports hunts in different countries, plans for sports hunt, implications of sport hunts to management). Discussion.
- 13.15 Trade in polar products and implications for management. Discussion.
- 14.15 Research.
Presentation: "The polar bear hunt in north western Greenland" (Aqqalu Rosing-Asvid, Greenland Fisheries Research Institute, Copenhagen). Discussion.
- 15.00 Coffee break.
- 15.15 Presentation: "Studies of mtDNA in polar bears" (Kristina Bodin/Ulfur Arnason, Department of Genetics, University of Lund). Discussion.
- 16.00 Presentation: "Status of Canadian studies of DNA in polar bears" (Malcolm Ramsay, Department of Biology, University of Saskatchewan). Discussion.

Wednesday 27 January

- 9.00 Research (continued).
Satellite telemetry. Evaluation of performance of transmitters.
- 9.30 Aerial surveys, other.
- 10.00 Coffee break
- 10.15 Presentation: "Heavy metals in polar bears" (Rune Dietz, Greenland Environmental Research Institute, Copenhagen). Discussion.

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10.45	Presentation: "Chlorinated hydrocarbons in polar bears". Status of work (Ian Stirling, Canadian Wildlife Service, Edmonton). Discussion.	12.15	Lunch
13.00	Presentation: "ICC's environmental strategy and polar bear management". Tentative title. Inuit Circumpolar representative.	14.15	Status Evaluation of the future status of the PBSG. Future objectives and actions of the PBSG. Criteria for membership. Suggestions for new members. Adoption of new members of PBSG.
11.15	Physiological studies of polar bears and implications of findings to the management of polar bears.	13.45	Identification of future research and management priorities.
11.45	Presentation: "Effect on polar bears of global warming" (Malcolm Ramsay, Department of Biology, University of Saskatchewan). Discussion.	15.00	Election of a new chairman of PBSG.
		15.15	Adoption of the compilation of status of population presented by the ad hoc editors.
		16.00	Adoption of press release.

Minutes of the 11th meeting of the IUCN/SSC Polar Bear Specialist Group, Copenhagen, Denmark 25–27 January 1993

25–26 January

I. Introductory Remarks

A. The meeting was called to order at 10:00 a.m. 25 January 1993 by the present chairman of the IUCN/SSC Polar Bear Specialist Group (PBSG), E. Born. He gave a series of introductory remarks and noted that this meeting was the first in which invited specialists included representatives of native groups with an historical interest in polar bears. He introduced members and invited specialists, and gave a brief preamble on the history of group. I. Stirling gave a brief summary of the PBSG since 1968 when the first official meeting was held. E. Born also noted that under current IUCN guidelines, it is the prerogative of the Chairman to designate members and invite specialists to attend the PBSG meetings.

II. Election of Meeting Chairman and Selection of Meeting Secretary

- A. E. Born was elected meeting chairman.
- B. S. Amstrup agreed to serve as co-chairman.
- C. M. Ramsay was appointed Secretary for the meeting.

III. Adoption of the Meeting Agenda

A. E. Born suggested that the membership of the PBSG be considered in the in-camera session on 27 January. Resolutions will be considered and adopted on 27 January. C. Brower asked whether invited specialists have a vote and can speak freely on any issues raised. E. Born explained that they do not have a vote, but they are free to participate on all issues except those carried out in the in-camera session.

B. The Canadian toxicology report was not available for presentation at the meeting, but will be included in the Proceedings.

C. S. Amstrup requested that the group make recommendations for his future research endeavors.

D. The final Agenda (as shown above) was adopted.

IV. Production of the Proceedings of the Meeting

A. Ø. Wiig, E. Born, and G. Garner were designated editors for the proceedings.

B. Ø. Wiig offered to have Norsk Polarinstitutt publish the proceedings in its Meddelelser series, which would require an external source of 50% of the publishing costs or, approximately \$5000 CAN total. M. Taylor offered to lobby for the necessary additional funds. S. Amstrup noted that if the Norsk Polarinstitutt published the proceedings, the IUCN imprimatur would be removed from the proceedings and the proceedings would not be one of their numbered reports. However, others suggested that the imprimatur of all the contributing agencies could be included as they were in the Proceedings published by the Northwest Territories

V. Miscellaneous Items

A. A discussion ensued between G. Garner, M. Taylor, and I. Stirling about whether the IUCN Bear Specialist Group does or does not include polar bears. E. Born postponed further discussion until 27 January.

B. S. Amstrup, E. Born, and M. Taylor were named to a committee to summarize the status of polar bears

world-wide. This world-wide status report, or a summary, could be published in the primary literature as well as in the PBSG proceedings.

- C. A committee consisting of I. Egede and I. Stirling was named to prepare a draft press release stemming from the meeting.

VI. National Overviews of Research and Management

Overviews of the research and management programs from each national jurisdiction were presented, which included summaries of research objectives and management concerns. As these reports will be included in the Proceedings, only some aspects of the discussions are included below.

- A. **Canada:** I. Stirling presented a summary of research programs conducted by the Canadian Wildlife Service, M. Ramsay outlined research projects carried out at the University of Saskatchewan, and M. Taylor outlined research programs carried out by the Government of the Northwest Territories. The Canadian management summary included a brief overview of the current programs. Of particular importance is the amount of effort being expended on the development of Management Agreements for each population, reducing quotas for populations thought to be over-harvested, and conducting research for populations which are being harvested but the status of which is uncertain.
- B. **Greenland/Denmark:** The Greenland Fisheries Research Institute is planned to move from Copenhagen to Nuuk by 1996. How this will affect future research and management of polar bears remains to be seen. E. Born presented a summary of current research and outlined the developing management situation in Greenland. Efforts are underway to develop a harvest reporting system, and some of the Greenland representatives discussed their perspectives on polar bear management. E. Born and A. Rosing-Asvid presented summaries of the status of polar bears in Greenland and the results of a survey of polar bear hunting done by A. Rosing-Asvid for his Master's thesis. These are the most detailed data provided from Greenland to date, and suggest a harvest of 40–60 per year in

West Greenland, from the population shared with Canada. These results are important because, when added to the harvest taken in Canada, they give the first reasonably reliable estimate of the total harvest for the shared polar bear population of Baffin Bay.

- C. **Norway:** Ø. Wiig reported on research conducted in Svalbard. Movements of satellite collared bears captured at Svalbard suggested a local population that had only limited exchange with Franz Josef Land and NE Greenland. Svalbard has no native people and, therefore, no traditional hunt is allowed. High levels of PCBs (30–90ppm) were recorded in polar bears at Svalbard, which were much higher than anywhere else in the world. The reason is unknown, but these levels have caused reproductive problems in other species. The Norwegians are also concerned about possible effects of offshore exploration in the Barents Sea and nuclear dumps in the vicinity of Novaya Zemlya. So far, there is little information available on the possible effects of nuclear wastes on the marine environment, but there is considerable interest in this area.
- D. **Russia:** S. Belikov reported on Russian research and management programs. Emphasis was placed on potential problems that may be faced in future as a result of the tumultuous political and economic events taking place currently in Russia. Little money is currently available to conduct an independent research program. Consequently, the cooperative research program conducted with the US offers the best opportunity for generating scientific data to develop a viable management plan. The potential for joint studies of polar bear behavior by biologists from the Canadian Wildlife Service, Russia, and the US Fish and Wildlife Service was discussed briefly. Other aspects of polar bear biology in Russia, Alaska, and Canada might also be studied together. No specific proposals were offered and no commitments were made by any party, although there are a number of ecological and behavioral topics that might be studied effectively on a cooperative basis.

Current thinking is to divide the polar bears inhabiting Russian territory into three populations. The Central population will remain listed in the Russian Red Book and the Eastern and Western

populations will likely be placed there as well. The population in the Eastern Russian Arctic appears to have increased since hunting stopped in 1956, and the Western population has perhaps doubled, with problem bears being encountered in the coastal villages on a regular basis. Data are not available for the Central population, although it is possibly stable. There is interest in developing a management plan for polar bears in the Bering-Chukchi area, in conjunction with Alaska, and then opening a hunting season in Russia. There is some debate within Russia about who would be allowed to hunt. S. Belikov favors hunting by resident indigenous people but interest has also been expressed by hunting organizations based in Moscow. Recently, interest in the development of commercialized sport hunting of polar bears in Russia has increased, especially in the eastern regions. Advertising for polar bear hunting in Russia has occurred, but was not authorized by Russian authorities.

Indigenous people claim they have a right to hunt polar bears and are working with US aboriginal groups in an attempt to achieve hunting arrangements similar to those currently in place in the Beaufort Sea region. Decisions concerning hunting patterns will be made by the Minister of Ecology. The government is prepared to open a polar bear hunt within the framework of the International Treaty on the Conservation of Polar Bears. A suggestion has been made that the quota be set at 65, which is approximately half of the current Alaskan harvest.

Legally, hunting is not presently allowed anywhere in Russia, however, polar bears are being harvested by local people in some arctic coastal communities. The government has few means to control illegal hunting and a change in regulations may be required. Lobbying efforts to legalize hunting are mounting and the situation may change in the near future in the Chukotka region. The Eastern hunt will be for local use only (i.e., no commercial hunting will be allowed because the government has no means of controlling and monitoring such a hunt). In the region bordering the Barents Sea there are no plans at present for hunting. S. Belikov offered to supply any interested parties with the names and addresses of institutions in Russia that

have input to decisions regarding changes in hunting regulations.

S. Belikov suggested that PBSG should adopt a resolution to support Russian authorities' efforts to control and manage future hunting programs. There was general agreement to such a proposition. The reported incidental take occurring along the Russian coast for local use is the first time Russia has acknowledged any harvest of polar bears in Russia. They apparently have little ability to control the take at the moment, but hope to do so if they develop a management plan in cooperation with the US. Similarly, there are few data to indicate the extent of the problem, although poaching is not thought to be extensive. At present, the Russians are largely dependent on the US, Norway, and ecotourism parties for financial support to conduct field work.

- E. **United States:** S. Amstrup and G. Garner reported jointly on American research endeavors. A considerable component of US research is conducted on the population of polar bears that move between US and Russian jurisdictions. Of particular interest is the amount of satellite tracking being done on the shared polar bear population resident in the Chukchi Sea, and denning on Wrangel Island. Plans are underway to attempt a large scale population estimate in the Chukchi Sea, involving adaptive sampling when the bear population is most dense along the southern edge of the pack ice in September 1994 or 1995. On the basis of the satellite tracking to determine the population boundaries and the estimate of population size, the US and Russia will develop a joint management plan. A total of 35% of Chukchi polar bears tested positive for canine distemper antibodies, which cross-react with phocine distemper virus. At present, field work in the Beaufort Sea is limited because the results of recently completed studies are being prepared for publication. Suggestions were sought for areas of investigation that members think important in the Beaufort Sea. Suggestions included another total population assessment in 5–10 years time; more detailed studies of the relationships between bear movements, seal numbers, and ice conditions; refinement of the western border of the population; lifetime reproductive histories of known females that have been followed for many years; continued

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monitoring of the apparent increase of terrestrial maternity denning along the Alaskan coast; and studies of the effects (or lack of them) or industrial activities on polar bear behavior or reproductive success.

S. Amstrup presented a report on the present status of polar bears in Alaska with particular emphasis on the discreteness of the populations inhabiting US territory and the extent these populations are shared with Canada and Russia. Much emphasis has been placed in recent years on determining the sites of maternity dens and whether they are on land or on the sea ice. S. Schliebe reported on harvest patterns and management practices for the United States. He discussed proposed changes to the US Marine Mammal Protection Act and the implications of those changes for the management and conservation of polar bears.

VII. Sex-Selective Harvest

M. Taylor presented a report on the management of polar bears in the Northwest Territories of Canada with especial emphasis on the "effects of sex-selective harvesting". A key point emphasized in this presentation was that reproductive rates in polar bears are very low and all populations are susceptible to over-hunting. There were numerous questions from the participating user groups. Results from recent simulations using the mathematical model of polar bear populations were presented. It was suggested that a population of bears would stabilize with about 30% more males than females, if the population were harvested at maximum sustainable yield and a sex ratio of 2 males:1 female in the harvest. The maximum skewing of the sex ratio of harvested bears that the population could withstand was about 28% female:72% male, if the population was being harvested for maximum yield. Current modelling projections suggest that the absolute maximum harvest level of independent females (i.e. 2+ years of age) is about 1.5% annually; however, the eventual outcome is that all cubs are harvested as 2-year-olds so this extreme is not realistic. If females were harvested at a rate of 1.5%, while males were harvested at substantially higher rates, the proportion of females in the population would increase. However, the population size would

initially decline, then increase in about 20 years. Concerns in the discussion included the difficulty of accounting for compensation in the model and the difficulty of convincing users to change their harvest practices so that the population would increase in 20 years. Also, if the population model was incorrect, or if ecological conditions changed substantially, the recognition that the predictions were incorrect might be delayed many years. Some felt this delay presented too high a risk for the model to be used as a management tool. Thus far, data from most settlements indicate that obtaining a ratio of 2 males:1 female in the harvest is a reasonable target.

VIII. Compliance with the International Agreement

There was a general discussion and evaluation of how the individual management programs of the circumpolar nations complied with the intentions of the articles of the "International Agreement on the Conservation of Polar Bears and their Habitat". This was a fairly lengthy discussion. Overall, it seemed that all countries were complying fairly well to the intent, if not necessarily the letter of the Agreement. There was some discussion about the extensive use of snow machines in Canada and Alaska to hunt polar bears and whether or not this complied with the reference to "... local people using traditional methods in the exercise of their traditional rights ..." as specified in Article III (d). The Canadian Letter of Interpretation allows Inuit-guided sport hunts using dog teams.

There was a certain amount of variation in the degree to which different countries specifically protected polar bear habitat. In Svalbard, about half the archipelago has at least some protection and the major denning area in Kong Karl's Land has complete protection. In Russia, the denning areas on Wrangel and Herald Islands are protected, but it was not clear if there was any protection for other areas. In Greenland, an area of Melville Bay has been set aside as a reserve for polar bears and the major part of NE Greenland is included in the National Park of North- and East Greenland. No areas are currently protected in Alaska, although there is some discussion taking place on providing protection of some sort in the area of the Arctic National Wildlife

Reserve because it contains the only known significant amount of terrestrial polar bear denning in Alaska. In Canada, the denning areas in Manitoba are both designated Wildlife Management Areas through which some control can be exercised. The Churchill denning area would be included in a proposed National Park if it proceeds. In Ontario, some denning habitat and coastal summer sanctuary habitat are included in Polar Bear Provincial Park. Some polar bear habitat is included coincidentally in some of the National Parks and National Park Reserves in the Northwest Territories. Nowhere is there any protection for offshore areas that may be critical breeding habitat. However, a recent proposal to drill near the shorelead polynya system in the eastern Beaufort Sea was denied because the company could not demonstrate their ability to clean up an oil spill. One of the principal concerns was the potential for detrimental effects on polar bears.

Several members questioned whether the "Agreement" makes any specific reference to whether cubs can be killed. I. Stirling noted that protection of females with cubs and bears in dens is covered in Annex E "Resolution on Special Protection Measures", not in the "Agreement" itself. Cubs are not defined, but it seems likely that the intent was to include all young that were still dependent on their mothers, up to 2½ years of age. In some areas, Inuit have indicated they would like to harvest a small number of yearlings and two-year-olds to supply tender meat to elders in their communities. From a management perspective, this strategy would be acceptable as long as the adult female was not harvested. No agreement was reached over interpretation of whether families and bears in dens are protected.

- A. **Canada:** M. Taylor suggested that Canada may be in non-compliance with the "Agreement" on three of the articles. Article II stipulates management according to sound conservation practices based on the best available scientific data. Some sub-populations of polar bears are thought to be over-harvested. Selling hides resulting from polar bears killed in self-defense violates Article II, section II. The use of aircraft to position hunting camps and transport hunters could be interpreted as a violation of Article IV.

M. Taylor noted that the existing quota hunting system in place allows reduction of quotas in response to a decline resulting from over-hunting. The government of the Northwest Territories has or is currently negotiating with local communities to reduce quotas in those jurisdictions where recent population data suggest an over-harvest has occurred. He also noted that all bears killed in self-defense are removed from local quotas so the sale of the hide does not constitute a conservation threat. He argued further that, under a carefully controlled quota management system, the use of aircraft to position camps does not result in over-hunting. He also noted that aircraft are not used in Canada to pursue or scout for polar bears during a hunt.

A principal area of non-compliance in Canada lies in Québec where, because of the James Bay Agreement, there are no quotas, seasons, or protection of females and young. These shortcomings were addressed by local resolutions of the Hunters and Trappers in Northern Québec. In past years, Makivik has conducted harvest studies in Québec but the data collection has been sporadic and has declined in recent years. So far, there has been little willingness to join with other jurisdictions that share polar bear populations to negotiate a management agreement. Only a fraction of the kill is reported and the data and specimens collected are variable in the information they provide. The Province of Ontario has only limited information available on the hunt taking place by aboriginals within their jurisdiction. The Province of Manitoba allows no hunting of polar bears within its jurisdiction, and records all known mortality of polar bears from human and other causes.

- B. **Greenland/Denmark:** E. Born outlined how Greenland hunting regulations comply with the "Agreement", especially with regard to aboriginal harvests. Under Article VII of the "Agreement", Greenland does not currently collect good hunting statistics and share them with neighboring jurisdictions. Complete protection for polar bears is afforded in the reserve in Melville Bay. A. Jensen summarized the Greenland hunting regulations as follows: i) there is no quota; ii) no motorized vehicles may be used for the hunt; and iii) hunters must be citizens of Greenland and hunt or fish full time.

U. Qujaukitsoq noted that as of 1 January 1993, Greenland residents are required to get special permits to hunt polar bears. This regulation will allow closer monitoring of the hunt and better data to be collected. He noted that it would be desirable to have future IUCN Polar Bear Specialist Group meetings closer to where the user groups live. He noted that the Inuit perceive things differently from many scientists and their input to these meetings should provide a useful insight.

- C. **Norway:** Ø. Wiig noted that the hunting of polar bears in Svalbard is prohibited; bears may only be killed in self-defense. Furthermore, approximately 50% of the land area of Svalbard is totally protected, including all major regions of denning by female bears. Norway, thus, is in total compliance with the Agreement. He noted, however, that protection of habitat is only on land and to 4 nautical miles offshore. Therefore, polar bears and their habitat are unprotected in the Barents Sea. Environmental regulations based on the Svalbard Treaty claim jurisdiction only out to 4 nautical miles. Norway, in fact, claims control of waters out to 200 nautical miles but, only Finland has accepted these Norwegian claims.
- D. **Russia:** S. Belikov outlined Russia's compliance with the "Agreement". Regions on Wrangel and Herald Islands where concentrated numbers of polar bears enter dens each year have been given complete protection. Under the new economic situation, Russia may be unable to comply with Article II and its stipulation of managing polar bears according to sound scientific principles. Dr. Belikov offered to draft a resolution for the group to offer support for the Russian predicament.
- E. **United States:** S. Schliebe suggested that the USA may be in non-compliance with the "Agreement" in three areas:
- i) protection of females and their cubs as well as protection of bears in dens;
 - ii) protection of habitat; and
 - iii) the use of aircraft and large vessels in polar bear hunts.

The US does have legislation in place that can protect habitat, but none specifically for polar bears. There are political debates on whether specific

protection should be afforded to areas within the Arctic National Wildlife Reserve known to contain polar bear dens. Significantly, this is the only region under US jurisdiction known to contain numbers of polar bear dens. The use of aircraft and large ships is specifically prohibited (Article IV). In Alaska, there have been two cases of native people using a small aircraft to hunt a polar bear. An effort is underway to institute legislation that would specifically prohibit the use of aircraft for hunting polar bears.

The Marine Mammal Protection Act is scheduled for review during 1993. The US Fish and Wildlife Service is considering a number of modifications to the act to allow the US to come into compliance with the "Agreement".

IX. Sport Hunting and Access to Harvest

E. Born initiated a general discussion on commercial sales of polar bear hunts. Article III (d) of the International Agreement on the Conservation of Polar Bears states that polar bears may be taken, "by local people using traditional methods in the exercise of their traditional rights and in accordance with the laws of that Party." Although not written as such, this is often interpreted to refer to indigenous people. The Norwegian Ministry of Environment's interpretation of the Agreement is that only aboriginal people are permitted to hunt. Applications from trappers in Svalbard (where there are no aboriginal people) to hunt polar bears have been refused for this reason.

In Canada and Greenland, most hunting of polar bears is done by aboriginal people. However, Canada and Denmark (Greenland) have interpreted these articles in a way that permits some non-native residents to hunt polar bears in specific circumstances. Canada also allows non-residents to hunt polar bears if they are guided by Inuit hunters travelling by dog team. In the United States, under the Marine Mammal Protection Act of 1972, no one can hunt polar bears except coastal dwelling native people for subsistence purposes. In Alaska, the State constitution prohibits limitation of access to wildlife resources on the basis of race but can do so on the basis of whether or not a person lives a

"subsistence" life style. However, because Federal Law supersedes Alaskan State Law in this case, the exemption for native subsistence hunters can still be made. In Alaska, Canada, and Greenland, maintaining polar bear hunting as part of the subsistence lifestyle is widely viewed as being of significant cultural importance. Although hunting polar bears is still illegal in Russia, there is now significant interest in reopening a hunting season. It remains to be seen how that will be done.

The interpretation of the commitment to use "traditional methods" to hunt bears differs between the arctic countries. For example, in Greenland, the prohibition on use of motorized vehicles, aircraft, and large vessels when hunting polar bears was motivated by the Agreement. In fact, this is probably the most effective way to limit the number of bears killed in Greenland since there is no quota system. In Canada and Alaska, there are no restrictions on use of oversnow machines, except during guided non-resident sport hunts in Canada. In Alaska it is technically legal for a native person to use an aircraft to hunt polar bears, although legislation to change this option is currently being developed.

In Alaska, hunting of polar bears in order to sell hides has been a non-issue since 1972 because the Marine Mammal Protection Act prohibits harvest of polar bears by anyone except for subsistence purposes. However, if Alaska and Russia negotiate a joint management agreement on the Chukchi population, this may become an issue. The Inupiat of the North Slope Borough are currently opposed to sport hunting, while those in Western Alaska are more interested. The Inuit Circumpolar Conference persons at the IUCN meeting were adamant that only indigenous people should have access to hunting polar bears. A. Qujaukitsoq expressed a strong emotional opinion on behalf of Greenland hunters that the relationship between Inuit hunters and polar bears was so special that it could be considered improper to guide someone on a hunt for money. L. Audlaluk felt the same about the personal importance of hunting polar bears to individual Inuk hunters. However, he also pointed out that there are limited opportunities for cash income in most of the small settlements so that the hunters become dependent on guiding for part of their income.

S. Belikov indicated that the term "local" people in Russia might be interpreted by some parts of government at least to include Russians who have been living in polar bear areas for a period of years. There is also interest in certain hunting groups in Russia in starting guided polar bear sport hunting because of the foreign currency it would attract. There have even been some advertisements for such hunts although Belikov thought none had occurred to date.

Of particular significance in the US is the feeling that the tenets of the Polar Bear Agreement should be enforceable by law. Some thought is currently going into how this might be done. At present, the terms of the Agreement are not enforceable in any country, a weakness that has been identified in a couple of reviews of international wildlife law.

- A. **Canada:** M. Taylor discussed the position of the Northwest Territories that allows sport hunting to occur as long as it is regulated under the existing quota system. He noted that sport hunters must be guided by a native guide using dog teams. Each sport hunt is taken directly from the quota assigned to the participating village, regardless of whether a bear is killed or not, and if a bear is not taken the tag is unused for that year.
- B. **Greenland/Denmark:** A. Jessen outlined the regulations governing the hunting of polar bears. No sport hunting is allowed there and they have no plans to initiate sport hunting. Before even opening a discussion of sport hunting, they feel they need considerably better statistical information regarding the impact of the current native hunt. U. Qujaukitsoq stated that he did not approve of the term "sports hunt". It sounded to him like an entertainment and his people do not hunt polar bears for entertainment.
- C. **Norway:** Because there is no hunting of polar bears in Svalbard, the issue is not an issue in Norway. They interpret the "Agreement" to limit hunting to indigenous people. Norway has no indigenous people in Svalbard but takes the view that the intention of the Agreement was to defer to native people for access to use.
- D. **Russia:** Russia currently does not allow hunting, but if these regulations are changed in the future,

they desire to limit the hunt to indigenous people. Their government is concerned that money would drive a market hunt and, thereby, make control and regulation of the hunt problematic.

- E. **United States:** S. Schliebe outlined the US position. Currently, polar bears may only be hunted by coastal dwelling native residents living a subsistence life style. Consequently, no sport hunting is allowed. Proposals and amendments to the US Marine Mammal Protection Act (MMPA) are being considered which could allow native guiding of sports hunters under a system which included regulatory authority.

C. Brower was asked by I. Egede to comment on these new proposals and amendments. C. Brower noted that the North Slope Borough opposes sport hunting and supports the native exemption clause of the MMPA and did not wish to endorse the regulatory authority component of the FWS proposal. His organization wishes to gain greater control over polar bear hunting in their area and, therefore, thinks that the points raised by proposed changes to the MMPA are outweighed by the government maintaining control over resources.

The US Marine Mammal Protection Act will be considered for re-authorization in 1993 and again in 1998. The FWS has developed a number of proposals to amend the MMPA in order to force some legal compliance with the Polar Bear Agreement. They are also seeking a waiver to allow legally taken polar bear hides to be imported into the US

X. Trade in Polar Bear Products

I. Stirling indicated that the fur market is currently glutted resulting in low prices for pelts on the open market. The trade in polar bear hides is fairly flat at the moment and the potential US market remains closed because of the MMPA. A. Jessen outlined how Greenland assists in the marketing of polar bear pelts for local communities. In 1992 a total of 60 hides were purchased by the Greenland tannery, of which 30 went to Denmark.

The group was concerned about the sale of gall bladders from polar bears because of the threat to the survival of other species of bears. It is difficult to

control illegal trade while there are still legal sources. S. Belikov stated that the sale of gall bladders (currently priced at 0.5 million roubles per gall bladder) drives the kill of brown bears in Russia. Polar bears could easily fall into the same situation; therefore, sale of their gall bladders should be prohibited. Only members of the Inuit Circumpolar Conference from Greenland wished to retain the right to sell gall bladders because they represent a potential source of income. They agreed to the resolution on restricting trade in gall bladders only when it was worded to allow each contracting party to determine its own approach to the problem, as opposed to recommending an outright ban. In early 1993, Greenland will be considering whether to sell polar bear gall bladders.

27 January

XII. Review of Polar Population Status

S. Amstrup, E. Born, and M. Taylor presented their report on the size of each of the world's polar bear sub-populations based on the best knowledge available for each. The total number of polar bears is thought to lie between 21,000 and 28,000. The IUCN Bear Specialist Group decided to include a review of the status of polar bear populations in their Bear Conservation Action Plan for bears of the world. Members of the IUCN/SSC PBSG felt that if an assessment was to be done by anyone, it should be done by the PBSG. Developing a summary of the population estimates for the circumpolar population was not an easy job. In particular, concern was expressed about possible over-harvests in several Canadian populations of polar bears. It was acknowledged by Canada that over-harvests had been occurring in Viscount Melville Sound and Foxe Basin. However, in negotiating a local Management Agreement between the users, the quotas had been reduced to levels that were believed to be sustainable. The status of the populations of polar bears in Baffin Bay and Davis Strait is not clear although there is no evidence of an over-harvest occurring to date. Research in both those areas is continuing. After considerable debate and revision, a set of estimates was made for all the subpopulations for which boundaries were known, and subjective

guesses were made about population boundaries and numbers for areas in which the data are too few to do anything else. For the purpose of this exercise, the total population was estimated to be between 21,370 and 28,270.

XIII. Special Topics

- A. Molecular genetics:** U. Arnason outlined his group's work in sequencing the complete mtDNA genome for a polar bear. He is willing to provide information for determining PCR primers to any researcher who so desires them. M. Ramsay outlined ongoing work in Canada using both mtDNA and nuclear DNA methodologies to delineate discrete subpopulations of polar bears.
- B. The polar bear hunt in northwest Greenland:** A. Rosing-Asvid presented data derived for his Master of Science thesis. These are the best data to date on the size of the West Greenland hunt. U. Qujaukitsoq described his experiences about hunting in NW Greenland. A. Jessen asked why Greenlanders cannot participate in their traditional hunt in northeast Canada. L. Audlaluk issued a statement of intent of Canadian Inuit to cooperate with northwest Greenlanders on letting them hunt in Canada in their traditional hunting range. U. Qujaukitsoq, as a parliamentarian, will continue to lobby to re-obtain the right to hunt in their traditional hunting ranges on northern Ellesmere Island. E. Born and M. Taylor mentioned that the cooperative research program in this area is likely to provide the basis for joint management discussions.
- C. Satellite telemetry:** M. Taylor reviewed the Northwest Territories/University of Saskatchewan research program being carried out in Canada. A 3-year telemetry operation has just been concluded in the Viscount Melville / M'Clure Strait region of the Northwest Territories. A similar multi-year program has recently been initiated in Baffin Bay involving both Canada and Greenland and also in the Beaufort Sea. Good success has been realized with satellite telemetry.
- Ø. Wiig outlined plans for Norway to deploy satellite collars in the Barents Sea in order to determine the movements of polar bears that inhabit the waters around Svalbard.
- D. Aerial survey:** G. Garner outlined a proposal for testing census methods to be used in the Beaufort Sea in Alaska in autumn 1993 and, eventually, to be used in the Chukchi Sea of Russia and Alaska. Current methods of censusing populations using mark-recapture techniques are thought to be prohibitively expensive. Considerable discussion of the cost-effectiveness of various census techniques were discussed. U. Qujaukitsoq expressed concern about the effects that low level aerial survey flights might have on wildlife.
- E. Heavy metals:** R. Dietz presented the results of the survey of heavy metal contamination in the polar bears of Greenland.
- F. Phocine distemper:** M.-P. Heide-Jørgensen outlined data for the degree of antibody titre seen in seals from Greenland.
- G. Sex determination via molecular biology:** S. Amstrup outlined results from their research indicating that the sex of a polar bear can be determined from tissue samples.
- H. Global warming:** M. Ramsay gave a brief overview of the current status of models predicting global warming and suggested several possible scenarios that might impact negatively on sea ice conditions and, hence, directly on polar bears. Because polar bears are so intimately associated with sea ice, polar bears might be an excellent organism with which to monitor early changes in the arctic ecosystem due to global warming. It was noted that there is considerable debate about whether or not global warming is occurring. However, it was agreed that it is important to be aware of the hypothesis and to consider some of the possible consequences for polar bear research and management.
- If climatic warming occurs, the first impacts on polar bears will occur at the southern limits of their distribution, such as in James and Hudson Bays, where the entire population fasts for approximately four months when the sea ice melts during the summer. Prolonging the ice-free period will increase nutritional stress on this population until individual animals are no longer able to store enough fat to survive the ice-free period. Early signs of impact will include declining body condition,

lowered reproductive rates, reduced survival of cubs, and an increase in polar bear–human interactions. Although most of these impacts are currently evident in the polar bears of western Hudson Bay, it cannot yet be determined if climatic change is involved.

In the High Arctic, a decrease in ice cover may stimulate an initial increase in biological productivity. Eventually however, it is likely that seal populations will decline wherever the quality and availability of breeding habitat is reduced. Rain during the late winter may cause polar bear maternity dens to collapse, causing the death of occupants. Human–bear problems will increase as the open-water period becomes longer and as bears fasting and relying on their fat reserves become food-stressed. If populations of polar bears decline, harvest quotas for native people will be reduced and eventually eliminated. Tourism based on viewing polar bears in western Hudson Bay is likely to suffer a similar fate.

Should portions of the Arctic Ocean become seasonally ice free for a sufficiently long period, it is likely polar bears would become extirpated from at least the southern part of their range. If climatic warming occurs, the polar bear is an ideal species through which to monitor the cumulative effects in arctic marine ecosystems because of its position at the top of the arctic marine food chain.

I. Inuit Circumpolar Conference (ICC): I. Egede presented an outline of the aims and goals of the ICC.

J. Population processes—a discussion: U. Qujaukitsoq argued that better monitoring of harvest is essential and that local people must take the initiative to do so in the future. He sees the use of indigenous knowledge as a priority in future research plans. I. Stirling agreed and felt that anywhere polar bear harvesting occurs, total and complete harvest data must be collected.

I. Egede indicated that the ICC is pleased to hear that the Chukchi people of Russia are being supported in their efforts to hunt polar bears. S. Belikov supports the native hunt, but is gravely concerned about possibilities of populations being heavily

hunted. He fully supports the concept that local users be included in management plans.

E. Born emphasized that management and research priorities should include population inventories and the monitoring of habitat in all regions.

U. Qujaukitsoq asked what would be the most effective means of monitoring environmental accidents and toxicological threats in the Arctic. E. Born outlined the Arctic Monitoring and Assessment Program (AMAP) ("The Finnish Initiative"). Although polar bears are not specifically included in that program, its results should be directly applicable to polar bear researchers and managers.

XIV. Future Priorities

S. Amstrup asked what are the major gaps in polar bear research. Suggestions included:

- better population dynamics methodologies
- better understanding of seal/polar bear/sea ice interactions
- clearer understanding of the effects of contaminants on polar bear reproduction
- better harvest monitoring data throughout the range
- population delineation, estimation, and trend
- periodic monitoring of toxic chemical levels on a circumpolar basis
- monitoring of long-term reproduction and condition in two or three populations of polar bears for evidence of climate change and determination of the natural range of environmental variability and its effects on polar bears
- determining population estimates in areas where they are suspect or lacking
- development of sustainable quotas and continued monitoring of populations for evidence of over-harvesting

XV. Membership and Attendance

A. There was unanimity that the IUCN Polar Bear Specialist Group should continue to exist.

B. There was a discussion about membership in the IUCN Polar Bear Specialists Group in future meetings. IUCN currently gives the Group Chairman the right to choose members of a specialist group, but acknowledges that the formation of the Polar Bear Group predates this decision and has had its own practices. Initially, membership was limited to government biologists working on polar bears because one of the principal tasks was negotiation of the Polar Bear Agreement. After the Agreement was signed in 1973, "Invited Specialists" were included to facilitate the input of experts in fields like population dynamics and physiology.

It was generally agreed that one of the reasons the PBSG has been so successful is that members have been appointed by government agencies and have usually been polar bear specialists as well. Most of the managers attending, who were not specialists, personally had the welfare of polar bears very much at heart and this was as important as the scientific knowledge exchanged. Because governments have been more directly involved in the work of this specialist group, they have also had a vested interest in its success. Consequently, the people attending meetings have had a fair amount of authority to make decisions and commitments.

Certain member nations wished to designate individuals from native user groups as official members, but wished to close the PBSG to all other user groups. M. Taylor proposed that a charter be drawn up to specify such matters. He also proposed that national governments may appoint any number of members, but each country only gets one vote and

non-government members cannot vote. Taylor offered to draft a "requirements for membership in the PBSG" document and circulate it to current members for discussion. After much debate, the issue was tabled.

Inuit were invited to participate as "Invited Specialists" at this meeting for the first time, through the ICC. The three delegates were very knowledgeable on polar bears and contributed significantly to the meeting. It was agreed that the emphasis in an invitation should be on the specialist knowledge. In particular, it was agreed that non-government participants are important to the PBSG meetings because of their ability to contribute to the content of the meeting rather than using it as an opportunity to advance a particular advocacy position.

XVI. Review of Resolutions

Considerable discussion ensued over the wording of the resolutions. At the end, there was unanimity on all resolutions.

XVII. Schedule and location of next PBSG meeting

No date was set for the next meeting but it was agreed that it would probably take place in two to four years time, probably in Oslo, Norway.

XVII. Election of Chairman

Dr. Øystein Wiig from Norway was elected to be the next Chairman.

Summary of Polar Bear Population Status 1993

This summary of the world-wide status of polar bears is the result of discussions held at the 1993 meeting of the IUCN/SSC Polar Bear Specialist Group and is based on the status reports given by each nation. The individual national reports are also included in these proceedings. The present summary will continue to be updated as new data are collected. For location of the various polar bear populations and population estimates, see Fig. 1 and Table 1 respectively.

Western Hudson Bay (A1)

The distribution and abundance of this population has been the subject of research programs since the late 1960s. Over 80% of the adult population is marked and there are extensive records from mark-recapture studies and the return of tags from bears killed by Inuit hunters. This population appears to be geographically segregated during the open-water season, although it mixes with those of eastern Hudson Bay and Foxe Basin on the sea ice covering Hudson Bay during the winter and spring. The population estimate of 1200 should be considered conservative because a portion of the southern range has not yet been covered by the mark-recapture program.

Eastern Hudson Bay (A2)

The information on this population comes from a three year study of movements and population size using telemetry and mark-recapture, mainly along the Ontario coastline. This study documented seasonal fidelity to the Ontario coast during the ice-free season, and intermixing with the Western Hudson Bay and Foxe Basin populations during the months when the bay is frozen over. The calculated estimate of 763 was increased to 1000 because a portion of the eastern and western coastal areas were not included in the area sampled. Additionally, the inshore area was under-sampled due to difficulties of locating polar bears inland from the coast in the boreal forest. The estimate of 1000 is considered conservative. The harvest quota for

this area is currently being revised to levels that will facilitate an increase in the size of this population. The process for these revisions is the development of management agreements between the jurisdictions that share this population (Northwest Territories, Ontario and Quebec).

Foxe Basin (C)

An eight-year study of movements and population size using telemetry and mark-recapture was concluded in 1992. During the ice-free season, polar bears were concentrated on the Southampton Island and Wager Bay areas. However, significant numbers of bears were also encountered throughout the islands and coastal areas in the remainder of the area. The marking effort was distributed throughout the entire area so the population estimate is believed to be accurate. The previous harvest quotas are believed to have reduced the population from about 3000 in the early 1970s to about 2000 in 1991. The harvest quota for this area has now been revised to levels that will permit recovery of this population. The process through which these revisions have been developed is through local Management Agreements between the Inuit communities that share access to these polar bears.

Lancaster Sound/Baffin Bay (F/D1)

For an interim period, this area is being considered as a unit because recent studies of movements indicate that bears from what were formerly considered to be three populations (Lancaster Sound, western Baffin Bay and eastern Baffin Bay) intermix during winter and spring. The total population estimate was obtained by simply pooling the previous estimates for the Lancaster Sound and NE Baffin population and assuming that a distinct and separate population for West Greenland will not be found. The original estimate for Lancaster sound (1657) was increased to 2000 because it was suspected that bias in sampling during the original studies could have resulted in an underestimate. A

population estimate of 470 bears for eastern Baffin Island was added to the Lancaster sound estimate of 2000 to give a total population estimate of 2470 for the combined area. This estimate is considered preliminary and may be conservative. The location of the southern and western boundaries are supported by movement data obtained by telemetry and from the movements of tagged bears. However, the northern boundary, and the possible existence of subpopulations within the pooled area have not yet been clarified. The distribution and abundance of this population is currently being researched in a cooperative study being conducted by Canada and Greenland. It remains a concern that, on the basis of existing, albeit incomplete data, the number of bears currently being harvested can probably not be sustained by a population of the size estimated. However, no management action is recommended until the current study has been completed.

South-eastern Baffin (D2)

The estimate of population size comes from a study using mark-recapture methods, completed in 1979. There is some recent, but limited, movement information gained by telemetry which is consistent with the population boundaries determined from movements of tagged animals in the 1970s. The population estimate of 818, calculated from the mark-recapture data, was increased to 950 to correct for bias in a sampling caused by the inability of researchers to survey the extensive area of offshore pack ice. The harvest quota for this area is currently being revised to levels that should permit it to grow slowly, through the development of local Management Agreements.

Gulf of Boothia (E3)

This population was the subject of a limited research program conducted in the mid-1970s. The tagging and recapturing of polar bears was geographically restricted to the western coastal areas and no movement data using telemetry were collected. The population estimate of 333 was increased to 900 based on information from local Inuit hunters and because the central and eastern portions of the area were not sampled. Although movement data from this area are limited, studies conducted in adjacent areas support the boundaries indicated. Because population data from this area are limited, the status must be considered uncertain.

M'Clintock Channel (E2)

A six-year population study using mark-recapture was conducted in this area in the mid-1970s. Most of the area was surveyed. The estimate for this area was 900. However local hunters have advised that 700 may be a more accurate estimate. Although studies of movements using telemetry were not conducted in this area, recoveries of tagged bears and movements documented by telemetry in adjacent areas support the boundaries indicated. Under a local Management Agreement between Inuit communities that share this population, the harvest quota for this area has been revised to levels that will permit the population to grow slowly based on the more conservative estimate of 700.

Viscount Melville Sound (E1)

A five-year study of movements and population size, using telemetry and mark-recapture, was completed in 1992. The population boundaries were based on the observed movements of female polar bears, and the population estimate is believed to be unbiased. Because this population occupies such a large geographic area, it was previously thought to be large and productive at the time the original quotas were allocated in the mid-1970s. However, this area is characterised by poor habitat for seals and the productivity of polar bears was found to be lower than expected. Consequently, quotas have been reduced. An all-male hunt for four bears was planned for 1994, followed by a five-year moratorium on hunting in this area. In 2000, harvest activities will resume with an annual quota of four males.

North Beaufort Sea (H2)

Estimations of population size and studies of population movements have been conducted in the North Beaufort Sea, using telemetry and mark-recapture, at intervals since the early 1970s. The population boundaries indicated are supported by data on movements obtained both through telemetry and recovery of tagged bears. The population estimate is believed to be unbiased and may be conservative. An ongoing study is investigating the possibility that this population extends further north than previous studies indicated. The current harvest is within sustainable limits.

Southern Beaufort Sea (H1)

The southern Beaufort Sea population is shared between Canada and Alaska. Mark-recapture and studies of movements using telemetry have been conducted semi-continuously since the late 1960s in Alaska and the early 1970s in Canada. The eastern and northern boundaries of this population have been determined from movements of marked bears and from telemetry. The western boundary, shared with the Chukchi population, is less clear at this point. The population estimate for this area is believed to be unbiased and possibly conservative. A reanalysis of the entire data base is scheduled for 1994. A management agreement for this area was developed by the Inupiat (Alaska) and the Inuvialuit (Canada) who harvest this population. The current harvest appears to be within sustainable limits.

Chukchi Sea

Tagging of polar bears for the purpose of estimating population size using mark-recapture in the eastern Chukchi Sea, based from the Alaskan coast, has been conducted at intervals since the late 1960s. However, cooperative studies between USA and Russia, using telemetry to study movements, have confirmed that polar bears in the area are widely distributed on the pack ice of the northern Bering and southern Chukchi seas. Consequently, shore-based mark and recapture studies cannot be used to estimate population size. The estimates given are based on observations of dens and are considered uncertain. Harvesting activities are currently restricted to Inuit in western Alaska and appear to be sustainable at current levels. This population is believed to have increased after the level of harvest was reduced in 1972. Because of the apparently low level of harvest, the population may still be increasing in size but this is unknown.

Laptev Sea

The Laptev population area includes the western half of the eastern Siberian Sea, the entire Laptev Sea and the eastern half of the Kara Sea, including the Novosibirsk and Severnya Zemlya islands. The estimate of population size for the Laptev Sea is based on aerial surveys and den counts. Although no studies of movements of bears have been done in this area using telemetry, the data available from the Chukchi Sea support the eastern boundary. A limited amount of telemetry data

from the west is also consistent with the proposed boundary. The population estimate should be regarded as preliminary. Reported harvest activities here are limited to defense kills and a small but unknown number of illegal kills. The population is not thought to be impacted by current harvest levels.

Franz Josef Land/Novaya Zemlya

This population includes eastern portions of the Barents Sea, the Franz Josef Land archipelago, and western portions of the Kara Sea, including Novaya Zemlya. The information for the Kara and Barents Seas in the vicinity of Franz Josef Land and Novaya Zemlya is mainly based on aerial surveys and den counts. Limited studies of movements, using telemetry, have been done in the eastern portion of this area but the results support the proposed eastern boundary. More extensive telemetry studies in the Svalbard area suggest the population associated with Svalbard could be regarded as geographically distinct. This is the current rationale for the western boundary. The population estimate should be regarded as preliminary. Reported harvest activities have been limited to defense kills and a small but unknown number of illegal kills. The population is not thought to be impacted by current harvest levels. However, contaminant levels in rivers flowing into this area and recent information on nuclear and industrial waste disposal raise concerns about the possibility of environmental damage.

Svalbard

The population estimate for the Svalbard area includes the western Barents Sea. Both movement and population studies using telemetry and mark-recapture have been conducted at intervals in the Svalbard area, beginning in the 1970s. Studies of movements, using telemetry, indicate that the polar bears associated with Svalbard are more restricted in their distribution than was previously believed. The population estimate is based on ship surveys and den counts in the early 1980s. This area is currently unharvested and population numbers are believed to be either stable or increasing. High levels of PCBs have been detected in a sample of polar bears from this area which raises the concern that industrial activity and contaminants may cause environmental degradation.

Eastern Greenland

The harvest data for this population are not completely documented but approximately 100 polar bears are reported taken each year (documented average for 1970–87: 72 bears per year). Historically, higher catches have been reported (e.g., 1910–20: 94 bears per year). High catches by European sealers on land and offshore ceased in the 1930s. There is no information

indicating an overall increase in hunting by East Greenlanders in recent times. No indications of decrease, nor increase, are apparent. Although no study has been done, the seasonal movements of polar bears in this area are thought to be extensive. The large area of adjacent available habitat suggests the possibility of a large population. However, to date there has been no population inventory in this area and the number can only be presumed to be in the low thousands.



FIG 1. Boundaries of polar bear populations throughout the circumpolar basin
(The captions identifying the populations are defined in the text)

TABLE 1. Polar bear population status

Population	Sex ratio % female in harvest	Number	Sustained annual yield	Current annual harvest	Environmental degradation	Status	Quality
Western Hudson Bay	33.0	1200	55	55	Possible	Stationary	Good
Eastern Hudson Bay	30.2	1000	50	52	No info	Stationary	Fair
Foxe Basin	33.0	2020	92	91	No info	Stationary	Good
SE Baffin Island	39.2	950	36	52	No info	Apparent decline	Fair
Lancaster Sound/ N Baffin Bay	31.0	2470	120	195–215	No info	Apparent decline	Fair
Gulf of Boothia	33.0	900	41	41	No info	Stationary	Poor
M'Clintock Channel	33.0	700	32	32	No info	Stationary	Fair
Viscount Melville	15.0	230	4	4	No info	Stationary	Good
North Beaufort	48.5	1200	37	33	No info	Stationary	Good
South Beaufort	45.8	1800	59	64	No info	Stationary Possibly increasing	Good
Chukchi	35.0	2000–5000	86–214	87	No info	Stationary Possibly increasing	Poor
Laptev	N/A	800–1200	N/A	Incidental	Possible	Possibly stationary	Very poor
Franz Josef Land/ Novaya Zemlya	N/A	2500–3500	N/A	Incidental	Indicated	Stationary Trend unknown	Very poor
Svalbard	N/A	1700–2200	N/A	Incidental	Indicated	Stationary Possibly increasing	Poor
East Greenland	50.0	2000–4000	60–120	100	No info	Stationary, Trend unknown	Very poor
TOTAL POPULATION ESTIMATE = 21,470 – 28,370							

Guidelines for the Polar Bear Specialist Group of the International Union for Conservation of Nature and Natural Resources (IUCN PBSG)

Statement of purpose

Following the first international meeting on polar bear conservation held in Fairbanks, Alaska in 1965, the IUCN PBSG was formed to coordinate research and management of polar bears on an international basis. In addition this group took on the role of developing and negotiating the International Agreement for the Conservation of Polar Bears and their Habitat (IACPB). That Agreement was signed in Oslo, Norway in May 1973 and came into effect for a five-year trial period in May, 1976. The Agreement was unanimously confirmed for an indefinite period in January, 1981. Article VII of the IACPB stipulates that: "The Contracting parties shall conduct national research programmes on polar bears, particularly research relating to the conservation and management of the species. They shall as appropriate coordinate such research with the research carried out by other Parties, consult with other Parties, on management of migrating polar bear populations, and exchange information on research and management programmes, research results, and data on bears taken." To meet the conditions of Article VII of the Agreement, the IUCN PBSG meets at 3–5 year intervals.

The PBSG has no regulatory function. Its main purpose is to promote co-operation between jurisdictions that share polar bear populations, facilitate communication on current research and management, and monitor compliance with the agreement. The PBSG is not an open forum for public participation, it is a technical group which meets to discuss technical matters which relate to the International Agreement for Conservation of Polar Bears. The deliberations and resolutions adopted by the PBSG are available to the public as are the published proceedings of the meetings.

Membership

The strength of the group has always been its small size. Because of the relationship of the PBSG to the International Agreement, membership must reflect not only technical expertise in polar bear research and management, but also equal representation of the nations signatory to the Agreement. For this reason, each nation is entitled to designate three full members. However, in matters which require a vote (e.g. elections and resolutions), each member nation is allowed only one vote. Each nation is at liberty to independently determine their process for casting a single vote. Only government-appointed members may vote. Government appointed members are chosen by their respective governments.

In addition to government appointed members, the chairman may, as per IUCN guidelines for membership in Specialists Groups, appoint five full members so long as they qualify as polar bear specialists. Full members appointed by the chair and government appointed members constitute the membership of the PBSG during the interval between meetings. The chair-appointed members are considered members until the election of a new chairman which occurs at the end of each meeting. In this way the number of members of the PBSG will not exceed 20.

A third category titled: "Invited Specialists" is recognized. These individuals are not considered full members, but are invited to participate in a given meeting or parts of the meeting as designated by the Chairman.

The intent of the group is to operate in a consensus manner but regular votes may be used when applicable. These guidelines are intended to maintain the integrity of the PBSG as a small working group of technical specialists on polar bears while still ensuring that it is responsible to the governments signatory to the IACPB, IUCN, and the international conservation community.

Resolutions

1. Thanks to the Greenland Fisheries Research Institute, Copenhagen, Denmark for hosting the eleventh working meeting of the IUCN/SCC Polar Bear Specialist Group

The IUCN Polar Bear Specialist Group

Recognizing that Article VII of the International Agreement on the Conservation of Polar Bears states that contracting parties shall exchange information on research and management programs, research results, and data on bears taken; and,

Recognizing that participation by all contracting parties and invited specialists contributed to the success of this meeting; and,

Noting the excellent organization, meeting facilities, support, and hospitality provided for its eleventh meeting, by the Greenland Fisheries Research Institute during its meeting in Copenhagen 25–27 January 1993;

Extends its sincere appreciation and thanks to the Institute.

2. Participation of users as invited specialists to meetings of the IUCN Polar Bear Specialist Group

The IUCN Polar Bear Specialist Group

Recognizing the increasing mandate of indigenous people with respect to management of polar bears in several jurisdictions; and

Recognizing the value and importance of traditional knowledge to the accumulation of scientific knowledge and management of polar bears; and

Recognizing the current and past contributions of traditional users to the research and management programs of the various nations signatory to the International Agreement for the Conservation of Polar Bears and its Habitat:

Therefore acknowledges the participation of northern indigenous people in this meeting of the IUCN Polar Bear Specialists Group and supports continued participation of northern polar bear specialists in the IUCN Polar Bear Specialists Group and in future research and management activities of polar bears.

3. Proposed opening of hunting of polar bears in Russia

The IUCN Polar Bear Specialist Group

Recognizing that the polar bear is a significant resource of the arctic region; and,

Recognizing that the International Agreement on the Conservation of Polar Bears and its Habitat requires that each Contracting Party shall take appropriate action to manage polar bear populations in accordance with sound conservation practices based on scientific data; and

Recognizing that the polar bear populations in some areas of Russia appear to have increased since the cessation of hunting in 1956; and

Recognizing that interest has been expressed by aboriginal people in the possibility of resuming harvesting of polar bears in Russia; and

Recognizing that Article III(d) restricts the harvesting of polar bears to local people using traditional methods in the exercise of their traditional rights and in accordance with the laws of that Party;

Hereby recommends that, prior to the initiation of any hunting in Russia, adequate scientific data on the sub-population concerned be collected; and

Further recommends that a management plan be developed, using sound conservation practices, providing for complete and ongoing monitoring, involving local aboriginal people, and, where applicable, in cooperation with other countries when shared populations are involved.

4. Environmental contaminants

The IUCN Polar Bear Specialist Group

Noting, that the International Agreement on the Conservation of Polar Bears and its Habitat requires each Contracting Party to protect the ecosystems of which polar bears are a part; and

Recognizing that anthropogenic global pollution, nuclear wastes, and offshore exploration activity, are having a detrimental effect on arctic marine ecosystems; and

Recognizing that because polar bears are at the top of the trophic pyramid they may be more affected by pollutants; and

Noting that disturbingly high levels of PCB concentrations have been found in the fat of polar bears in the Barents Sea and other areas, and that lesser but still substantial levels of PCBs and other substances have been found in the tissues of polar bears in other areas; and

While recognizing that detrimental effects resulting from such contamination have not been confirmed,

Therefore recommends that the levels of toxic contaminants in polar bears and the health of the bears be monitored by the Parties to determine trends and possible detrimental effects.

5. Restricting the sale of gall bladders from polar bears

The IUCN Polar Bear Specialists Group

Recognizing that the world-wide trade in bear parts, particularly of gall bladders, threatens the very survival of several species of bears; and

Recognizing that the legal availability of the gall bladders of any species of bear makes it impossible to control the traffic in illegally taken gall bladders and thereby encourages further illegal killing of all species of bears, including polar bears,

Hereby recommends, that each contracting party consider that an overall benefit to the resource and its users may be gained by restricting traffic in polar bear gall bladders.

Press Release

The 11th meeting of the IUCN Polar Bear Specialists Group was held in Copenhagen, Denmark 25–27 January, 1993, under the Chairmanship of Mr. Erik Born of the Greenland Fisheries Research Institute. Scientific delegates attended, representing each of the five circumpolar nations (Canada, Greenland/Denmark, Norway, USA, and Russia) signatory to the International Agreement on the Conservation of Polar Bears and their Habitats. Three indigenous hunters from Alaska, Canada, and Greenland, attended as invited specialists on traditional knowledge of polar bears.

The group reviewed progress on research and management of polar bears since the last meeting, held in Socchi, USSR, in 1988. Significant progress has been made in several areas. The extensive use of satellite tracking of female polar bears has made it possible to determine the boundaries of several relatively discrete subpopulations, some of which are shared by different countries and therefore require international cooperation to manage, as directed by the International Agreement on the Conservation of Polar Bears. For example, populations are shared between Russia and Alaska (USA), Canada and Greenland (Denmark), and Svalbard (Norway) and Franz Josef Land (Russia). It is essential to determine the distribution of each subpopulation before its size can be estimated. There appear to be about 15 subpopulations although the boundaries of some, especially in the vast unstudied areas of the Russian Arctic, have yet to be determined.

A review of the worldwide status of polar bear, based on available knowledge was conducted. The state of knowledge of individual subpopulations ranges from good to almost nothing. In summary, the world population of polar bears was thought to be between about 21,000 and 28,000. However, it is vital to remember that polar bears are distributed in geographically distinct subpopulations, each of which must be managed individually.

Hunting polar bears is an important part of the culture and economy of indigenous people throughout the Arctic.

However, because polar bears have low reproductive rates, sustainable levels of harvest are lower than in species such as caribou. Harvest levels in hunted populations must be set at very low levels to ensure that depletion does not occur. To be sustainable, the harvest should not include more subadult and adult females than about 1.5% of the population size.

Research on toxic chemicals indicated higher concentrations of PCBs in the vicinity of Svalbard than anywhere else in the Arctic. The reason for this is not understood. Fat samples have been collected from polar bears in a wide range of other locations throughout the Arctic for toxic chemical analyses but the results are not yet available. Concern was also expressed about the possible detrimental effects on the arctic marine ecosystem of nuclear waste dumping in the vicinity of Novaya Zemlya in the Russian Arctic. It is considered critical to continue to monitor polar bears to determine possible effects of man-made substances and activities.

Concern was expressed about the possible detrimental effects of climate warming on polar bears. Current models project the first and most significant effects will be detected at high northern latitudes and this will likely reduce the extent of sea ice. If the models are correct, then prolonging the ice-free period will shorten the period during which polar bears in many subpopulations are able to feed on seals and cause nutritional stress. Early signs of impact would include declining body condition, lowered reproductive rates, reduced survival of cubs, and an increase in polar bear–human interactions. Eventually, the seal populations would decline if the quality and availability of breeding habitat is reduced. Rain during the late winter may cause polar bear maternity dens to collapse, causing the death of occupants. Human–bear problems will increase as the open-water period becomes longer and bears fasting and relying on their fat reserves become food-stressed. Tourism based on viewing polar bears in western Hudson Bay will likely disappear. Should the Arctic Ocean become seasonally ice free for a long enough period, it is likely polar bears would become extirpated from at

Polar Bears

least the southern part of their range. Because the polar bear is at the top of the arctic marine food chain, and ice is an essential component of its environment, it is an ideal species through which to monitor the cumulative effects of change in arctic marine ecosystems.

Several priorities were identified as important for future research and management. These included

continuing to identify the boundaries and size of sub-populations; studying the effects of the harvest, and the effects of manipulating the sex composition of the harvest on populations; and the relationships between bears, seals, and sea ice conditions.

National Reports on Status and Research

In their status reports the nations and jurisdictions should address the following issues.

Status of polar bears in ... (country)

1. Population(s) (or management unit(s))

Short description and map of distribution (a: population/subpopulation borders; b: denning areas).

- 1.1 Population (subpopulation or management unit) borders (delineation). Evidence of exchange between populations, both national and/or international. Basis for and reliability of delineation of population(s). Short reference to method and source.
- 1.2 Size of population(s)(number of bears in population/ subpopulation/management unit). Basis of estimate (method). Reliability of estimate. Reference to source (coefficient of variation or qualitative rank: good, fair or poor).
- 1.3 Short note with data on (or consideration of) the influence of ecological changes (ice distribution, duration of ice cover, availability of food) on points 1.1. and 1.2. State of knowledge.

2. Harvest

- 2.1 Numbers taken by area (population, management unit) average of past 10 years for example (average, SD and range). Trends in number harvested. Reliability of numbers harvested. Reliability of information on harvest data (reporting). Methods: subsistence harvest, problem bears, sport hunts, other. Change in subsistence harvest strategies. Age and sex composition of harvest (most recent or representative. Quotas and/or recommended MSY (maximum sustainable yield). Recommended harvest strategy.

3. Management

- 3.1 Which jurisdiction responsible for management (reference to national law(s)). Very short summary of hunting and regulations particularly

referring to latest amendments and/or major changes.

- 3.2 Protection of polar bear critical habitats (e.g. denning areas). Short description and figure showing protected areas (reference to source).

4. Use and trade in polar bear products

- 4.1 Short summary of purpose of use (local vs. export).
- 4.2 Trade in products (e.g. hide, gall bladder, other). Listing of past 10 years' export of products (and country of import under national CITES permits). Trends in export, information on change in market and/or prices. Information on illegal trade.

5. Other impact (current or potential) on polar bear populations

- 5.1 Short summary of status of exploration for and exploitation of various resources. Other human disturbance (pollution).

6. Status by population/area

- 6.1 Based on above information a status category is applied to each population/subpopulation/management unit: unchanged, increasing, declining, unknown. Basis for categorization to be stated briefly.

7. Evaluation of how national (international) management of polar bears complies with the intentions of the articles in the "International Agreement on the Conservation of Polar Bear and their Habitat"

8. Identification of major gaps in knowledge

9. Listing of references (used in the review)

- 8.1. Listing of major gaps in knowledge to ensure the sustainable management of polar bear populations.
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Research on Polar Bears in Canada 1988–92

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Most polar bear research in Canada is conducted by Federal, Territorial, and Provincial governments. This is largely because of the cost involved, but also because of the management responsibilities of those governments. Often, several agencies cooperate on a large research project. Some research projects, conducted by university researchers, are coordinated with government research through bilateral discussions and through the Federal-Provincial Polar Bear Technical Committee (PBTC). This report summarizes the research conducted, and lists reports completed, between 1988 and 1992.

Cooperative Studies

Studies of physiology, fat, and fat metabolism

Malcolm Ramsay (University of Saskatchewan) has been the research leader for many of these studies, with the collaboration of Dr F. Messier (University of Saskatchewan), Dr R.A. Nelson (Carle Foundation Hospital, Urbana, Illinois), Dr Y. Plante (Saskatchewan Research Council, Saskatoon), Dr C.M. Pond (The Open University, Milton Keynes, U.K.), Dr I. Stirling, Dr M.K. Taylor, Dr C. Robbins and Mr. S. Farley (Washington State University) and Dr S. Arthur (US Fish and Wildlife Branch). In addition, two of Ramsay's students, J.Y. Arould (M.Sc. 1990) and K.A. Hobson (Ph.D. 1991) have worked on aspects of the research. Funding for research on fat and fat metabolism was received in 1989–91 from the National Science Foundation in the US.

Ramsay's long-term research plan is directed to understanding the ecological and physiological importance of fasting on the life-history attributes of mammals and birds. One of the major difficulties facing endothermic animals inhabiting seasonally variable environments is fluctuating food supplies. For large mammals, an important adaptation during periods when food is unavailable is reliance on previously-accrued body-lipid stores for metabolizable energy. Although the phenomenon of regulated weight change and fasting in homeotherms has been well documented, remarkably little is known about its adaptive significance in free-ranging terrestrial mammals.

The immediate research goal is to identify the morphological, allometric, and physiological adaptations that allow free-ranging polar bears to undertake extended fasts. Polar bears are the most carnivorous of the Ursids, preying mainly on ringed seals and to a lesser extent on bearded seals. Conditions on the sea-ice dictate seal distribution, abundance, and susceptibility to predation by polar bears. The frequency with which polar bears capture prey is incompletely known, but is seasonally irregular. In late spring and early summer, polar bears become hyperphagic and accumulate, in a relatively short time, the nutrient reserves required to meet their growth and maintenance needs during much of the rest of the year. During their hyperphagic phase polar bears often consume only the blubber layer of their prey and leave the lean body mass relatively untouched. The diet of polar bears may thus contain the highest proportion of lipids of any mammal. Polar bears undertake some of the most extreme fasts known for any terrestrial mammal and, consequently, display impressive metabolic adaptations to fasting.

Weight changes

Large weight losses are experienced by polar bears when on land during summer and autumn. Determining the dynamics of these weight losses, the associated intermediary metabolic processes involved, and changes in body composition are major goals of this research.

In 1990 and 1991, 90 and 30 individual bears respectively, in different reproductive classes, were sampled serially during the time spent on land in NE Manitoba. All bears lost weight over the period of study. The mean weight loss for adult males was -1.1kg/day, for solitary adult females -1.0kg/day, and for females with accompanying cubs -0.7kg/day. Extrapolated over the period spent on land (late July–November), adult males lost 27% of their body mass, solitary adult females 38%, and females with cubs 43%.

For the family groups handled on two occasions, females with accompanying cubs-of-the-year (COYs) lose weight at a somewhat faster rate (mean rate of -1.3kg/day) than do females with accompanying yearling cubs (mean rate of -0.9kg/day). This probably reflects differences in lactational demands by cubs of different ages.

Even though all bears handled on two occasions lost weight between captures, cubs continued to increase in length. It is noteworthy that COYs increased their body length by 5% and head length by 2% during the time that they declined in weight by 8%. No other class of bears showed comparable growth in size, although yearling cubs did increase in body length by about 1% between captures. Continued morphological growth during a period of food scarcity underscores the considerable nutritional stress that younger bears experience relative to adult bears during the time on land. Realizing that the sample sizes are small, it is notable that the two adult males and the adult female recaptured in autumn only declined by about 4% in body weight over a three-week period, whereas both cubs and adult females with cubs lost more than double that amount over a similar period of time.

When changes in the Corpulence Index ($CI = \text{Weight}/\text{Length}^3$) are plotted over an annual cycle, polar bears show distinct patterns of body fat storage. Adult males show the least change in fatness over the course of a year while solitary (and presumed pregnant) adult females show the greatest change.

Polar bears undertake extensive fasts during the time that they are on land in Manitoba. A pregnant female is forced ashore by the melting sea-ice in late July and will not return to the sea-ice until the following March after 8 months of fasting. During the time on land polar bears eat very little and are, therefore, critically dependent on their body fat stores. Earlier studies have shown that fasting polar bears recycle nitrogenous wastes from protein catabolism and, presumably, maintain themselves entirely through fat catabolism. Thus, the amount of adipose tissue that pregnant or nursing females accrue before beginning their on-land fast is of great importance. Lactating females do not fast as long in summer/autumn as do pregnant bears. They do, however, have to use their fat reserves to meet the nutritional demands of their nursing cubs. Lactating females presumably accrue smaller fat reserves than pregnant females during the peak feeding period in late spring because they have to meet the nutritional requirements of their growing cubs as well as their own needs, whereas pregnant females can consume all of their prey themselves.

Analyses of NOAA satellite imagery show that the timing of sea-ice melting varies greatly among years. Presumably, similar variation occurs among years in the timing of ice formation. The amount of time that bears spend on shore each year can vary by 10% or more. Thus, the variation in duration of imposed fasting, coupled with yearly variation in the amount of stored fat that bears have when they first come ashore in summer, implies that the polar bears of Manitoba might be expected to experience marked differences between years in the extent of their fat reserves at the end of the on-land period.

If anthropogenic global warming occurs in the near future, sea-ice formation and melting will be strongly affected. One consequence will be longer tenure on land in north-east Manitoba by the polar bears of western Hudson Bay. Longer on-land tenure will increase the likelihood of severe nutritional stress.

There now is some direct evidence that animals that fall below a minimum amount of body fat experience significant physiological effects. Females captured in the Manitoba denning region in late March are, on average, less fat than females captured in early March. This inverse correlation of fatness with date presumably reflects depletion of adipose tissue stores with

increased duration of fast. Most females emerging from overwinter dens have serum ratios of urea to creatinine (U/C) less than 10, indicative of protein recycling and facilitated fasting. Those females, however, that have a CI of less than about 20 show elevated U/C ratios, suggesting that they have such limited fat reserves that body protein stores begin to break down irreversibly.

By early November, some bears have reached a CI of 20 or less. Therefore, even bears that do not undertake the extended overwinter fast of pregnant females might, in late autumn, reach levels of body adipose tissue stores that are so low that they might be unable to maintain the facilitated fasting state for much longer. Bears that begin to break down body protein for maintenance requirements might be more likely to enter a human settlement to find food as well as be at increased risk of starvation and disease.

Terrestrial feeding

Although behavioural observations suggest that polar bears feed little when on land, the data are not definitive. An innovative test to determine whether an animal has been feeding on a terrestrial or marine food web is to measure the stable carbon isotopic composition of its tissues. The basis for this method is that the isotopic signature of carbon (^{13}C) incorporated by photosynthetic pathways differs characteristically between terrestrial C-3 and marine ecosystems and this difference is maintained through successive trophic levels in both food webs. The seal species that polar bears prey on feed entirely within a marine food web. If polar bears feed exclusively on seals, therefore, their tissues will have a stable carbon isotope signature characteristic of a marine system. If, however, they obtain a significant amount of food when they are on land in a C-3 biome, then the carbon isotope signature of their tissues will reflect that diet. In 1990, Ramsay analyzed small amounts of muscle and bone tissue from polar bears and ringed seals killed by native hunters, and analyzed them for their ^{13}C signature.

The mean stable-carbon isotope ratios ($\delta^{13}\text{C}$) for polar bear tissues (bone collagen, -15.7‰ , muscle; -17.7‰ ; fat, -24.7‰) were close to those of the same tissues from ringed seals (-16.2‰ , -18.1‰ , and -26.1‰ , respectively). The $\delta^{13}\text{C}$ values for four species of fruits to which polar bears have access when on land in summer ranged from -27.8 to -26.2‰ , typical of terrestrial plants in the Arctic. An animal's $\delta^{13}\text{C}$ signature

reflects closely the $\delta^{13}\text{C}$ signature of its food. Accordingly, the amount of food that polar bears consume from terrestrial food webs appears negligible, even though some bears spend four months or more of each year on land during the seasons of greatest primary productivity.

Adipose tissue dynamics

The gross masses of intra-abdominal viscera and superficial and intra-abdominal adipose tissue were compared in 41 randomly-obtained species of carnivores. The mass of the intra-abdominal viscera scale as: (lean body mass) $^{0.76}$. In a sample of 28 Carnivora native to the tropics or the temperate zone, in which dissectible adipose tissue is more than 8.5% of the total body mass, superficial adipose tissue scales isometrically to lean body mass, but intra-abdominal adipose tissue increases as (lean body mass) $^{0.74}$. Comparable measurements from 13 adult and subadult wild polar bears fit these allometric equations, indicating that the partitioning of adipose tissue between internal and superficial depots can be fully explained by the fact that they are larger and more obese than most other Carnivora. There is no evidence for adaptation of the gross anatomy of adipose tissue of polar bears to their semi-aquatic habits or arctic habitat.

The actual site of lipid storage in adipose tissue is in adipose cells (adipocytes), which are distributed in discrete anatomical sites. Adipocytes are numerically and volumetrically variable. Their size and number in a given depot reflect the age, sex, diet, and activity levels of the mammal (Pond 1985).

Polar bears can have annual changes in body mass of three-fold or more and can reach seasonal levels of obesity that exceed 50% adipose tissue. When prey are abundant and the opportunity presents itself, polar bears become hyperphagic. During these hyperphagic periods they may eat the superficial adipose tissue from their prey preferentially and thus amass large amounts of lipids in a relatively short time. Most of this adipose tissue is superficial and in sites from which a tiny biopsy sample can be taken. The relative sizes of adipocytes among depots do not vary with fatness of the bears, hence tissue samples from a single adipose depot allows one to monitor variation in all adipocytes.

Whereas females with cubs, adult males, and juveniles all showed a slight decline in adipocyte volume with season, solitary adult females did not. From this and other metabolic information, it is clear that the

adipose tissue of pregnant female bears has metabolic properties different from that of non-pregnant bears. These studies will be more fully developed as the data are processed.

Energetics of lactation

Aspects of the energetics of lactation in polar bears were studied in the Canadian Arctic. Milk yield was determined by a hydrogen isotope dilution-transfer method in females with cubs-of-the-year and females with yearlings during the summer ice-free period in western Hudson Bay. Females with COYs produced significantly more milk energy (10.4 MJ/day) than females with yearlings (2.6 MJ/day). Daily milk production represented a significantly greater proportion of the total body fat and protein reserves in females with COYs (<0.3%) than in females with yearlings (<0.8%). However, milk yield was not correlated with maternal body condition in either group of females nor were changes in body composition correlated with milk production. During the on-land period, milk production is not directly constrained by maternal body composition, at least within the range of body compositions observed.

Milk energy intake was correlated with metabolic size ($\text{kg}^{0.83}$) in COYs but not in yearlings. COYs consumed significantly more milk energy (7.5 MJ/day), and maintained a higher relative linear growth rate (0.22%/day), than yearlings (milk intake, 1.5 MJ/day; growth, 0.03%/day). However, cubs of both ages lost proportionally the same amount of mass, suggesting COYs are less able to survive nutritional restrictions than yearlings. Growth rate was not correlated with milk fat, protein or energy intake in either cub age class.

Patterns of serum urea and creatinine

Nelson *et al.* (1984, *Science* 226:841) proposed that the physiological state of black bears during their prolonged winter fast is characterized by a reduction in the ratio of serum urea to serum creatinine (U/C) from typical mammalian levels to values lower than 10. Although many species of mammals undertake fasts of long duration at specific times in their lives, usually when other behaviours preclude feeding or when food is unavailable, the decline of U/C when fasting to less than 10 has not been reported in other mammal species.

Values of serum U/C lower than 10 were measured in 8% of polar bears (25 of 315) on the sea-ice in spring,

11% of bears (6 of 55) near a refuse dump in autumn, 30% of bears (48 of 158) on land in summer, 65% of bears (99 of 152) on land in autumn, and 78% of females (42 of 54) emerging from dens in spring.

Thus, at any time of year, some polar bears are able to achieve low values of serum U/C. Furthermore, mean U/C values are clearly correlated with feeding opportunities. When food was readily available, (e.g. on the sea-ice in spring or at a garbage dump), serum U/C values were elevated in a large proportion of the animals sampled whereas when prey were unavailable during tenure on land the mean serum U/C value was low. If the underlying physiological processes accounting for low serum U/C values are similar between polar and black bears, then our findings imply that some polar bears are capable of recycling urea and conserving lean body mass whenever feeding opportunities are limited. At any season, therefore, some polar bears appear able to switch facultatively to a physiological state of facilitated fasting in response to the absence of suitable food items. This is in sharp contrast to black bears, which can only undertake extended fasting in certain seasons.

The lowest mean U/C values of any of the sampled groups were found in adult females recently emerged from winter dens with newborn cubs. Although the mean U/C value for these bears was less than 10, individual values were spread over a five-fold range (0.7–33.3). Their U/C values, however, showed a conspicuous inverse correlation with body weight.

A pregnant polar bear enters a den in autumn and fasts until the following spring. All energy and substrates required for gestation, lactation, and maintenance must come from body-tissue stores accrued prior to the fast. The low U/C values found in adult females after emergence from their winter den is consistent with the hypothesis that they are recycling nitrogenous wastes and conserving lean body mass during their fast. Female polar bears have determinant growth and reach adult body length by the age of first reproduction. Thus, variation in adult body weight very likely reflects variation in body composition among individuals, including the variation in adipose tissue depots. The observed inverse relationship between body weight and U/C ratio, therefore, suggests that females that weigh less than about 150kg may have insufficient energy reserves to maintain protein conserving mechanisms throughout their fast.

Respiratory quotient

Samples of expired air were collected from most bears handled by Ramsay and his co-workers in 1989 and 1990, then subsequently assayed for CO₂ and O₂ concentrations. From these data, a respiratory quotient can be determined for each sampled bear. Although there is a great deal of scatter, mean R.Q. values were 0.7 or less. Values this low imply that lipids are the principal nutrients being metabolized, supporting our contention that most bears in summer and autumn are fasting and maintaining themselves on their fat stores.

Field studies were primarily conducted to determine body composition of animals at different times of their annual cycle.

Body composition

An estimate of body composition was made for 31 bears by determining the dilution of a precisely measured volume of stable-isotope (D₂O) labelled water. By combining the data on body composition collected since 1989, one can see readily that percent body-fat (%BF) declines during the time spent on land. Mean %BF drops from about 45% in early August to less than 20% in November. The latter value is similar to that seen on the sea-ice in spring.

Virtually all of the weight loss of bears on land appears due to a reduction in adipose tissue depots; lean body mass remains constant throughout the sampling period. These data offer powerful support for the hypothesis that bears on land in Manitoba are in a physiological state similar to a hibernating bear such that urea from protein catabolism is recycled back into protein, resulting in a net sparing of muscle mass. Energy expenditures are met by catabolism of lipids in the adipose tissue.

Very small adipose tissue reserves (<10% BF) are seen during the on-land period in some animals, particularly cubs and lactating females. Such animals are particularly susceptible to starvation and, presumably, would be adversely affected by human activities that cause them to increase their energy expenditures during the on-land period.

Stable isotope analysis of claws

Possibly because of the dynamic nature of sea-ice, individual bears do not maintain discrete home ranges

but instead travel over large regions annually in search of their prey. In order to delineate polar bear population boundaries, managers have carried out extensive mark-recapture programs, hunter tag-return programs, radio-telemetry programs, satellite telemetry programs, and other expensive monitoring methods. None has been fully successful in delineating discrete boundaries among populations.

Carbon and nitrogen enter marine food chains with characteristic ¹³C/¹²C and ¹⁵N/¹⁴N ratios through uptake by marine phytoplankton of bicarbonate and nitrates dissolved in seawater. A major and characteristic fractionation or change in these isotope ratios occurs during photosynthesis and during metabolism and storage at each higher trophic level. Each tissue type has its own characteristic fractionation factor relative to the whole diet. Because protein and lipid macronutrients in the diet are usually assimilated in kind within the consumer, however, isotopic pathways for each macronutrient are evident throughout the food web.

Fractionation values between trophic levels for each macronutrient are not well understood. For proteins, either in the form of muscle tissue or skin collagen, ¹³C/¹²C and ¹⁵N/¹⁴N values appear to be enriched by about 1% and 3%, respectively. If there are characteristic isotopic differences among geographic sites, then the measurement of both ¹³C/¹²C and ¹⁵N/¹⁴N values in consumer tissues should, in theory, allow statistical segregation of animals based on their geographic location.

Isotopic analyses of claw samples collected from most polar bears handled in zones E1 and F since 1989 are continuing. Initial results indicate that, for the Canadian Arctic at least, no significant variation in isotopic signature occurs along a growing claw for any individual bear. Thus, a single sample from a claw tip appears sufficient to supply the isotopic signature of that animal. Furthermore, a cline in claw isotopic values is evident from the Beaufort Sea to Lancaster Sound, with claw tissue from more western bears showing significantly more enrichment.

Although stable isotope analysis is unlikely to supersede routine methods of population delineation, it should prove to be a useful adjunct method.

Mercury levels in hair

Hair samples (<0.5g) from the animals handled were assayed for total mercury load and also for organic

mercury levels. For all bears, the level of mercury burden of bears in Hudson Bay was low: significantly lower than for hair samples taken from the High Arctic (2.9ppm vs. 13.8ppm respectively; $t = 13.2$; $P < 0.001$).

Analyses of mtDNA

Variation in mitochondrial DNA (mtDNA) has been applied widely to mammals to examine geographic patterns of population dispersal and gene flow. Two characteristics of mtDNA make it particularly suitable for insight into population structure: (i) it has a relatively rapid rate of evolution; and (ii) it does not undergo recombination. If discrete populations of polar bears occur in the Canadian Arctic, with limited gene flow between them, then mtDNA analysis offers a good possibility of delineating their boundaries.

In 1990, Ramsay and his co-workers collected mtDNA samples from 50 bears (25 from the western Canadian Arctic and 25 from western Hudson Bay). These samples were cut with 31 different restriction enzymes for a total of 1550 runs. Two polymorphisms were detected for each of two restriction enzymes. In both cases the rare haplotype was found in only one bear, the same bear in both cases. The two restriction enzymes with which polymorphisms were detected were used to test an additional 60 bears (30 from each region). No further polymorphisms were detected.

Three nuclear DNA "fingerprints" were used to determine the degree of genetic heterogeneity within the polar bears of the Canadian Arctic. All three analyses, each using 16 bears from each region, gave similar results. The probability of two randomly selected polar bears having identical DNA fingerprints was $1:5.5 \times 10^5$. This is several orders of magnitude higher than that found in many other mammal populations, including humans.

The tentative conclusion is that polar bears show a remarkable genetic homogeneity. The reasons for this are unclear but may have important implications for long-term conservation of the species. In the short-term, however, mtDNA analysis appears to hold little hope of delineating functional subpopulations for management purposes. The rate of mutation calculated from some samples in Alaska was also very low.

Availability and assessment of Telazol

In 1990, A.H. Robbins, the manufacturers of Telazol, were bought by Ayerst McKenna and Harrison Inc. (1025 Boul. Laurentien, St-Laurent, PQ, H4R 1J6; phone Leo Conway or Marilyn Mountford 514-744-6771). Because dried Telazol powder is reported to have a shelf life of 18–24 months, they do not wish to hold a large supply that may become outdated while waiting for orders. It would be helpful if each project contact Conway directly with a projection of their needs and time-frames, to ensure they are able to get what they need in time. Costs are approximately \$18+GST/500 mg dry. Telazol is still classified as an experimental drug in Canada. Agriculture Canada (Janet Knowlton, ph. 613-957-3882) will give an emergency drug release number.

Telazol is the only drug available that is safe for both bears and researchers, and is sufficiently cost-effective to allow capture of the large numbers that are needed for population studies. In the US, it is a controlled drug, with no requirement that the meat never be eaten, but in Canada it is still a Class 2 drug, which means it has not been adequately tested and should not be used if the animal is likely to be eaten. Management of polar bears is based on the research done with Telazol, but if people cannot eat animals that have been drugged, then it may be much more difficult to do the research. Ramsay and a summer assistant had collected some information on clearing rates that suggests that the drug is metabolized to safe levels within 48 hours.

A proposal to examine the longevity of the components of Telazol in polar bears was developed in 1991. This work involved immobilization and subsequent sacrifice of up to 14 polar bears in the Resolute area. The Resolute HTA offered to support this work by providing at least 10 polar bear tags so that the experiment would not result in any additional mortality for the population. Resolute hunters would do the shooting and the pelt would be kept by the hunter. This would also provide an opportunity for systematic tissue sampling to determine contaminant distribution.

The protocol for the drug study was provided by Dr Bill Drennan of Health and Welfare Canada. Dr Ross Norstrom provided the guidance on the tissue sampling and will conduct the contaminant assays. Malcolm Ramsay is project leader for this work and will supervise the field portion of the study.

Ringed seal populations in Hudson Bay

The physical condition of polar bears in western Hudson Bay has declined for several years but we know little of the seal population they depend upon. From the preliminary results of satellite tracking of female polar bears from Zone A1, it is clear they spend most of their time offshore of the area between about the Nelson River, Manitoba, and Rankin Inlet, NWT. Prior to trying to plan more detailed work on polar bears, a cooperative study on ringed seals was undertaken between CWS, the HTA in Arviat, and Rob Mulders, the Regional Biologist at Arviat. The objective is to begin a monitoring study of the age structure, reproductive status, and condition of seals harvested by Inuk hunters at Arviat.

Specimens of seal jaws (for age determination), stomach contents, and reproductive tracts were collected in spring and autumn 1991 and 1992. Mulders and the HTA coordinated the specimen collection. CWS is analyzing the data and will provide a summary report in collaboration with Mulders. More research is planned for the seal population, in relation to the polar bear population in Zone A1.

National polar bear database

In 1988, the mainframe computer at the University of Alberta was still used for storage of the whole database, but increasingly more of the entering, editing, and analyses were done on personal computers at the CWS laboratory. NWT entered the kill records and their capture data in Yellowknife, then exchanged data tapes with CWS. Work began in late 1988 on developing the software necessary for transferring the whole database to microcomputers.

By 1990, the mainframe at the University of Alberta was used only for backup of database files and for some of the larger data manipulations. Most of the entering, editing, and analyses were on microcomputers. The software necessary for transferring the database to microcomputers had been written, and modifying existing database management software continued.

Entry, edit, extraction, and report generation of the main database in Edmonton were developed with Advanced Revelation database management software. This is a powerful program, also used by the Nature Conservancy and its cooperators for the largest

ecological database in North America, but it requires a large investment of time to design each new database. During 1990, all zone files were converted, and working versions of entry, edit, and report programs were developed. Improvements will continue to be made to these programs, and others written to improve access to the data, but about half the work is now completed.

During 1990, NWT eliminated use of their mainframe for data storage and analysis. All data processing is now done on PCs, using dBASE as the standard for database management. The NWT mark/recapture and hunter-kill data from both the NWT and Québec continue to be entered into a PC as they are collected, then edited and corrected. A Hardcard is used for weekly automated backups. Optical backup diskettes are kept in a safe for extra security. The information is then sent by tape and floppy disk to Edmonton for incorporation into the master database. The Advanced Revelation package CWS use is compatible with the dBASE III+ software used by the NWT on their microcomputers. Manitoba sends all data sheets on bears handled as part of their Polar Bear Alert Program, and any teeth collected, to CWS for entry and processing.

By 1992, programming of Revelation had progressed, so that extractions for data analyses with other software packages, for export to other jurisdictions, and for production of summary reports such as field books, would be easier.

Prior to the 1992 PBTC meeting, staff from NWT met with CWS to formalize a data exchange protocol, so that a second national database archive in Yellowknife will complement the one currently maintained by CWS. CWS and NWT have agreed on an annual schedule for updating the central database in Edmonton with kill and capture records from the NWT each September, then updating (overwriting) the subset file in Yellowknife each January. Error corrections will be summarized once a year, with the data exchange. The rules for access to the shared database will remain the same. Data belonging to others cannot be accessed or used for publication without written permission. Extraction of data for management purposes does not require written permission, but would normally involve verbal approval. Data extracted for management purposes cannot be published.

All of Canada's polar bear populations are within or shared with the Northwest Territories. Having regularly scheduled updates of data should enhance NWT's

Polar Bears

ability to determine the total kill on these populations and summarize the available information for management discussions.

There was also a discussion of standardizing the format and medium for data from satellite collars. Currently, there are various methods of dealing with the data: they are received as a hard-copy printout, downloaded intermittently from other computers, or mailed regularly on a floppy diskette. The consensus of most participants was to maintain the data on disk, but to continue consultations on the best method of editing, formatting, and ensuring compatibility. No final agreement was reached on the development of a single database, nor on what data should be archived from material that continues to be received or has already been received.

The 'Quickmap' digitizing/mapping program developed by ESL, Victoria, is used by NWT for all their distribution maps. It uses data from dBASE III+, works best on a 386 PC with at least 16MHz, and costs about \$700 for a site licence. CWS have begun to use Quickmap for some of their analyses of satellite locations.

Single agency research

Canadian Wildlife Service (CWS)

Continued budget cuts have decreased the number of projects in which CWS can participate. Marc Cattet completed his studies on evaluating the physical condition of polar bears and submitted his thesis papers for publication in 1989. Lois Harwood also completed her Master's degree study of ringed seal distribution during the open-water season in the Beaufort Sea in 1989. The locations of feeding concentrations of seals are similar to polar bear feeding areas in winter. Data from this study complements ongoing CWS studies of the relationships between polar bears and seals in the Beaufort Sea.

Studies on the biological importance of polynyas to polar bears and overwintering marine mammals continued at the Dundas Polynya from early February to early May 1989, and concluded for the present after a short field season from mid-February to early March 1990. Becky Sjare collected data on the vocalizations and behavioural ecology of walrus wintering in the polynya during four late-winter seasons, as the basis of a Ph.D. thesis. There has not been any field work at Dundas Island in 1991 or 1992.

At the 1989 IBA Conference, Calvert and Stirling summarized observations of interactions between polar bears and overwintering walrus in the area of the Dundas Polynya.

Studies of bear behaviour at Radstock Bay on Devon Island in April and May 1990 were very productive, with many good observations of all age- and sex-classes and of breeding and hunting behaviour. This study has been a continuing, but low, priority for CWS for many years; it did not continue in 1991 or 1992.

An analysis of DNA in blood samples collected in several areas of the Arctic over several years has been initiated in cooperation with the University of Alberta. Eventually, they hope to examine the relatedness of litter-mates and the contribution of individual breeding males to sampled litters. The low variability of polar bear DNA and the difficulty of sampling all possible parents will complicate this.

Analyses and writing are continuing on studies of subpopulations in Zones A1 and H, and proposals have been submitted for studies of polynyas, polar bear and seal populations on the ice of Hudson Bay, behavioural studies at Radstock Bay, and in the area jointly-managed by NWT, Québec, and Labrador. The availability of funding under the Arctic Initiatives Program of the federal Green Plan is still unknown.

LIA satellite radios in Labrador

A cooperative project with the LIA began in spring 1991 to study seasonal movements of polar bears off the Labrador coast. The hunters have reported that they encounter more bears than before, but this may be due to improved transportation, not a population increase. The LIA wishes to play a role in collecting data that may help to delineate subpopulations and eventually help in making decisions about cooperative management with other jurisdictions. Twelve bears were captured in April 1991, and two satellite radios were attached to adult females off the coast of Labrador. One radio transmitted for only one week. The other did not operate properly, but gave some locations. Telonics, the manufacturer, believe the problem could be with a switch or with chips not fully seated in their sockets. In the future, the chips will be soldered.

Andriashek deployed four new satellite collars in April 1992. All four are still transmitting. Twenty-two polar bears were captured in 1992.

Western Hudson Bay

The intensive population ecology studies begun in 1987 in western Hudson Bay have continued, with an emphasis on

- 1) age- and sex-specific survival rates of polar bears in the population and factors affecting the survival of cubs and subadults;
- 2) annual productivity and yearly cohort strength of the population;
- 3) size and trend of the study population and how these might affect survival and reproductive rates;
- 4) the fidelity of reproducing adults to their natal area, and the long-term reproductive patterns of adult females;
- 5) variations in the weights of polar bears in the population; and
- 6) collections of milk and fat specimens for toxic chemical analyses.

These studies were the basis of Ph.D. research by Andrew Derocher, who completed his degree in 1991.

Determining where polar bears feed on Hudson Bay will help in planning future studies on the biology and distribution of ringed seals in relation to polar bear populations and reproductive parameters.

During spring 1988, 40 adult females with COYs and one lone adult female were handled. The recapture rate of these adult females was 59% (24 of 41). The mean litter size of COYs was 1.82. Fourteen radio-collars were deployed on a representative sample of adult females.

During the autumn field season, the emphasis of the capture program was to obtain as large a representative sample of the population as possible. The objective was to obtain a random sample, proportional to density, and to ensure maximum coverage of the study area. Of the total of 307 bears handled, 52% were previously handled (61% if COYs were excluded). The sex-ratio was 0.88:1 (144 males:163 females).

Ten of the 14 radio-collars deployed in the spring were found in the autumn, including one that had been

dropped. Another five females handled in the spring with cubs were recaptured, giving cub survival information on 14 of the 40 families handled during the spring. The estimated spring-to-autumn survival rate of COYs was 50% (15 of 30 cubs still with mothers). Whole litter loss was seen in four of the 14 families (29%) and three of these females appeared to be pregnant again.

Only 28 females with COYs were handled in autumn 1988. This contrasts sharply with the 49 found during 1987 with a similar sampling intensity and design. Conversely, 26 family groups with yearlings were handled, 10 more than in 1987. Only one bear was field-aged as a lone yearling. If females were following the two-year breeding cycle reported for 40% of the females by Ramsay and Stirling (1988), then there should have been many more lone yearlings in the sample. The prevalence of a three-year breeding cycle for most of the females in the population in 1988 could be explained by two hypotheses. The first is that conditions were generally good, resulting in a very high survival rate for the 1987 cohort and a large number of yearlings remaining with their mothers. The second hypothesis is that the conditions on the sea-ice were poor, resulting in females keeping their cubs and not breeding in 1988. To adequately assess these two hypotheses, the weight and condition of bears in 1987 and 1988 will have to be compared to the long-term means.

Bad weather limited the tagging operations in March 1989 to 10 out of a possible 30 days. Females appeared to be in poorer condition than in previous years. Female weights (mean=124kg, SE=5) were the lowest seen since spring tagging began in 1980. In total, 23 families were handled including 49 COYs. There were two litters of single cubs, 16 with twins and five with triplets, giving a mean litter size of 2.1 cubs/litter. This was similar to other years. Two lone adult females were also caught in the denning area.

The weights of COYs were similar to those of previous years (mean=10.1kg, SE=0.5). The sex-ratio of COYs was 0.75:1 (21 females:28 males). The recapture rate for adult females was 92% and was markedly higher than the rates of 44% and 59% for the spring in 1987 and 1988, respectively. Fourteen conventional radio-collars were deployed on adult females with COYs to help determine COY survival through to autumn.

In September and October 1989, 302 bears were caught. The recapture rate, including COYs, was 67%. The recapture rate of adult groups was much higher

(e.g., 97% recapture rate for adult females with COYs). The proportion of lone adult females (49%) out of all adult females was higher than the 25–35% seen in previous years. It is possible that many of the females in poor condition in the spring lost their cubs. Females with COYs composed 31% of the adult females handled and females with yearlings made up the remaining 20%. As in the previous three years, the number of lone yearlings was moderately low at 23% of the yearlings handled (9 of 39). Therefore, most females are now on a three-year breeding cycle.

All but one of the 14 radio-collars deployed in the spring were relocated. The COY survival rate from the spring to the autumn was only 44% (12 of 27) and total litter loss was seen in 38% of the females (5 of 13). Additional autumn mortality of two litters of COYs brought the total litter loss to 54% and COY mortality to 67%. Both of these mortality rates were greater than in previous years.

Bears were in similar condition in autumn 1989 to those captured in the previous two autumns. The most marked changes noted were the large number of pregnant females and the high cub mortality from the spring.

Poor weather conditions throughout the 1990 spring field season resulted in a sample of only 12 females with COYs (mean litter size 1.5 cubs/litter) and two solitary females. Only one of the females had not been handled previously. Conventional radio-collars were placed on the twelve females with cubs. The mean weight of adult females was 159 kg (SE=5, n=12). The mean weights in the early 1980s ranged between 185 and 199kg.

During autumn 1990 studies, 179 bears were immobilized with no mortalities. The recapture rate of all bears was 68% (n=179) or 88% for all bears older than one year. Ten of the 12 radio-collars deployed in the spring were relocated and 11 of 14 radio-collars deployed on adult females in 1989 were removed.

The survival of COYs from spring to autumn 1990 was 62.5% (n=16), somewhat higher than in 1988 and 1989 (47.1% and 42.9% respectively). During the autumn, 47% of all adult females (n=85) were accompanied by COYs, 49% were alone, and 4% were accompanied by yearlings. The low proportion of females with yearlings indicates high mortality in the 1989 cohort. Litter sizes of females with COYs were similar to the long-term average of 1.5 cubs/litter. The sex-ratio of COYs was only 32% male, but was not significantly different from 50:50, given the sample size.

Blood serum samples collected were analyzed to determine progesterone levels in solitary adult females. The pregnancy rate was 94.3% (n=35), within the range of 82.4% to 100.0% determined as pregnant by this method between 1982 and 1989.

The weights of bears in all age and sex classes in 1990 were similar to 1989, but still lower than in the early 1980s. The declining trend in weight over the length of the study is significant for 15 of 16 age- and sex-classes in the population. The rate at which weight declined (regression slopes) varies from 1.1kg/year for male COYs to 6.1kg/year for adult males more than eight years of age. Adult females with cubs have lost an average of 2.9kg/year. Solitary females, most of which are pregnant, have lost an average of 2.8kg/year.

Milk and fat specimens were collected from a sample of bears to monitor the toxic chemical load. This project is coordinated by Dr Ross Norstrom of the Canadian Wildlife Service.

Twenty-six adult females and 50 cubs were handled in spring 1991. One handling mortality occurred due to poor dart placement. The two cubs from this female were adopted out to other mothers, but were not with those mothers in autumn. Overall, cub mortality was high in 1991.

The recapture rate was 92% (n = 26) and the ages of females ranged from 6 to 27 years. Average litter size was 1.92 cubs/litter, similar to the long-term average. Mean weight of females was 158kg (SE = 5) and was similar to that of the previous four springs, but 30–40kg lighter than the early 1980s. Five satellite collars and 20 conventional radio-collars were deployed as planned. Milk and fat specimens were collected from some bears to continue monitoring of toxic chemical loads.

In autumn 1991, all five satellite collars from the spring were recovered and two new collars deployed. Several old conventional radio-collars were removed. All bears were immobilized using Telazol and no handling mortalities occurred. Fat and milk samples were collected for toxic chemical analyses. Of particular interest were the samples collected from females with cubs that had been handled in the past. These samples allow us to determine transfer rates of toxins. In addition, samples were collected from bears handled in the past so the effect of condition on toxin load can be determined. Blood samples were collected from females

without cubs to monitor pregnancy rates. A paper on pregnancy rates and progesterone levels has been accepted for publication by the *Canadian Journal of Zoology*, but the additional samples will yield further insight into the reproductive ecology of polar bears.

The sex-ratio of the 160 bears handled was 49% female. Recapture rate for all bears was 64% and 77% for bears older than one year. Thirty-four COYs and six yearlings were handled. No independent yearlings were handled, similar to 1990 and the trend to fewer independent yearlings seen since 1987. Mean litter size of COYs was 1.45; mean litter size of yearlings was 1.13. Both of these litter sizes are similar to those seen in previous years, although the yearling litter size is lower than in the early 1980s.

Seventeen of the twenty conventional collars deployed in spring were relocated in autumn 1991. Survival of COYs from February to September was 47% (18/38). This was similar to the data collected in the previous four years (mean = 50.5%), but lower than recorded in the early 1980s (mean = 75.0%). Total litter loss was found in 27% of the females and was similar to that found in recent years.

The weights of females with cubs and yearlings were similar to those recorded in the previous four years. The mean weight was 196 kg (SE = 5, n = 30). Weights of other groups of bears captured have not been analyzed. It was our subjective opinion that the condition of adult males was substantially better than in the past four years. However, weights were highly variable and analyses are necessary before conclusive statements can be made.

Wildcat Films, from the United Kingdom, documented sampling procedures for toxic chemical analysis. Footage was aired on the news in the UK and a documentary about arctic pollution was completed for broadcast on television.

Toxic chemicals and tissue collections

As reported at the last meeting of the PBSG, Ross Norstrom (CWS, Ottawa) completed a comprehensive survey of chlorinated hydrocarbon contaminants (CHCs) and heavy metals in polar bears throughout their range in the NWT. The level of most CHCs, especially chlordane compounds, had increased from 1969 to 1984 in Hudson Bay and Baffin Bay bears.

There were no age, sex, or seasonal differences in the loads, except for mercury.

It is important to establish whether this increase is an anomaly or a long-term trend by continuing the monitoring program on an occasional basis and to increase the geographical extent of the database. Therefore, Norstrom proposed to examine samples collected in 1990–91 from all the Canadian jurisdictions, the US, Greenland, Norway, and the USSR in an international survey of CHCs in polar bears. All signatories to the Agreement agreed to help with the collection.

Collection of samples for the circumpolar survey of contaminants in polar bear fat was completed to the extent possible by autumn 1991. Over 700 samples from 34 areas or communities in Alaska, Canada, Greenland and Svalbard were collected. No samples were collected from Russia despite the assistance of USFWS scientists. Use of subcutaneous biopsies obtained by 3-mm biopsy punches proved highly successful. The Beaufort Sea/Amundsen Gulf area is still under-represented, and the sample size from Alaska was rather small and spread over several years. It may be worth pursuing further samples from these areas. However, program constraints make it very difficult to find time to analyze samples received past the autumn of 1991. Samples from these areas should therefore be collected, if possible, but Norstrom cannot make any promises of when or even if they will be analyzed.

The data gathered from the present survey should be sufficient to answer the large-scale geographical and temporal trend questions for a number of years. Norstrom does not anticipate repeating such a survey for another 10 years unless indications from other sources indicated a worsening contaminant situation.

The samples were analyzed for tetra-, penta- and hexachlorobenzenes; alpha- and beta-hexachlorocyclohexane; twelve chlordane-related compounds (mainly the metabolite oxychlordane); dieldrin; p,p'-DDT, DDD and DDE; and sixteen PCB congeners. All samples were analyzed by a single fraction gas chromatography–mass selective detector procedure.

A spreadsheet database has been set up in Quattro Pro (Lotus and dBASE compatible). In addition to the chemical concentrations, sample identity and geographical location, information that may be of value in analyzing the data, such as sex, age, accompanying bears, axial girth, standard length, zoological length, calculated weight, condition index, and fat index have

been added to the database where available. There are seventy potential fields of information for each sample. To ensure quality of data, upper and lower flags were set for data fields. Statistical analyses by SAS and other packages are in progress. A report should be available by February 1993. To date, only preliminary summary statistics have been completed and therefore it is not possible to comment on temporal trends. However, a few comments can be made on geographical distribution of residues and the effects of age and sex on residue levels.

As previously found, the major residues in all areas were PCBs and chlordane-related. Dieldrin, hexachlorocyclohexane and chlorobenzene levels were usually an order of magnitude lower. Mean total PCB concentrations ranged from a low of approximately 2ppm in the western North American arctic to a high of 15–20ppm in eastern Greenland and Svalbard. Levels in Baffin Bay and Hudson Bay areas were generally intermediate at 3–5ppm. Thus, there appears to be a trend for levels to increase from west to east, with a substantial jump going from the Baffin Bay to the Atlantic sites. Chlordane levels were somewhat more evenly spread, ranging from 1–5ppm in all areas, with a slight tendency for an increasing west–east trend. Chlorobenzene and dieldrin levels were more variable among areas, but there was no pronounced west–east trend. Hexachlorocyclohexane levels demonstrated a slight tendency to decrease from west to east, whereas DDT levels had a pronounced increase from west to east.

These data imply that most contaminants are quite evenly distributed at arctic and sub-arctic latitudes in the northern hemisphere. Asia appears to be a more important source of hexachlorocyclohexane than North America, whereas North and Central America are a significantly more important source of DDT in the Arctic than other areas. The significantly higher levels of PCBs in north Atlantic areas than Hudson and Baffin bays indicates that European, possibly Eurasian, sources are major contributors in this area.

The large numbers of biopsies taken from western Hudson Bay allowed a separation of the samples into three groups: solitary females, females with young, and males. A wide age range was available in each category. Preliminary analysis of the data indicates that there is a substantial negative effect of age from cubs to about six years of age in both sexes on PCB and chlordane residue levels in fat. Residue levels in cubs were about twice those in their mothers. After age six there was no discernible age effect, indicating that the

bears were in equilibrium with their diet. However, it is likely that statistical analysis will find some significant differences among groups. For example, males seem to have higher levels of PCBs than females, whereas females with young had the highest overall levels of chlordanes. Differences among ages and sexes were less obvious for the minor organochlorines.

Future sampling for chemical analysis

As mentioned above, continued biopsying of bears previously sampled in Hudson Bay is highly recommended to provide a time-trend for individual bears. In addition to fat samples, milk will also be collected from all adult females with cubs. Similarly, if any of these bears are later shot by hunters, it would be desirable to obtain a fat sample. Norstrom would like to be kept informed of other research projects in which biopsies (or other samples) may be obtained, in order to develop a comprehensive plan for ecotoxicology research (see below).

A new project on distribution and possible effects of methylsulfone (MSF) metabolites of PCBs and DDE was begun in 1991 as part of the Arctic Environmental Strategy Greenplan. Preliminary analysis in Sweden of fat and liver samples from two bears indicated that MSF-PCBs were present at 5% of the PCB levels in both tissues, and high levels of MSF-DDE were present in liver. These results were presented along with others at the DIOXIN'91 conference in Chapel Hill, North Carolina in September 1991. An analytical method for these compounds is being developed by a Ph.D. student at Carleton University in collaboration with the University of Stockholm. He will apply this method to study the distribution of MSF-PCBs and MSF-DDEs in the arctic marine ecosystem. MSF-DDE has been implicated as a possible causative agent in pathologies that are consistent with adrenal malfunction in non-reproducing populations of ringed and grey seal in the Baltic Sea in the early 1970s. It has an extremely high affinity for adrenal cortex in rats, causing adrenal hyperplasia and hyperadrenocorticism.

Ecotoxicology

Studies of PCBs in cetaceans indicate that PCB congener profiles can be used as a surrogate for liver mixed-function oxidase (MFO) enzyme activity profiles. Polar bears metabolize PCBs according to quite different

rules than cetaceans, which may be related to specialized biochemistry/physiology associated with high vitamin A intake (stellate cell involvement) or facilitated fasting. There have been no measurements of liver MFO activity in polar bears, nor any in other species of bears of which Norstrom is aware. Given the rather unusual capability of polar bears to metabolize certain PCB congeners and DDE, MFO studies would be interesting from a purely academic viewpoint. However, there is a more pressing reason to pursue this line of research. If there is a toxic effect of PCBs and other organochlorines in polar bears, MFOs are likely to be involved.

Norstrom has hypothesized that any effects of PCBs and other OCs in polar bears are likely to be found in female reproduction, or in cubs, which have the highest levels and exposure. To date, species with delayed implantation of ova, such as mink and ringed seal, have been found to be the most sensitive to effects of PCBs on reproduction. The effects are probably quite complicated, and variable among species, but there is at least some involvement of interference in hormone balance due to MFO enzyme induction. Uterine scars, blockage of Fallopian tubes, etc. are various pathologies found. It is worth initiating studies of these kinds in polar bears, but the requirements for sampling and preservation are big obstacles. MFO activities deteriorate rapidly upon death of the animal, and are lost altogether after a few hours. Current wisdom says the liver sample must be taken as soon as possible after death, and flash-frozen in liquid nitrogen. Lyle Lockhart (DFO, Winnipeg) has found that fish liver samples that are quickly cooled to near 0° on ice, but not frozen, can be kept for some hours without serious loss of MFO activity. Another approach that may be taken is to obtain liver biopsies from tranquilized animals. Logistics are therefore the most difficult problem. If these could be solved, the measurement of enzyme activities could be easily obtained.

An indirect approach to enzyme activity is mono/polyclonal antibody analysis of hepatic microsomal P-450 MFO protein. This technique can be applied to normal frozen samples in which the activity of the enzyme has been lost, and will give a qualitative idea of the cross-reactivity and probable equivalent activity of several isozymes that are inducible by various classes of organochlorines, including dioxins and PCBs. Samples of frozen polar bear liver from the CWS specimen bank will be analyzed as a preliminary test by Dr Stelvio

Bancliara at UBC (and possibly A. Brouwer at University of Wageningen in the Netherlands).

Another area of interest is the role of fat store size, facilitated fasting, and seasonal fat cycling in general on clearance levels and effects of organochlorines. Norstrom hopes that data obtained in the present survey will be applicable to answering at least some of these questions. To that end, he will be applying whatever information is available on condition index or estimates of total fat in the bear in analysis of the data. However, to answer this question properly it would be necessary to obtain data throughout the season, preferably recapturing the same bears.

Recent publications and results

A review paper of contaminants, arctic marine mammals, including a summary of findings on polar bears and joint research on seals and whales with Derek Muir of the Department of Fisheries and Oceans, was presented by Muir at the 7th International Conference of the Comité Arctique International in Oslo, Norway, in September 1989. A paper is in press in the proceedings of the conference (Muir *et al.* 1991).

A paper was published in *Environmental Pollution* on chlorinated dioxin/furan distribution in the Canadian Arctic for ringed seals, polar bears and some beluga samples (Norstrom *et al.* 1990). The geographical distribution was very different from other OCs, which implies a different source or path. TCDD and OCDD were the major components found, with highest levels in the high central Arctic and lowest levels in Hudson Bay. The proposed origin is combustion-related particulates in arctic haze, which has a mainly Eurasian source and does not penetrate to lower latitudes. Other organochlorines such as PCBS, Chlordane and DDT have lowest levels in the high Arctic and highest levels in Hudson Bay, indicating that the atmospheric vector is unlikely to be transpolar. Based on prevailing winds, the North American land mass is expected to be the origin of PCBs and other major organochlorines in the Canadian Arctic. Atmospheric lifetimes of these chemicals are in the order of tens of days to months, therefore all north temperate latitudes may be the ultimate source.

A paper on metals distribution in polar bear livers throughout the NWT was published in *Science of the Total Environment* (Braune *et al.* 1991). It provides

baseline levels of a number of essential elements (Fe, Ca, P, Mn, Na, etc.). There were some statistically significant differences in geographical distribution of these elements, but these differences are not likely to be of any physiological importance. There was strong opposite geographical distribution in Hg and Cd levels. Hg was low in Hudson Bay and Baffin Bay, and Cd was high. The reverse was true west of Barrow Strait. The reasons for this distribution are probably geochemical in the case of Hg, but may be related to food web differences in the case of Cd. Cd accumulates preferentially in some species of amphipods that are thought to form a larger part of the ringed seal diet in Baffin Bay and Hudson Bay. These data may have potential for group (subpopulation?) classification using principal components analysis. Norstrom would like to pursue this using the current data set.

A paper on circumpolar distribution of Hg in polar bear hair was published in *Polar Record* (Renzoni and Norstrom 1991). Bears from the Canadian arctic islands have much higher levels in hair than elsewhere. Levels did not correlate with Hg levels in liver of the same bears. This is explained by the difference in chemical form and history of Hg in the two tissues. Hg in liver is largely inorganic (mercuric) formed by metabolic demethylation of methylmercury, which is probably the form accumulated from the diet. Hg levels in liver may reflect exposure from the diet over a long period of time. Hg in hair is a covalently-bound methylmercury-protein (cystein) complex that reflects circulating levels during the time of hair growth.

A paper on tissue distribution of organochlorines and light-microscopy histopathological examination of liver from bears in Hudson Bay is in preparation (Braune *et al.* in prep.). Uniform tissue distribution of organochlorines on a lipid weight basis was found, except preferential accumulation of α -HCH (alpha-hexachlorocyclohexane—a transformation product of the pesticide lindane) in medulla oblongata. Japanese studies show a similar distribution in whales. Light microscopy investigation showed no lesions that would typically be associated with exposure to organochlorines. An important finding was that PCB levels were negatively correlated with age, or, at least, subadults had higher levels than adults. An older age distribution of sampled bears was likely the explanation for the lower levels of organochlorines found in the 1969 sample of fat from the CWS Specimen Bank than in samples analyzed in the comprehensive 1984 survey.

Northeastern Beaufort Sea and Western M'Clure Strait

Between 1971 and 1987, population and movement studies were conducted on polar bears in the eastern Beaufort Sea and Amundsen Gulf. Two of the objectives were to determine the size of the population and its geographic boundaries. Both were estimated within the limits of the samples and the technology available. No radio-tracking was done, thus movement data were limited to recapturing tagged animals or the return of tags from Inuit hunters. Field work on the west coast of Banks Island was based from Sachs Harbour. Although the northwestern end of the island was visited a number of times, it was difficult to spend much time there on each trip because of the distance from logistic support. Additionally, in more recent years, guided sport hunting by Inuit from Sachs Harbour was based in the vicinity of Norway Island. Because of concern about disturbing the hunt, mark and recapture studies using a helicopter were curtailed somewhat in that area. Consequently, the population estimates that were determined may have undersampled bears north of Norway Island.

In 1990 and 1991, population and movement studies were conducted on polar bears in the vicinity of Viscount Melville Sound and M'Clure Strait. A sample of individual bears were marked and a number of satellite radios were used to determine the full extent of annual movements. On the basis of the preliminary results of these studies, a population boundary between Zones E1 and H2 was proposed in the western portion of M'Clure Strait. Because of budgetary limitations, it was not possible to carry out the desired surveys north of the northwest corner of Banks Island, along the annual lead system that passes north across the western entrance to M'Clure Strait, and along the west coast of Prince Patrick Island. Similarly, because of budget limitations, only the minimum number of satellite collars were placed on female polar bears. Consequently, as in earlier studies, the polar bears in the northern area may have been under-sampled.

The reason it is important to fill out gaps in our knowledge of polar bear populations in this area is that the quota for Zone H2, including the additional six male tags recently allocated to the northwest corner of Banks Island, appears to be very close to the sustainable limit, based on data available to date.

The study has two main objectives:

- 1) to put satellite collars on adult female polar bears in the mouth of M'Clure Strait and along the west coast of Prince Patrick Island to determine where the boundary lies between the subpopulation of bears in the northeastern Beaufort Sea and those in M'Clure Strait and Viscount Melville Sound; and
- 2) to capture a sample of bears in the mouth of M'Clure Strait and along the west coast of Prince Patrick Island to examine the proportion of bears that might have been tagged further south in the Beaufort Sea.

Field work was conducted between 16 April and 18 May 1992, from Tuktoyaktuk, Sachs Harbour, and Mould Bay. The weather for much of the month was too foggy and overcast to allow for safe flying and for polar bear tracks to be visible. Of the 33 days we were in the field, the weather was good enough to fly for research purposes on only nine days, several of which were only suitable for half days. The visibility was poor on all four days used for ferry flights, and on 20 days the weather was too poor to make it worthwhile flying at all.

Satellite collars were put on two female polar bears north of Tuktoyaktuk, five on the west coast of Banks Island, one in M'Clure Strait, and three on the west coast of Prince Patrick Island. Twenty-five bears were handled, and 20 more were sighted. Six adult bears were caught on the west coast of Banks Island, of which five were tagged. In M'Clure Strait and the west coast of Prince Patrick Island, seven adult bears were caught of which none was tagged. Although these results are interesting, the sample sizes are too small to draw any conclusions.

The litter sizes of cubs of different ages either captured or sighted were as follows:

Age of cub	Number of litters seen	Average litter size
0.5 year	6	1.5
1.5 year	4	1.2
2.5 year	1	2.0

In 1993, nine satellite collars will be deployed and a sample of 60–80 polar bears will be marked.

Manitoba

Denning surveys in the Cape Tatnum area

Surveys flown in the early and mid-1970s showed that some denning activity occurred in the Cape Tatnum Wildlife Management Area and the area to the south. No surveys were done again till 1989 to determine if polar bears continued to use the area. A survey of the Cape Tatnum area in March 1989 found several denning bears, but tracking was poor because of unusual snow conditions. Fourteen observations of bears were made. Four family groups were sighted, three with two COYs each and one with one COY. Ten observations of tracks were also recorded. It is expected that the same bear or family group accounted for at least two observations on four occasions.

In 1990, 23 observations were recorded but only one bear, a solitary adult along the Hudson Bay coast, was sighted. Taking into account the time between survey flights and the poor weather conditions, it is probable at least five family groups moved onto the ice from this area.

The 1989 and 1990 surveys confirmed that polar bears still den in the area south of the Cape Tatnum Wildlife Management Area but it is not possible to quantify the level of activity and therefore determine its relative importance as a denning area. The sightings of bears and tracks observed indicate that denning can occur at sites more than 120km inland. No area of concentrated denning activity, such as is found in the Cape Churchill Wildlife Management Area, was identified. It is not known if females denning in this area are part of the Zone A1 or Zone A2 subpopulations.

Research permits

In 1989, some of the tour operators expressed concerns about the possibility of detrimental impacts on their industry because of the intensity of research being conducted on polar bears in Manitoba. The Department of Natural Resources, in assessing proposals for research on polar bears, will consider their value to polar bear management in Manitoba and the possible impacts the research could have on the tourism industry, in addition to ensuring the criteria are scientifically sound. It may therefore be more difficult to obtain a permit for polar bear research in Manitoba.

Polar Bears

The Department continues to receive comments, often negative, about the level of research it permits despite changes made in 1990, primarily by the researchers, to better integrate research and tourism activities. Manitoba, however, remains committed to providing opportunity for research if it meets certain criteria.

Manitoba staff have continued to assist researchers on approved projects in the western Hudson Bay.

Newfoundland

Newfoundland supported the development of cooperative research between jurisdictions sharing the Labrador-Baffin population.

In addition to the bears handled in 1991 under the LIA/CWS radio-collar and capture program off Labrador, three bears were captured and moved in Labrador, mostly as a response to perceived problems of bears approaching settlements. A helicopter pilot reported evidence of denning in Saglak Fiord, and the sighting of a different adult female accompanied by two COYs. Another 10 individual bears were observed off the southeast Labrador Coast in 1991.

Northwest Territories

Tetracycline biomarking

Most inventories of polar bear populations to date have been done through mark and recapture. Aerial survey methods have been found to be unreliable at comparable effort because not all polar bears are seen (even directly under the survey aircraft) and because polar bears occur at low densities. Most of the polar bear inventory work has been carried out in spring on the sea-ice. However, polar bears in Foxe Basin and northern Hudson Bay are inaccessible in the spring because of sea-ice conditions. In the late summer and early autumn the ice cover disappears and the bears come ashore. Many of the polar bears can be captured with standard immobilization methods. However, a significant fraction of the bears are found in the sea, on sea cliffs, or on coastal plains that are mainly covered by lakes. Operational risks from immobilization tagging were not considered acceptable in these circumstances.

An alternative to immobilizing and tagging was developed using the antibiotic tetracycline as a

biomarker. Tetracycline is calciphilic. A portion of any tetracycline introduced into mammals is permanently deposited in the cementum annuli of the teeth. Under ultraviolet illumination, the biomarked cementum annuli exhibits a yellow fluorescence. When a single mark is given per year, the year the mark is given may be determined by counting the annuli back to the year of sampling. Counting cementum annuli is done under polarized light or with other stained sections of the tooth.

The marking was done from a helicopter using equipment developed for that purpose by Pneu-Dart Inc. Design constraints included a barbless needle, a transparent syringe (to allow visual verification of injection), a non-explosive injection (to allow 15ml volume), and a slow muzzle velocity (to prevent darts bouncing). The injection system utilizes CO₂ produced when 10% acetic acid is injected into a reservoir of bicarbonate of soda. Commercial preparations of oxytetracycline (200mg/ml) were used.

To determine the amount (mg tetracycline/kg bear) of tetracycline required to reliably biomark polar bears, dose levels ranging from 2mg/kg to 25mg/kg were tested. All bears marked at 25mg/kg tested positive for the biomark when sampled one week or longer after injection. Seventy-three of 74 polar bears marked at all dose levels and sampled 180 days after injection tested positive for the biomark. The identity of the animal that did not exhibit the biomark may have been confused with another harvested animal.

Not all polar bears marked at dose levels of 15mg/kg tested positive when sampled 180 days or fewer after injection. Of the short-term samples (i.e., <180 days), bears younger than six years were significantly ($p < 0.05$) more likely to be biomarked than older bears. Doses higher than 7mg/kg resulted in 50% more positive tests than lower dose levels, although the increase was not significant ($p > 0.05$).

For reliability in field application, a dose level of 15mg/kg was used. The dose levels for various sex and age categories of polar bears were determined. To avoid marking individual animals more than once, each bear was marker-darted with a removable roofing tar. Tetracycline darts were aimed at the neck or shoulder to ensure intramuscular injection. Approximately 5% of the darts either bounced or failed to inject completely. These shots were repeated so each bear was known to receive approximately 15mg/kg. Some 384 polar bears

were bi-marked in all types of habitat throughout the study area between 7 September and 5 October 1989. Only one bear was seen but not marked because it escaped to a snow cave.

The recapture samples (teeth) come from returns of lower jaws from harvested polar bears. Although the harvest is not geographically non-random, the biomarking effort was geographically random. The reduced handling time per bear allowed the entire coastal habitat to be covered and all bears encountered to be marked. The expected annual harvest from the population is 130–150. The harvest sample may be augmented with first premolars taken from captured bears if a more precise estimate of the marked-to-unmarked ratio is required.

By marking in subsequent years, a mortality rate for marked animals may be estimated. That mortality estimate may be partitioned into natural mortality and harvest mortality (known from the harvest return). By correcting the "marks at risk" for annual mortality, the population number may be estimated each year until the fraction of the population marked (or the total number harvested) becomes insufficient.

Foxe Basin

During September 1986, 32 VHF radio-collars were deployed on polar bears located onshore in summer retreat areas throughout Foxe Basin and northern Hudson Bay. In spring 1987, an additional 15 radio-collars were deployed during the maximum sea-ice coverage in the same area. An additional 20 radio-collars were deployed during September 1987. Radio-collar failure reduced the total active radio-collars to 54 that were monitored by five aerial survey flights per year in 1986, 1987, and 1988. Although the survey tracks were planned to provide 100% coverage, not every radio was located every flight.

Based on these movements and movements recorded from marked bears that were recaptured or killed by hunters, a management area (C) was identified. It was recognized that migration within this and other areas did occur; however, the movement information indicated that these movements were insignificant relative to the tendency for individual bears caught within the area to remain within the area. The likelihood that bears within area C and other areas contiguous to C were using the pooled area equally was less than 0.001.

The marking phase of the Foxe Basin Polar Bear Study was concluded in autumn 1990. A total of 687 polar bears were marked with tetracycline in autumn 1989 and 1990 (389 and 298 respectively). The tetracycline permanently marks the teeth of the bear so it is important that each jaw from harvested bears is turned in. As explained above, we can estimate the population number for each year from the jaw returns, as long as enough marked bears are still alive in the population.

The entire coastal area of Foxe Basin and northern Hudson Bay was surveyed by helicopter in September and October. With one exception, every polar bear seen was marked. The 1991–92 hunting season was the first time that all marked bears would be observed due to the requirement of 180 days to be certain of detecting the mark. Based on the data from the 1991–92 hunting season the population is estimated to be 2022 bears. This estimate is tentative and no variance has been calculated. A previous estimate of 1200 for the Southampton Island area only was based on limited conventional mark–recapture data.

From 1986–87 through 1990–91, the mean annual kill from this population was 138, although a kill of only 77 is sustainable at the current sex-ratio (39% females). Computer projections suggest that this population has declined from about 3000 since the early 1970s. A recommendation to manage the population for increase has been given to the communities that share this population. This would entail increased selectivity for males and reduced kill.

Viscount Melville Sound

Forty-five satellite radio-collars were put on female polar bears in the Viscount Melville Sound area between spring 1989 and spring 1991. The recorded movements of these bears (Fig. 1) suggested a relatively discrete population of polar bears inhabited this area. The subjective boundaries were tested against the null hypothesis of random use of an equal-sized surrounding area using Chi-square procedure. The null hypothesis of equal use was rejected at [*sic*].

Polar bears were marked and recaptured in this area from 1973 to 1976 and from 1989 to 1992. The mark–recapture effort in spring 1991 and 1992 was intensive and covered the entire population area. The weighted mean population estimate realized by pooling data from these two years was 231 (SE= 20). The population estimation procedure was the Fisher–Ford model with a jack-knife estimate of variance. The estimated annual

Polar Bears

survival rate of marked animals was 0.918 (SE= 0.016). The recruitment potential for polar bears in Viscount Melville Sound was less than for other areas. Presumably this is a reflection of poor habitat quality relative to other areas. This population could sustain an average harvest of approximately 0.6 adult females per year, or a harvest of about 1.2 adult males and females at 50% males and 50% females, or a harvest of about 1.7 at 66% males and 33% females. However, harvest sex-ratios of over 50% males result in a decline in the abundance and mean age of males. The sex-ratio of adults in this population has become heavily skewed to 29% males and 71% females.

The current annual quota for this area is 12 per year (six for Cambridge, six for Holman). If the quota of 12 resulted in a kill of no more than two per year, this quota would be sustainable, but would not allow the population to recover. An alternative harvest strategy would be a male-only harvest that was restricted to two per year over the next 20 years. The harvest could be alternated annually between Holman and Cambridge. This would allow the population to build back to previous levels, and increase the sustainable harvest for future generations while still allowing current users to hunt polar bears.

Information on seasonal movements and denning behaviour was also collected for adult female bears. Regardless of the reproduction status of the bear, females were most active during the mating, seal pupping and seal moulting season (April–July), and all females sought dens for shelters during the winter months (average of 53 days per non-maternity den). All 25 maternity dens were onshore, and all but six of the 20 non-maternity dens were also onshore. Based on activity level of transmission and signal quality, it appeared that pregnant females enter maternity dens on about 17 September and leave about 21 March. However, these dens were not visually verified, and the entry date is earlier than observed in other areas. It may be that den site selection occurs in mid-September and den construction occurs gradually as snow accumulates.

A grizzly bear was captured on the sea-ice about 50km south of Dundas Peninsula, Melville Island. This location is about 800km further north than grizzlies have been previously reported.

Northeast Baffin

The area referred to as Northeast Baffin includes Canadian polar bear management areas F and D. The

degree of exchange between polar bear populations in the Lancaster Sound and Northern Baffin Bay is poorly known. This information is important for management because polar bears are harvested by communities in both the Northwest Territories and Greenland. The degree to which harvests in one area affect population numbers in other areas has not been evaluated. Additionally, population boundaries must be established as a prerequisite to abundance estimation.

Three satellite radio-collars were deployed in April 1991 in Prince Regent Sound in cooperation with the Arctic Bay Hunters and Trappers. An additional 11 radio-collars were deployed between Bylot Island and Cape Dyer, Baffin Island in September 1991. The September 1991 deployment was in cooperation with Greenland Fisheries Research Institute, the Pond Inlet, Clyde River, and Broughton Island Hunters and Trappers, University of Saskatchewan, and Parks Canada. In spring 1992, an additional three collars were deployed in Prince Regent Inlet, 10 were deployed along the east coast of southern Ellesmere, Devon, and northern Baffin Island, and six were deployed by Greenland in the Melville Bay area.

The locations and movements of the satellite-collared bears to date are given in Fig. 2. Although these data are preliminary, it appears that the northeast Baffin population is shared with Greenland, but not Canadian management area D2. The degree of mixing between area D1 and F suggests that boundary may not be useful, however there is some suggestion of an east-west boundary in Lancaster Sound. These suggestions are based on qualitative examination of preliminary data. Two more years of telemetry work are planned to resolve the issue of boundaries in this area.

In areas where the ice pack melts completely in summer, most polar bears seek onshore summer retreats. Although both males and females are found along the coast during the ice-free season, females are less common. The sex-ratio of subadults and adults observed in coastal areas was 33% females and 66% males. Both males and females patrol the coast for carrion and may hunt seals and whales. However, females with cubs may regard the males as threats and spend more time in the inland areas where males are not as common. The sex-ratio observed by this survey is typical for autumn coastal surveys in areas where polar bears use summer retreats, but is not a good estimate of the actual population sex-ratio.

A young adult male bear was found dead in a small bay off Eglinton Fiord, Baffin Island. The hide was taken and turned over to the Clyde River HTA pending a final decision on disposition. A field autopsy indicated the cause of death was drowning. No haematoma, bruising, bullet holes or other physical injury was observed in either the body or internal organs. The heart was examined closely, but no discolouration or clotting was observed. The lungs were full of water and were pinkish in some areas and iridescent purple in other areas. The stomach contained about 750ml of fish bones and small white squares identified locally as shrimp flesh. The stomach contents and skull were collected. The kidneys were still slightly warm suggesting that the bear had been dead only a few days. The meat was evaluated by a local hunter who determined it to be spoiled and unfit for human consumption.

The density of polar bears observed during autumn 1991 and 1992 was low compared to the number thought to be present in this area. Eighty-five percent of all NWT polar bear defense-kills occur along the eastern Baffin Island coastline. Harvest quotas for Clyde River and Broughton Island were reduced in 1985 to enable the population to recover in that area. The numbers seen did not indicate that a large number of polar bears were using the coastal areas as a summer retreat. However, weather conditions in 1992 were better for surveying higher altitudes and both males and females were encountered there. Resolution of the number of polar bears in this area will require conventional mark-recapture analysis.

Population estimates from an earlier (1981–86) study suggest population decline or no change in numbers with the current (past five years) harvest levels. The number of bears taken by Greenland hunters was previously estimated at three per year. However, Greenland has recently completed a harvest study that indicates the number killed by West Greenlanders averages between 40 and 60 per year. The effect of the Greenland harvest on the northeastern Baffin polar bear population is unknown. To date, at least 21 polar bears marked in Canada have been taken by west Greenland hunters. The combined Greenland/Canada harvest exceeds the sustainable levels based on population estimates that were adjusted for "capture bias".

Population depletion and continued decline are not supported by the perceptions of local hunters. Local

hunters feel the number of bears has increased. This perception is supported by an increase in reported "problem bear" incidents. Increased travelling and hunting activities make it difficult to determine if the increase in bear-human encounters is caused by increased bear numbers or increased land use. Most summer and autumn travel is by boat, which concentrates both bears and people in coastal areas.

The status of polar bear populations in the north-eastern Baffin area cannot be determined with the available data. The marine environment of this area is strikingly rich. Seals and whales are very abundant, suggesting a rich marine food chain that should result in an abundant and productive population of polar bears. If managed for recovery, the population might eventually support a harvest that is significantly greater than the number now taken by Greenland, Clyde River and Broughton Island combined. The first step to realization of the full harvest potential of this population is determination of stock numbers and a more systematic recording of the Greenland kill. Both objectives fall within the Greenland protocol for the cooperative polar bear research planned for this area.

The geographic boundaries of the polar bear population that inhabits NE Baffin Island have not been established. There are no apparent natural barriers to movements between NE Baffin Island, Lancaster Sound, eastern Ellesmere Island, Kane Basin, and Greenland. The degree of exchange is not known. Additionally, there is a possibility that previous mark-recapture studies were biased because spring capture was only possible in coastal areas. Research is needed to determine if bears captured along the coast are a random subset of the entire population, or if the population estimates only pertain to the bears that tend to remain close to the coast. Both issues need to be resolved before past population estimates can be interpreted, and before new estimates can be obtained. Preliminary data suggest that the polar bear population in Baffin Bay is shared between Greenland and Canada.

This project is a cooperative effort. Participants include Greenland, Canadian Parks Service, CWS, University of Saskatchewan, and the HTAs of Clyde River, Broughton Island, Arctic Bay, Pond Inlet, Resolute Bay, and Grise Fiord.

Deterrent studies

The proceedings of the Bear Deterrent Symposium held in April 1988 have been published. An updated version of the Safety in Bear Country Manual has been prepared.

Polar Bears

Preliminary testing of capicum spray was attempted by distributing the spray to Renewable Resource Officers in communities that sometimes have problem bears. However, the delivery system has not performed reliably in cold weather, and the constraints on distance (<10 metres) and wind direction limit the effectiveness of sprays currently commercially available.

There is still considerable need and call for an effective, all-weather deterrent system for polar bears. The rubber slugs and cracker shells have proven to be effective in many, but not all instances. Parks Canada has expressed a need for a non-firearm type deterrent for parks that contain polar bears. One difficulty is that a deterrent that is commercially available and effective against polar bears can also be used against people (e.g., by the police, or in muggings). Any new technology will likely be banned once it has been misused.

Ontario

1984–88 field study

Reports on the field research conducted during 1984–88 were completed, including a paper on estimating the weight of polar bears from body measurements. The final report will be submitted for publication in the *Journal of Wildlife Management* monograph series. A copy of the abstract follows.

During 1984–86, 457 different polar bears were captured 536 times in southern Hudson Bay. The sex-ratio of captured bears was not significantly different from unity ($p < 0.010$). The mean ages of captured males and females were 6.9 and 5.8 years respectively. The calculated mean annual survival rates for males and females were 0.89 and 0.85 respectively. The mean natality rate for females aged 5–21 was 0.85. Seventy-five percent of females ≥ 5 were accompanied by young. Most females produced their first litters at five or six years of age. There was no evidence of reproductive senescence in our samples as four of six females ≥ 19 years were accompanied by young. Yearly summer litter sizes ranged from 1.4 to 1.8 and averaged 1.6. Weights of solitary females considered to be pregnant (338 ± 43 , $n=20$) were heavier than the non-pregnant group (283 ± 47 , $n=14$). When captured, 38% of the yearlings were alone, suggesting a two-year breeding interval for some females. We estimated a population of about 700 in southern Hudson Bay in 1985 and 1986. Adult females

averaged 295kg and adult males 489kg during the 1984–86 capture period. Overall, bears were heaviest in 1986 and lightest in 1985. For females, ultimate growth for front foot width and skull length occurred at age three and for body length, neck circumference, chest girth, weight and skull width at age four. For males, ultimate growth for front foot width and chest girth occurred at age five, body length, skull length and neck circumference at age six, skull width at age seven and weight at age 12. Of 73 individuals or family groups recaptured in 1985 and 1986, 46 were within 50km of where they were first caught. Only 10 were more than 100km and only four were more than 200km from previous capture sites. During the winter, adult females used areas that ranged from 74 to 502km east to west and 292 to 925km south to north. A few females were located over 600km north of the coast. The sex-ratio of 45 tagged polar bears harvested by Inuit and Indian hunters between 1984 and 1988 was 2.5 males:1 female. Most were killed in the vicinity of the Belcher Islands. Movements of tagged bears confirmed the validity of the boundary between management zones A2 and A1, but suggested Zone A3 should be combined with Zone A2.

Late autumn–winter distribution

Radio-collared females were monitored at irregular intervals from late October to early April 1984–88. In three years, 157 relocations were obtained. In late October, bears concentrated along the coast as they awaited the formation of sea-ice in Hudson Bay. By late November, they returned to the ice and dispersed throughout most sections of Hudson Bay as the winter progressed. From late January through April, a few adult females were north of 60° latitude and the others were dispersed from the Ottawa Islands in the east to a few hundred kilometres northeast of Churchill to the west. The greatest straight-line distance north was 682km. Perpendicular distances from the coast from November to April ranged from 24 to 568km. Mean monthly distances ranged from 125km in November to 278km in February.

The seasonal movement pattern of adult and subadult males, based on locations of solar ear-tags and locations of hunter kills, was similar to that of adult females. However, because ranges of solar ear-tags were more restricted than those of radio-collars and locations of hunter kills were restricted to areas where hunting occurred, our winter locations of males should be regarded as preliminary.

The 26th consecutive autumn aerial survey of polar bears in Ontario was conducted from 3 to 5 September 1988. Two other surveys were done earlier in the summer to monitor changes in numbers and age/sex composition as the summer progressed. The first survey on 26–30 July with a Bell 204 helicopter located 36 bears; the second on 15–17 August with a Twin Otter located 152 bears. Ice breakup was much later in 1988 than 1987, which probably accounts for the few bears recorded in late July. The total of 143 bears sighted in Ontario during the early September flight was considerably higher than the 26-year average of 106. The proportion of family groups was similar to the long-term average but lower than the previous five-year average. In late July, 36% of the bears observed were family groups, but by early September, only 14% were family groups. Other workers have commented on the inland movement of family groups during summer along the southern and western coasts of Hudson Bay. The distribution of bears in 1988 was similar to the long-term average and suggests that changes in distribution thought to be caused by tagging activities during 1984–86 were temporary.

During a telemetry survey flight from 18 to 23 January, 1988, four active collars were located on the sea-ice, one active unit was at an inland den, and five units were in mortality mode along the coast. No ear-tag transmitters were located. The ear-tag transmitters proved to last less than seven months; the radio-collars lasted up to 29 months. Because of the few radios located, no future flights are planned.

In 1989, field activities were restricted to four aerial surveys during the late summer–early autumn to assess numbers and distribution along the Ontario coastline. The final report of the 1984–86 field study of polar bears in southern Hudson Bay is undergoing final internal review.

The autumn aerial survey of polar bears in Ontario was conducted from 3 to 8 September 1989. As in 1988, two other surveys were flown earlier in the summer to monitor changes in numbers and age/sex composition as the summer progressed. The first survey on 27–29 July with a Bell 204 helicopter located 29 bears and the second on 14–16 August with a Twin Otter located 162 bears. A fourth, later survey on 15–16 October with a Twin Otter located 120 bears. Survey methods were similar to previous years.

Ice breakup was later in 1989 than in 1988 and 1987, which probably accounts for the few bears recorded in

late July. The total of 167 bears sighted in Ontario during the early September flight was the highest recorded since 1981, but the proportion of females with young was well below the long-term average. The results of the first three seasonal surveys were similar to those recorded in 1988, and support earlier observations regarding the activities of family groups after arrival on the coast. In late July, 21% of the bears observed were family groups, but by early September, only 11% were family groups. Five weeks later, although the total number of bears observed declined 28%, there was no decline in the number of family groups. Other workers have commented on the inland movement of family groups during summer along the southern and western coasts of Hudson Bay. The distribution of bears in 1989 was similar to the long-term average for each of the three areas.

J.O. Leafloor, the biologist at Moosonee, prepared a report on the results of four aerial surveys during summer–autumn 1990 and on trends in numbers during the last 28 years. There has been an upward trend in the number of bears counted since 1963, and the count of 236 in 1990 was the highest ever recorded. The abstract of the report is summarized here.

Four aerial surveys were flown in 1990 to count polar bears along the Ontario portion of the James and Hudson Bay coasts and on the near-shore islands. In the September survey area, 236 individuals were counted. An additional 12 bears were sighted on Akimiski Island and 11 were on the mainland coast south of Hook Point. The proportion of females and young was slightly lower than the long-term and five-year averages. The first bears were observed on shore in the first week of July. A large number came ashore between Winisk and Fort Severn between 26 July and 30 July. Seasonal trends in numbers followed a consistent pattern in the past three years: bears were relatively scarce on the coast in late July, increased during August, peaked in late August or early September, then declined by early October. In each of the last three years, the proportion of bears found in western, central, and eastern portions of the survey area depended on survey timing (G test, $p < 0.05$ in all cases). The September distribution of bears among these three areas also differed between years ($G = 51.7$, p). The Ontario polar bear population has increased since the 1960s (ANOVA, $p < 0.05$), and trend analysis suggests that the population is still increasing ($r = 0.70$, $p < 0.001$). Despite high variability

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in distribution, numbers, and social components of polar bear populations observed during these surveys, they are useful in monitoring gross changes in population size and distribution, and should be continued in the future.

Research activities in 1991 were restricted to a single aerial survey 22–23 August, to assess numbers and distribution along the coast of Ontario from Ekwan Point to the Manitoba border, and the north shore of Akimiski Island.

The survey was conducted with a deHavilland Twin Otter at a speed of about 140km/h and altitude of about 150m AGL. Weather conditions ranged from dark overcast at the start to cloudy-bright at Cape Henrietta Maria to bright for the remainder of the survey. Overall, conditions were considered favourable for sighting bears.

The total of 149 bears sighted in the traditional survey area was considerably lower than that of 236 sighted in 1990, but was almost identical to the previous five-year average of 148. One female and a yearling were sighted south of Hook Point, and six adult bears were seen on Akimiski Island. In the regular survey area, 14 family groups with a total of nine COYs and 13 yearlings were counted. The percentage of females with young and total numbers of young exceeded both the long-term average and the average during the past five years.

The distribution of bears was similar to the long-term mean, with greatest concentrations in the Cape Henrietta Maria and Pen Islands regions. Compared to 1990, numbers of bears in Area 3 were similar, but were less in Areas 1 and 2. Reasons for differences could be related to patterns of ice breakup in Hudson Bay or differences in bear movement patterns between years.

Daily and seasonal movement of bears can lead to much variation in annual counts of polar bears in Ontario. During the 1984–86 marking studies, the sighting frequency of tagged bears was about 20%. If that ratio holds true, then annual counts represent about

20% of the total population. The long-term trend of increasing polar bear numbers is probably real, but the variability of counts among years makes it difficult to detect a real change in population size over the short term. Mark–recapture and radiotelemetry studies similar to those done during the mid-1980s will probably be required to determine more accurately the actual size of the southern Hudson Bay–James Bay populations. In the meantime, annual surveys should be continued because they are the only means currently available to assess population size and distribution.

The 1992 survey was flown 29–30 August. Only 111 bears were sighted, including 10 family groups with 16 COYs or yearlings total. The percentage of females with young was 23.4.

Field research on polar bears in Ontario appears unlikely in the immediate future. Even annual autumn aerial surveys that have continued for 30 consecutive years may be in jeopardy because of continued cut-backs and rising aircraft costs.

Québec

The laboratory analyses of 30 bone samples from Québec hunter-kills will probably not permit polar bear populations to be distinguished on the basis of levels of trace elements. Data collected in 1988 on an aerial survey of polar bears in which survey and double-survey techniques were tested have been analysed and published (Crête *et al.* 1991). The harvest studies previously done by Denis Vandal will continue.

There has been no research conducted on Québec polar bear populations since the last meeting of the PBSG. A manuscript proposing a census technique for bears living around Hudson Bay was prepared.

Yukon

There was no research in 1988 through 1992.

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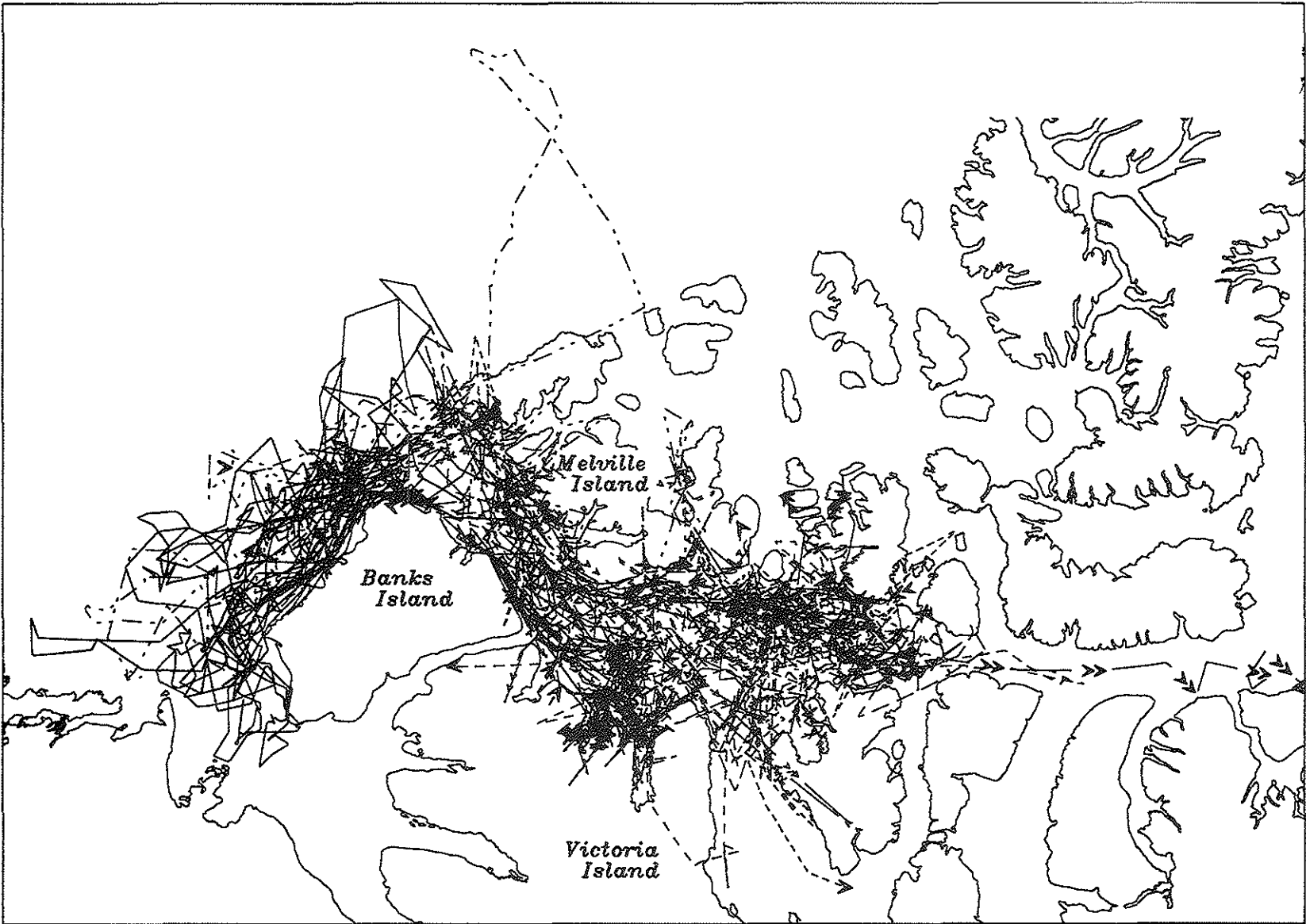


Fig 1. The movements of satellite-collared female bears within and outside Viscount Melville Sound

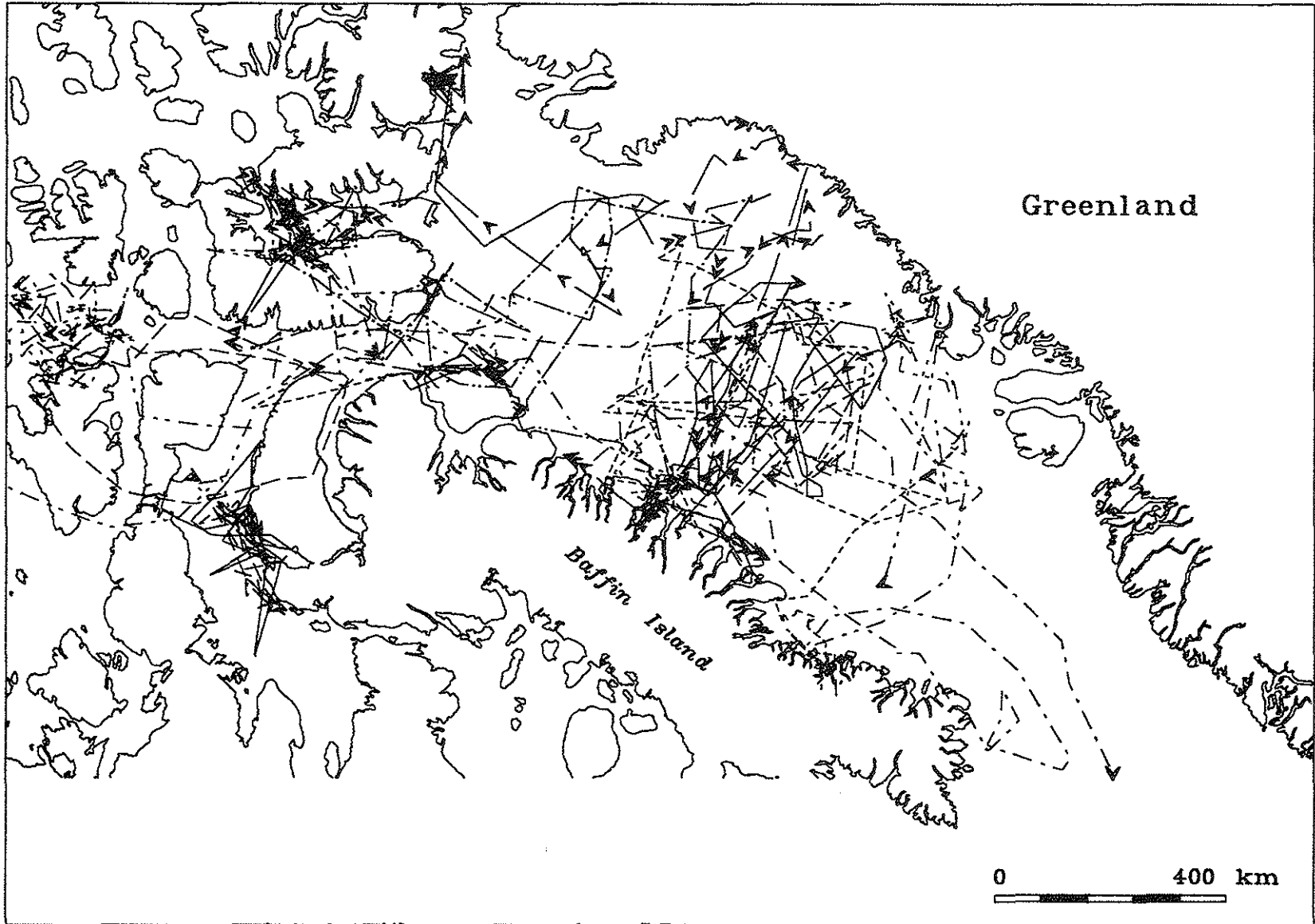


FIG 2. The movements of satellite-collared female bears within and outside the north-east Baffin area, September 1991 to September 1992. Although this study is ongoing, and these results are preliminary, it appears that the north Baffin populations are shared between Greenland and Canada

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Since the Tenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group in October 1988, there have been some changes in the management of polar bears in Canada. The regulations covering polar bear management in Canada as of 31 December 1992 are summarized in Table 1. Changes made prior to 1988 are outlined in the management reports included in the proceedings of previous meetings of the IUCN Polar Bear Specialist Group.

The Federal-Provincial Technical and Administrative Committees for Polar Bear Research and Management (PBTC and PBAC, respectively) representing the Federal Government, two territories (Northwest Territories and the Yukon Territory), and four provinces (Manitoba, Newfoundland, Ontario and Québec), continued to meet annually to discuss research results and to make management recommendations. Research arising from these meetings is outlined by Calvert *et al.* (1995).

Attendance and participation in the PBTC

Several times, various non-government organizations have requested permission to participate in meetings of the PBTC. Although it has never been fully clarified who may attend PBTC meetings, the PBAC has felt that non-governmental groups should have their input at the management level of the PBAC, since the PBTC has mostly a technical role. Hence, the IGC and LIA have both attended PBAC meetings in recent years. However, an exception was made for participation of some

representatives of Anguvigak at the Québec meetings of the PBTC and for a representative of the Yukon WMAC at the 1990 PBTC meeting in Whitehorse.

Several members of the PBTC felt there is a role for representatives of Inuit groups such as the Inuvialuit, Nunavut, Makivik, or the Inupiat from Alaska, and that these groups should be sent a copy of the minutes, even if they do not send an observer to the meetings. The PBTC recommended to the PBAC that such groups be invited to send an observer if they are interested, but they wanted the PBAC to clarify who may attend, and what role an invited group should play. Also, the travel expenses for potential participants should be paid by their own organizations.

When Canadian Parks Service began to have concerns about polar bear management and potential bear/people encounters in their northern parks, they approached the PBTC and have sent a representative to the meetings twice since 1990.

PBTC priorities

At the 1990 PBTC meeting, future PBTC priorities were discussed and the role of the PBTC reviewed. Most members felt annual meetings were valuable for the continuing cooperation between jurisdictions and for recommending management actions to the PBAC. There was a consensus that the two most important priorities were (a) problem areas (geographical) where the polar bear populations were not well defined or studied, and (b) research problems, such as the present studies on metabolism and fat, that would contribute significantly

to other aspects of polar bear biology and management and be applicable to all zones. The ability to do population inventory research, especially, is being lost with shrinking budgets.

Approaches to conservation and education

The PBTC identified Conservation Education as a high priority for polar bear management. The greatest needs for educational materials were those to:

- 1) promote male-selective harvests;
- 2) promote responsible polar bear viewing;
- 3) promote greater understanding of polar bear sensitivity to oil spills, over-hunting, and seal declines;
- 4) promote inclusion of problem bears within quotas;
- 5) promote greater understanding of the economic importance of polar bears to communities; and
- 6) provide better information on the need for, and value of, specific research.

WWF carnivore conservation strategy

The World Wildlife Fund (Canada) began a Carnivore Conservation Strategy in 1990. To initiate the project, Sherry Pettigrew and Monte Hummel wrote a popular review of large carnivores in Canada that included interviews with researchers on the species. Stirling distributed the questionnaire for polar bears and invited suggestions for answers. It was agreed that global pollution, global warming, habitat destruction, environmental damage, and unregulated hunting should be listed as the greatest threats to the species (question 8); more money for essential studies, native participation in conservation strategies, more non-consumptive use, and an emphasis on males during the hunt would be strategies to ensure the future of the species (question 9); that the approach that should be avoided in the book (question 10) is thinking protection solves all problems; and that the behaviour of all bears is the same and predictable. The book, *Wild Hunters*, is now available for \$19.95. It is a good summary of the biology, natural history, and conservation problems of large carnivores in Canada.

Polar bear kills by jurisdiction

The quota of polar bears taken by each jurisdiction is based on recommendations by the Federal-Provincial Committees. The quotas and numbers of polar bears killed in 1987–88, 1988–89, 1989–90, and 1990–91 are summarized, and recommended quotas for 1991–92 are given in Table 2.

From 1990 on, the quotas in the NWT have been organized by community, so there are minor changes in the zone totals in the table. This is meant to reflect more closely the population being hunted; it does not affect total quotas or kills.

Management changes or reports by jurisdiction

Manitoba

The annual Polar Bear Control Program for the Churchill townsite and surrounding area continues each autumn. The primary objective of this program is to ensure the safety of people and the protection of property from damage by polar bears; the secondary objective is to ensure bears are not unnecessarily harassed or killed. Program highlights are summarized in Table 3.

Following the 1990 Alert Program, Department staff reviewed the Policy and Procedure Directives and the Operational Guidelines for the Polar Bear Alert Program to ensure consistency with actual program delivery and to incorporate some changes to these Directives and Guidelines that had already been put into practice. The Program policy was modified to emphasize the Department's position that polar bears will be protected from unwarranted killing and harassment. It was also changed to reflect the Department's desire for it to be more prevention than control-oriented. The Program procedures were altered to provide staff with additional discretion to decide the fate of bears with a history of three or more years in the immediate Churchill area. These and several other minor changes were approved at the Executive level and were in effect for the 1991 Program.

Two polar bears were killed outside the Churchill townsite area in the autumn of 1990 by Treaty Indians exercising rights granted to them under the Natural Resources Transfer Agreement (1930) and affirmed under the Constitution Act (1982). In both cases the

animals were killed for personal use by the individuals. Though Treaty Indians have killed polar bears on several occasions before, and have been allowed to retain the hides for their personal use, in those cases the animals were shot "in defense of life or property". This was not the case in 1990.

For Manitoba to address the issue of a quota kill, it is important that the quota for the Zone A1 subpopulation be clearly stated. Currently on paper the Zone A1 quota kill is listed as 35 for Manitoba and 62 for the Northwest Territories (which includes 15 tags borrowed from Manitoba). However, the PBTC at a 1988 modelling workshop indicated a sustainable harvest of a maximum of 65 animals based on a population estimate of 1200 animals and a sex-ratio of 28 females:72 males in the harvest. From 1980–81 to 1984–85, the kill in the NWT has averaged 55 bears. Problem kills, bears transferred to zoos, and handling deaths throughout the zone are additive.

In 1991, Manitoba made a significant change to its management of polar bears by changing their status under the Wildlife Act to Division 6 (Protected Species) from Division 1 (Big Game Species). This change in status actually reflects more accurately how Manitoba has treated and recognized polar bears since the 1970s. It also enhances Manitoba's ability to manage this internationally important species, rather than solely guard against its potential over-harvest. This is because those parts of the Wildlife Act dealing with protected species are considered to be general laws of application, and hence applicable to all persons. The result is that all hunting of polar bears is prohibited except as specifically otherwise permitted by the Minister of Natural Resources. This allows Manitoba to conform to the conditions of the International Agreement on the Conservation of Polar Bears as it relates to hunting. It also makes it more consistent with the CITES and COSEWIC listings of the species and the legislative protection afforded by other Canadian jurisdictions.

This should not be construed as meaning Manitoba has placed a total ban on the hunting of polar bears in perpetuity. Rather, the Minister can authorize any person(s) to kill 'x' number of polar bears in any year for any purpose not contrary to public interest.

For 1991–92, as an interim policy, Manitoba took the position that no person would be granted a permit to hunt polar bears until biological staff have established whether there is a harvestable surplus over and above the conservation needs of the population and in consideration of all other political and scientific concerns

including those of the international scientific community. Further, and in response to a request from the Churchill Local Fur Council to administer and allocate 15 hunting tags for polar bears, the Department has stated that no tags or permits will be issued in Manitoba for the recreational or commercial taking (killing) of polar bears. This includes trapping, hunting and outfitting.

As a result of this legislative change and of the inferences that can be made respecting population number and dynamics based on Canadian Wildlife Service research, Manitoba is recommending the existing quota of 97 be re-evaluated and adjusted if necessary, and a cooperative management strategy be developed for the Zone A1 population of polar bears.

Non-consumptive use of polar bears

A permit system to regulate tour operators at Cape Churchill was implemented in September 1988, as a result of concerns of residents, tourists, the tour operators, and polar bear managers and researchers. In the past decade, polar bear viewing has become a major tourism industry at Churchill, generating considerable dollars for the local and provincial economies. It was refined over the next several years by Wildlife Branch staff following consultation with tour operators, local residents, and polar bear researchers.

The permit system applies to all commercial tourism operations using the Cape Churchill Wildlife Management Area and

- 1) requires tour operators to keep their vehicles on designated routes;
- 2) restricts access to prime polar bear staging areas;
- 3) prohibits tour operators from placing food for feeding or holding polar bears;
- 4) allows for limited, temporary overnight facilities at designated locations for extended tours.

Item 3, to do with baiting, caused concern among some of the tour companies. They lobbied senior staff, including the ministers of the Tourism and the Natural Resources departments to allow the use of foods or attractants to attract and hold free-ranging bears in the area 20km east of Churchill that is currently used by tour operators. After some deliberation, the Department of Natural Resources decided it would not allow baiting.

The majority of the members of the PBTC were also against baiting. A consensus was that a survey of the attitudes of tourists, townspeople, and others should be conducted; that an education program about polar bear management at Churchill and explaining why baiting is not tolerated would take some of the pressure off tour operators to provide close-up photo opportunities all the time; and that feeding should be done only in conjunction with research designed to evaluate its effects.

Some baiting and feeding was still occurring in 1989. Too many vehicles at the same site at one time also caused problems, including a reduction in the quality of the experience. By 1990, there were no overt infractions to the regulation prohibiting baiting. In one instance, several cases of lard were intercepted by a tour operator after the Department informed him that a tour group chartering his facilities intended to take this unusually large quantity of lard with them.

Two complaints raised in 1990, one from a tourist about the harassment of polar bears by two operators, the second from the local Churchill Land and Resource Use Steering Committee, and directed at several aspects of the tour operations, prompted a meeting of this Committee, the tour operators, and Department staff to discuss their concerns in more detail.

There are still the annual concerns expressed by local residents, tourists, and commercial operators alike about the congestion that occurs at the peak of the viewing season and its impact on the area's aesthetics and environment and the quality of the tours. However, there is no consensus for a solution to these concerns. Interestingly, the Department has had requests from two existing operators for an additional vehicle each and from three interested parties for new permits since the 1991 tour season ended. The Department has taken the position that no additional permits will be issued to new operators and no additional vehicles permitted to existing operators.

The Department is addressing the issue of the safety of existing vehicles from two perspectives: straightforward commonsense, and the liability of the government should an accident occur involving a bear. It is likely that none of the existing vehicles are 'bear-proof' and it has been observed that some methods employed by operators are dangerous. The issue that must be addressed is at what point does the Department's responsibility end and the operator's begin.

Proposed national park in the Churchill–York factory area

The status of the land area currently designated the Cape Churchill Wildlife Management Area may change in the future. A proposal has been made for a national park in the Churchill area. The study area includes the Hudson Bay lowlands area from Seal River to Cape Tatnum. The proposal identifies an area within the existing Cape Churchill Wildlife Management Area for a Natural Park designation. It includes most of the primary autumn staging areas and winter denning area currently used by the Zone A1 polar bear population.

An emphasis was placed on local community consultation and involvement, in particular with Churchill residents. Other communities, including Tadoule Lake, York Landing, Shamattawa, Bird, and Gillam were given an opportunity for input, and open houses were held in Thompson and Winnipeg. The proposal attempts to accommodate the major concerns and desires of Churchill residents, Manitoba Natural Resources, and Canadian Parks Service, among others. Some additional discussions are continuing with representatives of native communities because some of their concerns are not dealt with adequately in the proposal.

A working group and seven technical committees also formed to try to cover concerns such as marine and land resources, or the effects on the community. Both the Steering Committee and the Working Group were restructured in 1991 to include representatives for local Native communities that could be affected by the establishment of a national park. This was in addition to federal, provincial and Churchill representatives. A representative of Parks Canada pointed out that most northern parks in Canada are classified as 'wilderness', with minimum development.

The parties are now trying to finalize a Memorandum of Understanding that will:

- 1) summarize and reflect the broad cross-section of government, community, organizational and private interests related to the establishment, development and management of a national park in the Churchill–York factory area;
- 2) clearly outline unresolved issues requiring further investigation and/or negotiation;
- 3) establish the process for negotiating a Federal-Provincial Park Agreement between the governments

of Canada and Manitoba but with special reference to the role to be played by local representatives.

As of mid-1992, this Memorandum of Understanding was in the preliminary draft stage only.

The PBTC expressed concern about what effect a park might have on ongoing research. Some studies, including the polar bear studies, have been underway for over 20 years. In the case of polar bears, there is a unique database that will likely never be duplicated in other areas. Because the entire population is ashore and accessible in a relatively small area, several research opportunities exist there that do not occur elsewhere. In some southern parks, guidelines for research have been quite restrictive in some cases. Perhaps on polar bears at Churchill contributes to conservation of the species on a world-wide basis and helps Canada to live up to its commitments under the International Polar Bear Agreement. One of the main reasons for the proposed park is the polar bear denning area and the accessibility of the whole population. Perhaps research could be one of the areas in which this park could contribute overall.

Newfoundland

Although Labrador has had a quota of four since 1978–79, there is no regular hunting season. Hunting is facilitated by the allocation of special permits by the Minister. In Spring 1991, the government authorized a season with a quota of four bears. Eligibility for hunting was defined as "... a person who has resided in the Torngat Mountains Electoral District for at least six months prior to the hunting season.", with no distinction between natives and non-natives. The LIA objected to the eligibility requirement.

Although the International Polar Bear Agreement states that "local people" and "nationals" may take polar bears, Canada submitted a Declaration at the time of ratification that states, in part, that the hunt is an important traditional right and cultural element of the Inuit and Indian Peoples, but that local people in a settlement may authorize the selling of a polar bear permit from the subpopulation quota to a non-Inuit or non-Indian hunter, but with the additional restriction of a native guide and a dog team within Canadian jurisdiction. The intention in Canada was to limit the hunt to Inuit and Indians. At the time, there was no hunt in Labrador, and the Newfoundland government supported the Canadian position.

Under land claim settlements in the NWT and Québec, access to polar bear hunting is clearly limited to native people. The approach to eligibility in Labrador is different than in other jurisdictions, and may set important precedents. The issue may be best resolved during the settlement of land claims in Labrador.

Eleven bears were killed in late 1991. Of these, two were illegal kills and three were problem kills. (These were included in the 1991–92 kills). Another three bears were moved by Newfoundland Wildlife officers. Both an ice build-up quite far south, and a large harp seal herd just offshore may have contributed to the unusually large number of kills and problem bears.

Currently, the fines for illegal kills of moose or caribou are higher than for illegal kills of polar bears; the department is looking into changing those regulations.

Northwest Territories

Northwest Territories polar bear management plan

A draft management plan has been developed for the Northwest Territories. This plan has been reviewed by the Canadian Federal/Provincial Polar Bear Technical Committee (PBTC), and Territorial Biological Staff. It is currently under final Review by the Department of Renewable Resources Directorate. A key facet of the Management Plan is the development of "Local Management Agreements" between the communities that share a population of polar bears. Under the Inuvialuit and Nunavut Land Claim Agreements, polar bear management and research is an expressly cooperative venture between the local users, their representatives, and government. A five-part process to address management changes has developed that begins with local meetings and concludes with Local Management Agreements that are witnessed by the Minister of Renewable Resources. These Agreements are then used to develop regulation changes that enable the agreements.

- 1) Community visits where scientific information and traditional knowledge is shared.
- 2) Development of Local Management Agreements between the communities that share polar bears (two representatives per community).
- 3) Review of proposed agreement by the community.

Polar Bears

- 4) Agreement amended as necessary, signed by communities, and witnessed by Minister of Renewable Resources.
- 5) Regulation modified to enable agreement.

Other jurisdictions that share a population are encouraged to participate in this process. However, these relationships must be worked out individually.

Status of local management agreements for polar bears

Zone	Status of Agreement
A1	First meeting of parties held (Manitoba not present), interim Agreement expected in early March 1993
A2	Initial community consultation in NWT settlements completed
C	First meeting of parties held (Québec not present), final in early March 1993
D1	Agreement signed 1992 for 3 year period*
D2	Initial community consultation in NWT settlements completed
E1	Done,* reviewed September 1992
E2	Initial community consultation completed
E3	Initial community consultation completed
F	Done, March 1992
G	Initial community consultation completed
H1	Done, reviewed September 1992
H2	Done, reviewed September 1992

*These agreements were for a harvest that exceeds the sustainable yield; they will be revisited in subsequent meetings.

*See Appendix 1 for an example of a Local Management Agreement (Area F)

Conservation education

A poster to encourage hunters to be more selective for males was produced and distributed. The poster is titled: "Save the Females". A booklet on how to tell males from females was prepared based on traditional knowledge of hunters in the Baffin region.

The development of the Local Management Agreements has required an extensive series of meetings with local hunters. During these meetings the scientific information for the local population, the harvest information, and the knowledge of the local hunters is exchanged. Our approach to management is explained and the reasons for the quotas and regulations are explained. Prior to these meetings many of the hunters regarded the regulations as arbitrary interference in their hunting. The meetings leading to the agreement have increased concern for conservation and increased local confidence in our research and management programs.

Traditional knowledge

Local involvement in both research and management has increased considerably. The local and traditional knowledge of northern residents is being systematically collected by interviews and by conducting field research with traditional methods as much as possible. An example is polar bear capture using dogs and snowmachines, rather than helicopters. The Department has formed a standing committee on Traditional Knowledge to promote development of cross-cultural initiatives.

Population status

The status of polar bears in the 12 populations that are wholly within or shared with the Northwest Territories is determined by the number of individuals in the population, the rates of birth and death of the population, and the rate at which animals are harvested. These factors have been considered in a number of workshops by the PBTC. The status of polar bear populations within and shared with the Northwest Territories (Table 4) has varied considerably. Inventories of polar bear populations are made periodically, and quota allocations are modified based on those results. The inventory is repeated approximately every 20 years, and management changes are made as required. This process is described in the Northwest Territories Draft Polar Bear Management Plan. The Draft Plan also contains summaries of other information relevant to the status of the respective populations.

At the 1992 meeting of the PBTC, there was considerable discussion of the population status table included in the NWT submission. The population estimates for some zones have been reviewed and revised conservatively according to the available data, but in the absence of additional new documentation. Although the PBTC have noted the need to conduct studies on these populations, the funding has not been available. One of the problematic populations is in western Hudson Bay (Zone A1). Although Zone A1 extends from about Rankin Inlet to the Manitoba–Ontario border, the current estimate applies only to the study area between the Churchill and Nelson rivers. It is unclear at this point how many additional bears may be present north of the Churchill River and, probably more importantly, south of the Nelson River in the Cape Tatnum coastal and inland areas. To date, there have not been sufficient funds to facilitate extending the capture program to the southern area.

Ontario, Yukon

There have been no management changes in these jurisdictions

Québec

In accordance with the law on hunting and fishing rights in the Baie James and Nouveau-Québec Territories, the polar bear harvest is restricted to native people. This law aims at protecting traditional rights of northern Québec natives as recognized by the government of Québec. The law makes provision for guaranteed harvest levels; harvests can be taken as long as the principle of conservation is respected. Guaranteed harvest levels were established based on observed polar bear harvest, between 1976 and 1980; Inuit have agreed already on the levels while negotiations are much advanced with the Crees.

Following discussions on the 'Polar Bear Tactical Plan' with native organizations, it was agreed that the Ministère du Loisir, de la Chasse et de la Pêche (MLCP) will not impose hunting regulations in addition to those already accepted with Inuit after an amicable settlement, as long as bear harvests remain below guaranteed levels. These tentative levels, subject to minor changes, are 22, 31, and 9 annual kills for hunting zones A2, D2, and C respectively; they constitute harvest targets. These harvest levels apparently agree with the principle of conservation as the polar bear populations involved do not exhibit any sign of decrease. However, the

MLCP will try to convince Inuit to stop hunting bears in summer refuges during the ice-free period, in accordance with the Tactical Plan.

Canadian Parks Service interests

The Canadian Parks Service of Environment Canada has become progressively more involved with arctic areas that include polar bear habitat. They will eventually have to deal with human–bear problems and make management decisions affecting polar bears in existing and proposed parks. In 1989, an invitation to send an observer to the PBTC was sent to the Canadian Parks Service. Charles Pacas, the wildlife management officer for northern parks, attended for the first time in 1990.

Under the revised Parks Act of August 1988, polar bears are classified as threatened. Any person who hunts, disturbs, confines, or is in possession of wildlife, or who is in possession either in or outside a park of such wildlife killed or captured in a park, is guilty of an offence and is liable,

- a. **on summary conviction**, to a fine not exceeding \$150,000; or
- b. **on conviction or indictment**, to a fine not exceeding \$150,000 or to imprisonment for a term not exceeding six months or both.

Canadian Parks Service (CPS) realize they are involved more in people management than wildlife management. Parks have a dual mandate to protect the resource but also to encourage use of the parks.

The recent Justice Tobler decision involving a bear attack in Banff National Park contained information that is pertinent to CPS's management of its wildlife resource and users of the resource: a) the CPS as the operator, manager, and controller, has the responsibility to ensure the safety of the visitor; b) when policy has been approved, it must be implemented and that implementation must be complete (i.e., when CPS have a bear management policy or garbage policy in place, it must be enforced); c) misrepresentations of safety are a common cause of personal injury and a familiar form of negligence that the law has long considered actionable (from the decision: "...often the misrepresentation consists, not in something he said, but in failing to say anything at all (that is to warn)..."); and, d) the information CPS presents to the public must be current, accurate, and easily available.

Each park has a management plan that must be tabled in Parliament within five years of the park being created. The Minister reviews the management plan every five years and tables any amendments in the House of Commons. Maintenance of ecological integrity through the protection of natural resources is given the first priority when considering park zoning and visitor use in a management plan. Included in the plan for Auyuittuq is the goal of increasing visitor use, which could lead to an increase in bear-human conflicts. The TFN agreement also encourages an increase in visitors to the park, training of natives, and an increase in the economic benefits of tourism to residents of Broughton Island.

Parks have prepared an information booklet on polar bears in national parks. Currently, only natives, Parks employees, and researchers are allowed to carry firearms within northern parks. A superintendent can authorize persons to carry firearms for park management purposes. Research is usually included under this category, but it might also include activities such as guiding, running concessions, etc. Because several proposed parks—Wager Bay, Bylot Island, Banks Island, a possible arctic marine park, and an enlarged North Yukon Park, for example—may also have polar bear concerns, there is a need to review this policy and assess possible alternatives to firearms for safety and deterrence of bears (while at the same time ensuring protection of bears and, in particular, any critical habitat area).

The PBTC discussed the issue of visitor safety and protection of bears at some length at their 1990 meeting. A multi-level zoning based on assessment of danger of polar bear-human encounters was proposed. The following draft contains modifications suggested by Pacas and Bossé:

People and polar bears in Canada's arctic national parks

The Canadian Parks Service is creating new national parks in the Arctic, several of which are inhabited by polar bears during part or all of the year. As the parks develop, they will attract visitors, which will inevitably bring people into contact with polar bears. In the southern parks, visitors are not allowed to carry firearms for protection from black or grizzly bears. However, polar bears are much more predacious than other species of bears and are much more likely to be dangerous to people. In the view of the Polar Bear Technical Committee, the safety of visitors in at least some areas of the arctic parks, at particular times of the year, could not

be ensured without firearms. At the same time, the PBTC recognizes that firearms in the hands of an inexperienced or frightened person may be more dangerous than not having them at all. We also recognize that CPS does not wish to establish a precedent for visitors carrying firearms in national parks. Consequently, as a starting point for discussion, we suggest establishing risk zone areas that would reflect potential danger from polar bears, and structure the response accordingly.

The following is a preliminary draft for discussion.

1. Area closures

This approach is already used in the southern parks when conditions are judged to be unsafe for visitors. Known areas of high concentrations of polar bears (such as the Hudson Bay coast south of Churchill in the summer and autumn), should simply be closed to hiking, camping, and kayaking until visitor management techniques such as controlled group tours or viewing facilities can be implemented without adverse impacts on critical bear habitat areas.

2. Compulsory guide

In some areas where bears are common, an experienced person can still travel safely (such as the east coast of Baffin Island). It could be made mandatory to hire a local guide who would be fully trained, allowed to carry a firearm, and be responsible for the safety of visitors.

3. Firearm-propelled deterrents permitted

For many people, the presence of a guide and possible motorized transport will eliminate enough of the essence of the wilderness experience that they will not visit the Park. For remote areas where the possibility of meeting a polar bear is judged to be possible but unlikely (such as the Yukon coast or Herschel Island), groups that can demonstrate sufficient competence could be allowed to take a firearm that can fire deterrents for protection in the unlikely event of an encounter with a problem bear.

4. Bear-proof shelters

Some people will not wish to be accompanied by a guide and not be competent with firearms. In areas where the possibility of meeting a polar bear is judged to be very low but still possible (such as the interior of Banks Island), bear-proof shelters containing radios could be provided at intervals of some reasonable distance so people can camp in safety and be prudent about walking, kayaking, and other activities.

5. Firearm-free areas

Firearms might not be allowed at all in areas where the possibility of meeting a polar bear is judged to be virtually non-existent (such as on the Penny Ice Cap).

Management of polar bears in the Beaufort Sea

In October 1988, the Joint Commissioners and Technical Advisors of the agreement between the North Slope Borough Fish and Game Management Committee (NSBFGMC) and the Inuvialuit Game Council (IGC) met to discuss the size of the allowable harvest of polar bears and how it would be allocated. The following items were recommended for approval of the jurisdictions:

1. That the following guideline harvest levels be established for polar bears: Canada, 38 bears annually; Alaska, 38 bears annually.

That the guideline harvest levels be based on the following assumptions:

- a) The Beaufort sea polar bear population is estimated at 1800–2000. The population estimate may change as information becomes available.
 - b) The sex-ratio of the harvest is two-thirds males to one-third females.
2. That the USFWS, in consultation with the Alaska Department of Fish and Game, the NSB, and Canadian agencies, develop guidelines for monitoring and mitigating conflicts between polar bears and human activities.
 3. That all possible means be used to reduce the proportion of female polar bears in the harvest.
 4. That an information and education program on the Agreement be undertaken in both countries.

These harvest guidelines are significant, because their implementation marks the first time since enactment of the MMPA that a harvest limit, based upon sustained yield principles, has been placed on polar bears in Alaska. Further, implementation is by the individuals most affected by the Agreement. Recognition of the need for a more active management program for this area is the basis of the Agreement. The NWT Department of Renewable Resources, in cooperation with the other agencies, initiated the development of a

slide show and poster to be presented or distributed to local villages.

The harvest of polar bears in 1988–89 was lower than the number of bears available. There were even examples of bears being chased from villages rather than being shot.

In 1989–90, there was some concern about an over-harvest in Alaska. However, since few of the bears killed were females, there should be no effect on the population. However, there was clearly a need for improved contact and awareness of the management concepts. In Canada, some settlements, especially those with no resident game officer, had a variable record in reporting of kills. Efforts were made to improve this. At the consultative meeting that year, the possible need to shift the boundary between zones H1 and H2 was discussed. However, recent analyses indicated that, while a small movement might be needed, there will be no large change in the position of the boundary.

The total 1990–91 Canadian harvest of polar bears in the area covered by the Agreement was 34, out of a quota of 38. The sex composition of the kill was approximately 1.3 males to 1 female, but the sex of three bears was not recorded. This represented a higher proportion of females than desired. The reason for approximating the sex composition of the harvest was that the total for Paulatuk had to be estimated on the basis of one-third from the mainland population and two-thirds from the Banks/Amundsen Gulf population. In the past three years, 12 of 15 bears killed as problems throughout the eastern Beaufort Sea and Amundsen Gulf were included in the quota. From earlier analyses, it appears that polar bears were likely being over-harvested in the late 1960s and early 1970s. The average age of polar bears killed by hunters was quite low and in 1971–73, only 2.2% of the bears were over 10 years of age. Similar results were presented from Alaska. It seems likely that hunting pressure was so heavy that bears were being killed before they had a chance to grow old. For the past 10 years, it appears that the average age of the harvest has been relatively constant and a healthy proportion of the population is reaching old age. This is particularly important for the adult females. The Inuvialuit Game Council recognises that there is a need to improve the reporting of the sex of bears killed and the collection of jaws for age determination. Some difficulties are still being experienced in this area but should be rectified in future years.

The Inuvialuit and Inupiat agreed that the accuracy of the harvest statistics is of paramount importance to the continued success of the Agreement. The quota of 76 for the southern Beaufort Sea population of polar bears was agreed upon for 1991 and 1992. It will be shared evenly, with 38 bears being allowed to each Party to the Agreement. The 1991–92 kill was 30 (16 males) in Alaska, and 32 (12 males) in Canada.

Polar bears and assessment of impacts of hydrocarbon exploration

On 6–7 November 1989, representatives from the Inuvialuit Game Council, Esso, and the NWT Department of Renewable Resources met to develop an oil spill contingency plan for the ISSERK I–15 1989–90 drilling season. The scope and tenure of this plan was limited, but an approach was developed that could prove useful for development of other or more comprehensive plans. Copies can be obtained through Mitch Taylor.

Several years ago, the PBAC decided to drop the Oil Spill Contingency Plan developed by Schweinsburg and Lee. However, the possibility of damage to polar bears because of spilled oil keeps coming up in a variety of contexts. In 1989–90, in response to the possibility of polar bears being oiled if a blowout occurred in the Beaufort Sea at a proposed well site, the Government of the NWT cooperated with Esso Resources Canada Limited to draft what was called a polar bear protection plan. Although not as extensive as the original oil spill contingency plan, this plan was similar in a scaled-down form and responded to many of the original concerns of the Technical Committee. Copies of the plan "Esso Resources Canada Limited Polar Bear Protection Plan for Isserk 1–15 (1989–90 Drilling Season)" can be obtained from the NWT Department of Renewable Resources.

In December 1990, a Gulf proposal to drill was reviewed in detail by a group of 30–40 people who met in Calgary for a two-day workshop. Compensation and mitigation in event of an oil spill in the Beaufort Sea were discussed. Polar bears were perceived as one of the most important resources likely to be affected by an oil spill. The Oil Spill Contingency Plan/Polar Bear Protection Plan was used as a background document.

In January 1992, Scott Schliebe and Andy Derocher attended a meeting in Anchorage, Alaska on the impacts of hydrocarbon exploration on polar bears. Oil and gas companies operating in the Beaufort Sea are concerned that future polar bear–human interactions be minimized. Information required of operator site-specific polar bear interaction plans (voluntary action in the absence of incidental take regulations and Letters of Authorization) have been reviewed for completeness and consistency with conditions of the US Marine Mammal Protection Act.

In the NWT, NOGAP has provided funding for a two-year study of oil-spill preparedness. The capability of responding to an oil spill with local transportation (snow machines) will be developed in 1992–93 and tested in 1993–94. Tubs for cleaning oil-fouled bears and cages for holding oil-fouled bears will be constructed and stored in Tuktoyaktuk. In winter 1993–94, a simulated oil-spill will be marked out and local hunters will be hired to respond. A 24-hour watch will be initiated, and deterrence, capture, and cleaning activities will be simulated. This test will ensure a local ability to respond quickly and independently to an oil spill.

COSEWIC status of polar bears

In 1990, the PBAC decided the classification of the polar bear as "vulnerable" under COSEWIC was not appropriate because the definition was loose and overstated the case. For COSEWIC, the definition of vulnerable reads as follows: "Any indigenous species of fauna or flora that is particularly at risk because of low or declining numbers, occurrence at the fringe of its range or in restricted areas, or for some other reason, but is not a threatened species." Since the reasons for the polar bear being classified as vulnerable fall into the phrase "or for some other reason," the Technical Committee felt it appropriate to explain their support of this classification with a justification, as follows.

Polar bears are distributed at low densities. The current estimate is approximately 13,000 polar bears in Canada, in about 12 subpopulations, each of which is estimated to number from less than 1000 individuals up to a few thousand. Polar bears have a low reproductive rate. Consequently, the size of a population could decline quickly as a result of over-hunting, or damage to

significant parts of the ecosystems on which they depend. A decline in the size of a subpopulation, for whatever reason, would be difficult to detect from monitoring the harvest until it was serious, after which it could take decades to recover. At present, management of polar bears in Canada is based on extensive research that reduces, but does not preclude, the possibility of a subpopulation declining because of over-hunting. For a few populations, we do not have enough information to determine whether current harvest levels are sustainable. In these areas, research and community-based monitoring programs are ongoing. Recent computer modelling has shown that polar bear populations are particularly sensitive to the harvest of adult females. Large-scale environmental damage, while not highly likely to occur, is beyond the ability of government or industry to control. Oiling of the fur and ingestion of oil are lethal to polar bears if not treated quickly. Because polar bears are at the top of the marine food chain and prefer to eat the fat of seals, in which toxic chemicals such as PCBs are deposited, they concentrate these substances. If levels of local and global pollution increase, polar bears, and other apical predators, will be subject to the detrimental effects of increasing concentrations of toxic chemicals in their tissues. The

long-term effects of such concentrations are unknown but cannot be ignored. Similarly, possible long-term effects of climate change on polar bears are unknown.

Federal Government

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973) (CITES) has been in effect since July 1975. Polar bears are included in Appendix II to the Convention ('all species that, although not necessarily now threatened with extinction, may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with their survival').

The Federal Government, through the issue of permits, has maintained a permanent record of all polar bears, hides, or any other products legally exported or imported. The 1987 through 1990 data are summarized in Table 5. In those years, most of the exported hides were again destined for Japan.

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TABLE 1. Summary of regulations covering polar bear management in Canada as of 31 December 1992

CATEGORY	JURISDICTION					
	Manitoba	Newfoundland	Northwest Territories	Ontario	Quebec	Yukon
Hunting	closed	has been closed; reopening under consideration	01 Oct. to 31 May in Keewatin, Foxe Basin and Grise Fd; 15 Nov. to 31 May for 12 tags in Repulse; 1 Oct. to 31 May for 4 tags in Lake Harbour; 1 Dec. to 31 May all others	closed	none	01 Oct. to 31 May in GMZ1 only
Who can hunt	Treaty Indians if specifically permitted by Minister of Natural Resources.	Inuit only during season	Inuit residents and non-residents with Wildlife Certificate if HTA provides necessary tag	permissible kill by Treaty Indians	Inuit and Indians	Inuit only who are issued polar bear tags
Quota	total quota of 50, 15 of which are currently on loan to the NWT and included in the NWT total, and 35 are not exercised at present.	4 continuation of season not yet determined	quota by settlement 1988-89 limit equals 615 (including 15 loaned by Manitoba and 6 administered for Yukon)	permissible kill of 30 (by restricting sales over 30)	none	total quota of 6, all of which are presently included in NWT total
Females and cubs protected	yes	yes	cubs and females with cubs under 1.5 m in length, prior to being stretched and dried or 1.8 m after being stretched and dried	no	no	yes
Bears in den protected	yes	yes	yes	no	no	yes
Proof of origin of untanned bear	documented proof	documented proof (no seal implemented to date)	seal on hide and export permit	seal on hide proof of origin required on imported hides	seal on hide	seal on hide kill monitored by export permit
Export permit required and cost (out of province or territory of origin)	required no cost	required \$5.00	required \$1.00	required no cost	required no cost	required \$5.00
Export permit out of Canada	required by CITES for all polar bears or parts thereof exported out of Canada obtained from Province or Territory in which port of export					
Scientific Licences	discretion of Minister	discretion of Minister	discretion of Director of Wildlife Management, Department of Renewable Resources	discretion of District Manager	discretion of Minister	discretion of Conservation Officer (Wildlife Research Permit)

TABLE 1. Summary of regulations covering polar bear management in Canada as of 31 December 1992 (cont'd.)

CATEGORY	JURISDICTION					
	Manitoba	Newfoundland	Northwest Territories	Ontario	Quebec	Yukon
Selling of hide by hunter	prohibited skins of nuisance bears sold by Manitoba Gov't. through sealed tender	allowed if legally obtained	yes must be sealed	must be sealed by Ministry staff	\$15.00 Royalty fee must be sealed	permit required from Conservation Officer
Basis of Regulation	Wildlife Act 1991	Wildlife Act 1970 classified as big game	Wildlife Ordinance and Regulations; 1960 Order in Council (Endangered Species)	Game and Fish Act R.S.O. 1980 Chap. 182	Wildlife Conservation and Management Act 1983 Order in Council 3234-1971 Bill 28-1978 (James Bay Agreement)	Wildlife Act, 1981: Wildlife Regulations
Fur Dealer Authority	\$10.00 restricted \$25.00 general \$25.00 travelling	\$2.50 for each store \$2.50 travelling	\$150.00 Fur Dealer's Licence for each of the first 2 consecutive years, then \$10.00 for each year after \$200.00 Travelling Fur Dealer's Licence for each of the first 2 consecutive years, then \$100.00 for each year after	\$28.00 licence	\$200.00 licence Order-in-Council 1274-1984	\$25.00 Resident \$300.00 Non-resident \$5.00 Agent \$25.00 Non-resident restricted
Taxidermy	\$5.00 Wildlife Act Licence	legislation in preparation; legal if obtained legally elsewhere	\$25.00 Taxidermist Licence	see Tanner's Authority	see Tanner's Authority	\$25.00 Resident Licence, \$30.00 Non-resident Licence
Tanner's Authority	\$10.00 licence	no legislation at present	\$25.00 Tanner's Licence	Game and Fish Act (\$28.00 licence)	\$150.00 Tanner's Licence	\$2.00 Resident, \$10.00 Non-resident
Live Animals Capture	Ministerial permit	illegal unless authorized by permit from Minister for scientific purposes	\$5.00 licence to capture live wildlife	District Manager	Ministerial permit	free Wildlife Research Permit, \$5.00 fee for capture of live wildlife
Live Animals Export	Ministerial permit	Wildlife Export Permit	Wildlife Export Permit \$100.00-\$5000.00 licence to export live wildlife	District Manager	Ministerial permit	Special permit

TABLE 2. Quotas¹ and known numbers of polar bears killed² in Canada, 1987–88 through 1990–91

	Man. ³	Nfld.	NWT ³	Ont. ⁴	Que. ⁵	Yukon	Norway ⁶	Total
1987–88 Quota	35	4	611	30	62	6	5	753
Bears killed ²	6	0	525	16	47	5	0	599
Bears captured and held in zoos	0	0	0	0	0	0	0	0
1988–89 Quota	35	4	611	30	62	6	5	753
Bears killed	6	8	553	17	60	4	0	648
Bears captured and held in zoos	0	0	3	0	0	0	0	3
1989–90 Quota	35	4	611	30	62	6	5	753
Bears killed	6	0	540	16	66	4	0	632
Bears captured and held in zoos	1	0	0	0	0	0	0	1
1990–91 Quota	35	4	611	30	62	6	5	753
Bears killed	8	0	490	23	47	4	0	572
Bears captured and held in zoos	0	0	0	0	0	0	0	0
1991–92 Quota	35	4	609	30	62	6	5	751

¹Management year extends from 1 July to 30 June the following year. Numbers may change as more information is received from the villages.

²All known kills, including quota and sport-hunt kills, problem kills, illegal kills, bears found dead, and bears that die while being handled by scientists.

³Fifteen of the Manitoba quota of 50 are administered by NWT; any kills under this quota are included in the NWT total.

⁴Permissible kill.

⁵The total allowable kill in Quebec is a maximum harvest level controlled by the length of the hunting season and by allowing only certain sex- and age-categories to be taken.

⁶Allowed to Norway for protection of life under the Agreement on the Conservation of Polar Bears (1973).

TABLE 3. Manitoba Polar Bear Control Program 1988–91

Program duration	1988 mid-Aug.– mid-Nov.	1989 Jul.– mid-Nov.	1990 Sept.– mid-Nov.	1991 mid-July– 31 Oct.
No. of occurrences	99	94	89	71
No. of bears captured	35	51	64	18
No. of bears killed:				
– by Department	2	1	0	0
– by public	2	1	0	0
Handling deaths	1	0	0	0
Natural deaths	0	0	1	0
No. of bears to zoos	0	1	3*	1*

*One bear died after being shipped to the zoo.

TABLE 4. Population and harvest estimates for Canadian polar bear subpopulations

Sub-population	Harvest % Females	Revised Population Estimate	Reliability of Estimate	Sustainable Harvest ³	Current Total Kill	Population Status
A1	33.0 ¹	1200	G	54.05	55	Stationary
A2	30.2 ¹	1000	F	49.07	51.7	Stationary
C	33.0 ²	2020	G	91.00 ¹	91.0 ⁴	Stationary
D1-F	31.0 ¹	2470 ⁷	F	119.05	195–215	Declining (data uncertain)
D2	39.21	950	F	36.04	51.8	Declining (data uncertain)
E1	15.0 ²	230	G	3.07 ⁵	4.0 ⁶	Increasing
E2	33.0 ²	700	P	31.08	32.0	Stationary (data uncertain)
E3	33.0 ²	900	P	40.09	41.0	Stationary (data uncertain)
G	40.7 ¹	200	P	7.04	6.0	Stationary (data uncertain)
H1	45.8 ¹	1800 ⁷	G	59.00	63.6	Stationary
H2	48.5 ¹	1200	G	37.01	33.4	Stationary
TOTAL⁷		12,670		532.0	624.5–644.5	

Source: Polar Bear Technical Committee, revised August, 1993.

G = GOOD (Minimum capture bias, acceptable precision)

F = FAIR (Capture bias problems, precision uncertain)

P = POOR (Considerable uncertainty, bias and/or few data)

¹Average percent of killed bears that are females (1987–88 to 1991–92) for populations in which the sex-ratio of the kill is not set by law is based on the Northwest Territories sample plus harvest and problem kills by Greenland, Alaska, Manitoba, Ontario, Québec, and Labrador, as data were available.

²Percent of killed bears that are allowed to be females as regulated by law.

³Except for subpopulation E1, the sustainable harvest is based on the sex-ratio of the harvest, the subpopulation estimate (N) for the area and the estimated rates of birth and death (Taylor *et al.* 1987):

$$\text{SUSTAINABLE HARVEST} = \frac{(N \times 0,015)}{\% \text{ FEMALES HARVEST}}$$

Unpublished modelling indicates a sex-ratio of 2 males to 1 female is sustainable, although the mean age and abundance of males will be reduced at maximum sustainable yield. Harvest data (Lee and Taylor, in press) indicate that selection of males can be achieved.

⁴The communities of subpopulation C have agreed to a phased reduction in quota to 91 or the sustainable yield as determined by subsequent population estimates by 1997. The total kill in will not exceed 122 in 1994.

⁵Subpopulation E1 has reduced rate of sustained yield because of lower cub and yearling survival, and lower recruitment, compared to other subpopulations. The projected percent of females in the harvest is 15% based on the intention to take only males.

⁶A five-year moratorium on harvesting E1 will begin in 1994/95.

⁷Totals refer to sums of subpopulations including those Canada shares with Alaska and Greenland.

TABLE 5. Number of permits issued for polar bears, polar bear hides, and polar bear parts to be legally exported from Canada, 1 January 1987 to 31 December 1990

	1987	1988	1989	1990	Total
Live polar bears ¹	4	1	5	1	11
Polar bear hides ²	349	396	426	410	1581
Skulls/jaws	7	13	24	36	80
Claws	20	0	0	2	22
Tissue specimens	0	> 05kg	525	170	> 695
Bones	2	> 10kg	> 206	2	> 210
Feet	4	8	0	0	12
Preserved organs	0	0	10	0	10

Source: Heppes *et al.* 1989, 1990a, 1990b, and 1991.

¹For zoos.

²Includes some hides with skulls and some as whole mounts.

APPENDIX 1

Management Agreement for Polar Bears in Population F

An agreement between the Hunters' and Trappers' Association of Resolute Arctic Bay Pond Inlet and Grise Fiord

Preamble

As with many species being actively managed, our understanding of the habits of polar bears has increased in recent years. Information has come from the harvest reporting system which emphasizes community involvement and for research projects that identify population boundaries and estimate population numbers.

During 1990, 1991 and 1992, meetings were held in many communities throughout the Northwest Territories to exchange information on polar bears. A main development was the realization the polar bears live within 12 fairly distinct populations within the Northwest Territories and surrounding jurisdictions. The Territorial Department of Renewable Resources expressed a desire to move towards a system of management that was based on populations. The suggested cornerstone of this system was Population Management Agreements drawn up between communities that share the populations.

Workshops were held 6–9 February 1992 and 26–27 March 1992 in Nanisivik which brought together representatives from the four communities that hunt polar bears from the F population. This agreement identifies the management objectives as defined by the users of the polar bear resource and describes how these objectives are to be achieved.

Management Agreement for polar bears in polar bear management area F

Definitions

- (a) The species considered is the polar bear (*Ursus maritimus*).

- (b) The area covered by this agreement is Polar Bear Management Area F, as defined in Appendix I.
- (c) The people who are party to this agreement are the Inuit of Resolute, Grise Fiord, Arctic Bay and Pond Inlet; and the outpost camps associated with those communities.
- (d) Sustained yield is the level of taking which does not cause the population to decline.

Objectives

- (a) To maintain a healthy, viable population of polar bears in the Polar Bear Management Area F.
- (b) To provide the maximum protection to female polar bears, including maintaining the level of females harvested at 28% or less of the total kill. It is recognized that it would be beneficial to the polar bear population to reduce further the number of females harvested annually.
- (c) To minimize detrimental effects of human activities, especially industrial activities on polar bears.
- (d) To manage polar bears on a sustained yield basis in accordance with the best information available, including harvest statistics.
- (e) To encourage the collection of adequate technical information on a timely basis to guide management decisions.
- (f) To encourage wise use of polar bears and polar bear by-products within the context of management on a sustained yield basis.
- (g) To identify research priorities and encourage involvement of local people in research projects and collections of harvest data.
- (h) To hold management meetings with representatives of the communities of area F at least once every three years to update information and set direction for the continuing management of polar bears in this zone.

Regulations

To conserve this population of polar bears, the parties have agreed as follows:

- (a) All female polar bears in dens or construction dens are protected. No one will knowingly approach a female polar bear den closer than 2 kilometres.
- (b) All bears in family groups comprising female with attitalaaq (newborns) or female with attirta (yearlings) are protected.
- (c) The hunting season for Area F will open October 1 and close 31 May; however the Hunters' and Trappers' Associations of each community reserve the right to open their season later or close earlier and allocate polar bear tags in a manner that optimizes their polar bear hunting opportunities.
- (d) Quotas for hunting polar bears shall be allocated to communities on the following basis:

COMMUNITY	QUOTA
RESOLUTE	38
ARCTIC BAY	19
POND INLET	21
GRISE FIORD	27
TOTAL	105

counted as a female for quota setting purposes.

- (e) The sex-ratio of the harvest will remain between 25% and 28% females.
- (f) (1) All bears killed during sports hunts, subsistence hunts, or as a result of defense of life and property shall be taken from the overall quota for the polar bear population in area F.
- (2) When a GHL holder kills a bear the tag will be taken from the quota of the community where that hunter lives.
- (3) If a polar bear is killed accidentally or in defense of life and property by any person engaged or associated with industrial activity, then full compensation will be paid to the nearest F Area HTA, which will provide a tag. The amount of compensation will be set by agreement with industry.

- (4) Other defense or illegal kills will be taken from the quota of the nearest community.
- (5) If a female is shot the attitalaaq or attirta of that female will also be given a quota tag. An abandoned attitalaaq or attirta will be counted as a natural death.
- (6) In all cases the HTA that gives the tag will take possession of the hide and meat after the investigation has been completed by the Renewable Resource Officer.
- (g) Evidence of sex (bacula) of all male polar bears harvested shall be provided when the kill is registered with local Renewable Resource Officer. Where evidence is not provided the kill will be counted as a female for quota setting purposes.
- (h) Hunters from Arctic Bay, Resolute Bay, Pond Inlet and Grise Fiord shall participate in the polar bear research conducted in their area.
- (i) The following data shall be recorded for each bear killed: date, sex, location and hunter's name.
- (j) The following shall be collected from each bear killed: lower jaw, (or undamaged premolar tooth), ear tags or lip tattoos if present, bacula from all male bears, and other specimens as agreed by the hunters for any additional studies. If the bear with a radio-collar is accidentally taken, the radio-collar will be turned in to the local HTA for return to the research project. Any damage on the hide from the radio-collars or capture of the polar bear will be compensated for by the research project.
- (k) Critical areas for polar bear denning and feeding will be identified and protected via the land use permit process and the direction from the local HTA.
- (l) All terms of the agreement, including quota levels, shall be reviewed by the parties when new research is available or within three years.
- (m) The following research and management goals are identified.
 - (i) Development of positions for the community residents in wildlife research projects.
 - (ii) Research and development of methods to protect meat caches from polar bears.
 - (iii) Examination of methods for monitoring movements of male bears.

- (iv) Requirement of a bond for adventurers, explorers, or other travellers to insure that they can meet the compensation requirements for any polar bear that may be killed as a result of their activity.
 - (v) Collection and archival of traditional knowledge of critical areas for polar bear feeding and denning so that these areas are not compromised by human activities.
 - (vi) Collection and archival of traditional knowledge of polar bear behaviour, ecology, and cultural importance to Inuit.
 - (vii) The Department of Renewable Resources will provide funding to enable the above mentioned goals are met.
-

Status of the Polar Bear in Greenland 1993

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Distribution of polar bears

Names of places mentioned in the text are shown in Fig. 1.

The distribution of polar bears in Greenland is largely determined by how extensive the pack ice coverage is and how long the ice remains along the coasts (Fig. 2). These factors not only influence the number and distribution of bears, but also determine their accessibility to the Greenlanders, and the Greenlanders' hunting effort (Vibe 1967; Born and Rosing-Asvid 1989). Polar bears occur most regularly along the entire coast of eastern Greenland (Pedersen 1945; Dietz *et al.* 1985; Born and Rosing-Asvid 1989) and in northwestern Greenland (Pedersen 1945; Born and Rosing-Asvid 1989; Rosing-Asvid and Born 1990). During the summer sea-ice is present in northeastern Greenland and in Melville Bugt and Kane Basin (Fig. 2); polar bears can be found during summer in these areas as well. The occurrence of polar bears in southwestern Greenland is variable and correlated with the distribution of the East Greenland pack ice extending south of Kap Farvel. The pack ice is usually absent from the West Greenland coast between Paamiut (Frederikshåb, approx. 62°N) and Nuuk (Godthåb; approx. 64°N), and consequently polar bears are very rare in this region. In late winter and spring, polar bears occur offshore along the edge of the pack ice in Davis Strait. At locations where the pack ice reaches the coast of western Greenland, polar bears sometimes occur on land (Born and Rosing-Asvid 1989). Polar bears are scarce along the northern coasts of Greenland (Dietz and Andersen 1984).

Location of maternity denning areas

Although there have been no specific studies designed to document the location and density of polar bear denning sites in Greenland, it appears that polar bears den at low densities over most of their range along the coast of eastern Greenland north of approximately 68°N, and in the Melville Bugt and Kane Basin regions (Fig. 3).

This conclusion is based on observations of dens and/or female polar bears with newborn cubs (Pedersen 1945; Born 1983; Dietz *et al.* 1985; Born and Rosing-Asvid 1989; Rosing-Asvid and Born 1990; Glahder 1992). In Greenland polar bear denning sites mainly occur in areas devoid of permanent human dwellings, and where there is sea-ice for a long period of the year (Fig. 3).

Delineation of populations

Significant differences in the concentrations of mercury in the hair of polar bears from eastern Greenland and northwestern Greenland (Born *et al.* 1991), and in the cranial traits of bears from the two areas (Henrichsen and Sjøvold 1986; Henrichsen 1988) suggest that there is little exchange of polar bears between western and eastern Greenland.

East Greenland

The information on stock discreteness is somewhat contradictory and does not allow delineation of polar bear populations in the East Greenland region to be determined. The information suggests: 1) that there is a directional movement of polar bears in the pack ice southward along the East Greenland coast, and a movement in the opposite direction on land and on the land-fast ice; 2) the possibility of more or less sedentary groups; and 3) the occurrence of infrequent (?) long-range movements.

Apparently, polar bears move south along the coast of eastern Greenland with the pack ice in the East Greenland Current. Two percent (4 of 98) of the polar bears tagged off NE Greenland and in the Svalbard and Franz Joseph Land regions between 1966 and 1982 have been recovered from south-west (winter 1968/69; 1983), south-east (1982) and central East Greenland (1980) (Larsen 1986a; Fig. 4). Observations by Inuit and others indicate that there is a general movement of polar bears in the opposite direction on land and on the

land-fast ice along the coast of East Greenland (Dietz *et al.* 1985; Born and Rosing-Asvid 1989).

There are indications of more or less sedentary groups of polar bears in eastern Greenland. Mark-recapture studies conducted in the period 1973–75 showed that a small group of bears consisting primarily of adult females remained in the area between Kong Oscars Fjord and Kejser Franz Joseph Fjord (approx. 73° N) (Vibe 1976a, b, Dietz *et al.* 1985; Born and Rosing-Asvid 1989). Differences in non-metrical traits in polar bear skulls collected over a long period of time indicate that bears in SE and SW Greenland may be separate from bears in NE Greenland and in the Svalbard–Franz Joseph Land region, respectively (Henrichsen 1988).

A connection between polar bears in eastern Greenland and in other areas of the Arctic has been shown. Satellite tracking of polar bears off northeastern Greenland in the spring of 1979 demonstrated that polar bears can move from eastern Greenland to the Svalbard–Franz Joseph Land region against the main direction of the ocean currents (Larsen *et al.* 1983). Polar bears also move to eastern Greenland from other areas of the Arctic; a polar bear tagged near eastern Baffin Island (Canada) in 1983 was shot at the entrance to Scoresby Sound in late February 1992 (Fig. 4). Between May and December 1992, a female with two cubs was tracked by satellite from Prudhoe Bay in Alaska across the Polar Sea to Nordostrundingen in Northeast Greenland (Fig. 4; Amstrup and Durner 1995).

According to Larsen (1986a) a shared polar bear population ranges from East Greenland to the Svalbard–Franz Joseph Land region, and possibly into parts of the western Russian Arctic. However, of 143 bears tagged at Svalbard between 1988 and 1992, only one (0.7%) has been recovered in 1992 from Scoresby Sound (Wiig, pers. comm. 1992; Fig. 4). In addition movements of female polar bears collared with satellite transmitters indicate that the population found in the Svalbard–Franz Joseph Land area is perhaps more discrete than believed earlier (Wiig 1995).

West Greenland.

Polar bears in northwestern and western Greenland are shared with the eastern Canadian High Arctic.

Including the fall of 1992, a total of 1521 polar bears have been tagged within the Canadian management zones (Fig. 5), D₁ (n=371 bears), D₂ (294), F (844) and G (12) (Taylor, in litt. 1992). Between 1973 and 1992,

at least 21 of these bears have been killed in western Greenland north of 69°N (recoveries = about 1.3 % of the bears tagged in the respective Canadian management zones). The majority were taken in the Avanersuaq (Thule) and Upernavik areas (Fig. 6; Born and Rosing-Asvid 1989; Rosing-Asvid and Born 1990).

There are no physical barriers separating bears in zones F, D₁ and western Greenland north of approximately 66°N. On the basis of data from an ongoing satellite telemetry study it appears that the boundary between the Canadian management zones F and D₁ is not warranted. The majority of polar bears from management zones F and D₁ appear to be intermixed on the pack in Baffin Bay and then spend the ice-free season (late summer and fall) on land along the east coast of Baffin Island north of Cape Dyer, the north coast of Baffin Island, and the southeastern coast of Devon Island. Most maternity denning in this shared population appears to occur in Canada although some have also been recorded in Melville Bugt in Greenland (Born *et al.* 1995; Figs. 6, 7 and 8).

Vibe (1982) suggested that a more or less sedentary population of polar bears spends part of the year on the eastern side of the "North Water Polynya". (i.e. in NE Baffin Bay including Melville Bugt). The finding that of seven bears tagged in the Melville Bugt area in the spring of 1978, two were caught in the same area by Inuit during the spring of 1981 and 1984 (Vibe 1982; Born and Rosing-Asvid 1989) may support this hypothesis. However, it may also simply reflect that individual animals tend to show a high degree of seasonal fidelity to particular coastal areas. During May 1992, when an estimated 20 to 30 polar bears were present in the Melville Bugt area, the majority of bears were found at the edge of the offshore Baffin Bay pack ice. Only a few signs of polar bear activity were seen along the coast of Melville Bugt (Born *et al.* 1992).

Estimates of population sizes

Generally, numbers of polar bears in the populations which are harvested in Greenland are poorly known.

East Greenland

Population estimates are available for some areas of the polar bear's range in eastern Greenland. mark-recapture estimates from 1973–1975 indicated that there were approximately 48 bears between approx. 72°N and 73° in eastern Greenland. The estimated number of bears within the entire study area between 72°N and 77°N

(areas A and B in Fig. 4) was about 182 polar bears (Born and Rosing-Asvid 1989). An attempt has been made to estimate the number of polar bears in the entire eastern Atlantic Arctic. By extrapolating the densities of polar bears found at Svalbard in 1980 to the total ice covered-area between East Greenland and the western Russian Arctic, Larsen (1986a) estimated that there were between 3000 and 5000 bears. By extrapolating information on den counts from Svalbard to the same total area, the estimated number of polar bears in the eastern Atlantic Arctic population was 4000–6700; of these between 1700 and 2000 were in the Svalbard area alone (Larsen 1986a).

West Greenland

A mark-recapture estimate for 1980 of 2000 polar bears was presented for the Canadian management zone F (Schweinsburg *et al.* 1980; Canadian Polar Bear Technical Committee 1992, see Taylor 1992). The revised estimate of 2000 in zone F is considered to be conservative (Born *et al.* this volume). A population of 420 (CV=29%) polar bears were estimated for the Clyde River–Broughton Island region within management zone D₁ (Calvert *et al.* 1986); a revised estimate of 470 bears for this area was given by the Canadian Polar Bear Technical Committee in 1992 (see Taylor 1992).

Aerial surveys (1978–79) of western and northwestern Baffin Bay indicated that about 1680 polar bears were present in the pack ice during May (Koski 1980).

Assuming that the catch of polar bears in northwestern Greenland was sustainable, Vibe presented (Anon. 1985a:40) a crude estimate of at least 300 bears for the northwestern Greenland and eastern Ellesmere Island region.

Ecological factors influencing on the numbers of bears

The distribution of polar bears in Greenland is largely determined by the distribution of pack ice (Vibe 1967). Information obtained in 1990 from the hunters living in the municipality of Upernavik (NW Greenland) indicated that the occurrence of polar bears has increased in the northern part of the area during the 1980s, and that the range of the polar bears has extended southward to approximately 73°N. The hunters believed that these changes reflect a change in ice conditions in northern Baffin Bay (Rosing-Asvid and Born 1990).

Harvest

Magnitude and composition of the catch

In Greenland there are no quotas for the catch of polar bears, and the information on the magnitude and composition of the Greenland catch of polar bears is poor (Born and Rosing-Asvid 1989). Reporting of catches by an individual hunter, settlement, or region has not been mandatory. Until 31 December 1992 the catch has been reported on an individual voluntary basis via the Hunters' Lists of Game (HLG; Anon. 1950–1987). The reliability of this system of reporting has deteriorated since about the mid-1975s (Born and Rosing-Asvid 1989). A new system of reporting catches in Greenland was introduced in January 1993 (see 'Summary of research required to ensure sustainable exploitation of polar bears in Greenland' below).

According to the HLG, the annual take of polar bears between 1955 and 1987 averaged 113.2 animals (SD = 35.0; 28–182 animals). This figure includes estimates given in the published HLG to compensate for unreported catches. If these estimates are excluded, the average annual catch of polar bears during the period was 104.4 animals (SD = 39.8; 28–182 animals). The catch shows great annual fluctuations with no evidence of any trends. Catch data obtained from various sources for 1980–92 are presented in Table 1. It is estimated that the actual take of polar bears in Greenland has averaged about 150 bears per year during the last several decades. Based on interviews of hunters the estimate of the average annual catch of polar bears in western Greenland (SW Greenland not included) during the late 1980s and early 1990s ranges between 40 and 60 bears (individuals/year; Avanersuaq/Thule: 20–30; Upernavik: 15–20; other areas: 5–10). The remainder of the Greenland catch is taken in eastern and southwestern Greenland.

The majority of the catch is taken while on sledge trips during late winter and spring (February–April; Fig. 9). Of 61 catches in Avanersuaq (NW Greenland) for which the method of hunting was known, only 1.6% of the bears were taken using motorized boats (usually skiffs with 40 hp outboard engines). The corresponding figure for Scoresby Sound (E Greenland) was 4.9% (n=84; Born and Rosing-Asvid, unpublished data). According to Sandell and Sandell (1991) the number of polar bears taken from boats increased in Scoresby

Polar Bears

Sound in the mid 1980s. Biological samples obtained from the hunt indicate that independent (> 2 years of age) females comprise about 40% and 36% of the total catch in Scoresby Sound and Avanersuaq, respectively (Table 2). Young and subadult bears (< 4 years of age) make up a large proportion of the catch (Fig. 10; Born and Rosing-Asvid, unpublished data).

Guided sports or photo-safaris are not permitted in Greenland. According to the hunting regulations, a hunter is not allowed to receive payment from anybody participating in a polar bear hunt if these persons themselves are not licensed as full time hunters (Hunting Regulations §1; Born 1991:30; Anon. 1992a).

Over the years, a very limited number of polar bears have been shot in self-defense by military or station personnel in the national park of North and East Greenland. Such cases must be reported and the hides delivered to the police.

Management

Management scheme and hunting regulations

There have been polar bear hunting regulations in northeastern Greenland since 1937 (Anon. 1938, 1956). However, following the signing of the International Agreement on Conservation of Polar Bears and Their Habitat in 1973 (Anon. 1973, 1974a), regulations were extended to include all areas of Greenland and were enforced by 1 January 1975 (Anon. 1974b). Since then, several minor amendments have been made to the regulations. When Home Rule was established in 1979, Greenland took over the legal responsibility for management of its renewable resources, including polar bears. The hunting regulations issued by the Greenland Home Rule in 1985 (Anon. 1985b) remained the same as those issued by the Danish government (Born and Rosing-Asvid 1989). In 1977, Denmark, on behalf of Greenland, ratified the International Agreement on the Conservation of Polar Bears and their Habitat (Anon. 1978). When polar bear studies conducted by the Greenland Fisheries Research Institute (Greenland Home Rule) were initiated in 1991, Greenland *de facto* took over the responsibility providing scientific data for the sound management of its polar bear populations as outlined in the International Agreement on Conservation of Polar Bears and their Habitat.

The polar bear hunting regulations state that bears can be taken only by hunters who hunt and/or fish as a full-time occupation and have a valid hunting license issued by the Greenland authorities (Hunting Regulations §1; Born 1991; 30, Anon. 1992 a). Basically, these regulations try to control hunting effort by ensuring that polar bears are taken only by traditional means as a part of the Inuit's subsistence hunting. Hence, it is forbidden to use motorized vehicles (aircraft, helicopters, snowmobiles and large vessels) for the hunting of polar bears or for transportation to and from the hunting grounds. All Greenland municipalities completely protect females with cubs up to 12 months of age. However, there are some regional differences. In all areas outside the municipalities of Avanersuaq (Thule), Upernavik and Ittoqqortoormiit (Scoresby Sound) females accompanied by young up to 24 months of age are completely protected (Born 1991). The latest revision of the hunting regulations for the municipality of Tasiilaq (Ammassalik, SE Greenland) in 1992 (Anon. 1992a) permits the killing of polar bears between 12 and 24 months of age, and females accompanied by such young (*ibid.*). All bears are protected in July and August (August–September in the Tasiilaq area). In May 1988, the law was revised to permit killing of single, adult male bears all year round (Anon. 1988).

Protection of polar bear critical habitats

The Greenland Home Rule Authorities restrict access to certain coastal areas. In the Melville Bugt Nature Reserve (established in 1980) permits are required from the Home Rule Authorities to enter zone II along the coast (Anon. 1981, 1989). This action protects polar bear dens in the area (Fig. 3; Born and Rosing-Asvid 1989; Rosing-Asvid and Born 1990). When the National Park in North and East Greenland (Fig. 3) was established in 1974 (Anon. 1981) the intention was to completely protect polar bear den sites and summering areas. Originally, polar bears were completely protected within the National Park (Anon. 1976). Since 1976 hunters from the municipalities of Scoresby Sound and Avanersuaq have been allowed to catch bears in the park provided that they do not settle permanently in the area and do not rely on aid from the permanent stations in the park (Anon. 1981). In all areas of Greenland, disturbance of polar bears in dens is prohibited (Anon. 1992a).

Use of polar bear products and trade

Use of products

In the municipality of Avanersuaq, polar bears are taken mainly for their hides which are used to make traditional clothing. This is to some extent also the case in the Upernavik area (Rosing-Asvid and Born 1990). In other areas of Greenland, polar bear hides are used only to a very limited extent for clothing and the majority of hides are traded. For Scoresby Sound, another traditional hunting community, Sandell and Sandell (1991) estimated that one-third of the hides are sold privately. The remainder is sold to the Greenland Trade Company. In other areas of Greenland the hides are either sold to the trade company or privately. The meat of the bears is eaten locally in northwestern Greenland (e.g. Rosing-Asvid and Born 1990) and in eastern Greenland (Born 1983; Sandell and Sandell 1991; Glahder 1992). In other areas of Greenland the meat is also eaten locally.

Trade

The number and value of hides traded to the Greenland Trade Company since 1980 are listed in Table 1. These statistics do not take into account the proportion of hides that are sold privately. The estimated value of the 121 polar bear hides bought by the Greenland Trade Company in 1991 was approximately US\$192,400 (US\$1 = approx. 6.04 Danish kroner in December 1992; Table 1). This amount is an underestimate given that the value of hides sold privately, and the value of other bear parts (for example claw and skulls), are not included. The 1993 prices paid by the Greenland Trade Company for a polar bear hide range between about US\$364 and US\$1738, depending on quality and size of the hide. Winter hides less than 1.6m can not be traded (Anon 1992c).

Other impact on polar bear populations

Large-scale industrial exploration and development may adversely affect polar bears and polar bear habitats (e.g. Anon. 1990, Dietz 1992). Exploration and exploitation of mineral resources in Greenland are supervised by the Denmark–Greenland Joint Commission for Mineral Resources ("Fællesrådet") and are regulated by the Mineral Resources Act ("Råstofloven"; Anon. 1992b). The Greenland Environmental Research Institute

(Danish Ministry of Energy, Copenhagen) assesses the environmental impact of exploration and exploitation of mineral resources in Greenland, and takes part in the approval procedure of the Mineral Resources Administration for Greenland ("Råstofforvaltningen"). At present, there is no exploitation of non-renewable resources in Greenland, but exploration activities occur in several areas (Fig. 11; Anon. 1992b). Noteworthy in this context are onshore explorations for gold in the Kangerlussuaq area (SE Greenland) and for various minerals within the National Park in North and East Greenland (Figs. 1, 3 and 11). Both these areas are important polar bear habitats. Furthermore, since 1991 there has been some marine seismic exploration activity during the open-water period along the coasts north to 79°N in east Greenland and 77°N in West Greenland in association with the KANUMAS project (Kalaallit Nunaat Marine Seismic Program; Larsen 1986b; Anon. 1992b).

The regulations for the protection of the National Park in North and East Greenland do not preclude exploration and exploitation of non-renewable resources in the park (Anon. 1987, §25). However, in each case where permission for exploration is granted by the Mineral Resources Administration for Greenland, the Council of the National Park must also be consulted. The council has the opportunity to ensure that special environmental conditions are maintained so that impacts on wildlife, and wildlife habitat are minimized. Similarly, the regulations for the Melville Bugt Nature Reserve allow for exploration and exploitation activities within the reserve provided permission is granted (Anon. 1989, §9).

The current low level of exploratory activities appears to have little or no impact on polar bear populations. The potential impact of future large-scale exploration and exploitation of non-renewable resources on polar bears can not be assessed at the moment; the risks will have to be evaluated case by case when scenarios are known.

Status of populations

Polar bear populations can probably sustain an overall exploitation of 2–5% per year (Larsen 1986a). The polar bear harvest model of Taylor *et al.* (1987, 1988) indicates that the sustainable harvest (H) of a population

can be estimated as: $H = N \cdot (0.015/P_f)$, where N is total number of individuals in the population and P_f is the proportion of females in the harvest. Hence, the catch of adult females should not exceed about 1.5% of the population (see Calvert *et al.* 1988).

East Greenland

In the mid-1970s, the catch of polar bears in the Kong Oscars Fjord–Kejser Franz Joseph Fjord area (Central East Greenland) increased from a few to 10 to 20 bears per year (Born 1983; Sandell and Sandell 1991). Catches this large were beyond the maximum sustainable yield of the presumed resident population; the resident group must therefore have been replenished by bears coming from other areas to sustain this harvest for several years.

If eastern Greenland is considered as a whole, then the estimated annual catch of approximately 100 bears is within the limits of sustainability, assuming the population estimate of 3000–6700 (Larsen 1986a) is valid, and the sex composition of the catch is as indicated by the sample from Scoresby Sound (this study).

In eastern Greenland the availability of polar bears to the hunters is affected by fluctuations in ice conditions. Furthermore, the majority of the bears are taken in spring during sled trips that originate from towns and settlements which are situated in a few relatively concentrated areas. Hence, it is doubtful whether the polar bear hunters can extend the range of the hunting area or effort to a level that will seriously affect the entire population.

However, the picture is complicated by indications of discrete subpopulations in eastern Greenland (Born and Rosing-Asvid 1989) and in the Svalbard–Franz Joseph Land region (Wiig 1995). These findings make it difficult to evaluate the effect of the current harvest on the population(s) of polar bears in eastern Greenland. To date there is no indication of a major decrease or increase in the population. Given the large amount of potentially good polar bear habitat in the East Greenland area it is likely that a large population is supported. However, there have been no population inventory studies in this area, and the number of bears can only be estimated as probably thousands.

West Greenland

Movements of female polar bears collared with satellite transmitters indicate the presence of a shared population in the northern Baffin Bay region (Figs. 7 and 8). The population estimate for Canadian management zones F and D1 are 2000 and 470, respectively. The present Canadian quotas are 105 (F) and 50 (D1) while the average harvest of polar bears in West Greenland is estimated to range from 40 to 60; making an annual total harvest of 195 to 215. Thirty-one percent of the total harvest are females. The polar bear harvest model of Taylor *et al.* (1987, 1988) suggests a sustainable harvest of about 120 for the northern Baffin Bay region. On the basis of these data, the possibility of an over-harvest must be considered (Born *et al.* 1995). The objectives of an ongoing Canadian–Greenland joint study in Baffin Bay, Smith Sound and Kane Basin are to obtain better data to delineate the range of the population and to determine the number of polar bears in the shared population.

Management in relation to the agreement on the conservation of polar bears and their habitat

The following text provides an evaluation of how Greenland legislation and management of polar bears comply with the articles in the International Agreement on Conservation of Polar Bears and their Habitat (Anon. 1973).

Article I:

The taking of polar bears in Greenland is prohibited except as provided in Article III (Anon. 1992a).

Article II:

Greenland has intentionally protected important polar bear habitats by establishing the National Park in North and East Greenland and the Melville Bugt Nature Reserve. By adopting hunting regulations that emphasize and encourage the use of traditional hunting practices and by protecting females in dens and females with cubs, the Greenland polar bear management scheme is based on sound conservation practice. Generally, too little data have been available to give advice on a scientific basis on the levels of sustainable exploitation.

Article III:

The Greenland polar bear hunting regulations comply with this article. Bears are only taken according to points d and e of Article III.

Article IV:

According to the Greenland polar bear hunting regulations (Anon. 1992a) it is not permitted to use aircraft, motorized vehicles and boats above 40 BRT during polar bear hunts, or as transportation to and from the hunting area.

Article V:

Greenland/Denmark have signed the CITES convention.

Article VI:

Comments as under Article IV and V.

Article VII:

Since 1973, polar bear research has been conducted on both a national and international basis within Greenland territory. The Greenland Fisheries Research Institute (the Greenland Home Rule Government) has been engaged in cooperative polar bear research with other countries since 1991.

Articles VIII, IX and X: No comments.

Summary of research required to ensure sustainable exploitation of polar bears in Greenland

The following information is necessary to establish a sustainable level of harvest for polar bears in Greenland.

- 1) Number of polar bears taken in all areas (including exact information on the method of catching, the date and location).
- 2) Sex ratio of the catch in all areas (including exact information on sex and age of each catch).
- 3) Number of animals in the harvested populations in all areas.

It should be mandatory to report each polar bear catch with the exact information as outlined in points 1 and 2. By continuously monitoring the harvest to obtain information on the levels and type of exploitation it will probably be possible to monitor trends in the populations at a relatively low cost.

A new system of reporting catches was adopted in Greenland on 1 January 1993. A new hunting license will only be issued if the hunter has reported his catch of game, including polar bear, during the previous year (Anon. 1992d). This system has to prove its efficiency; however, there are no control measures available to determine the accuracy of individual reportings.

To provide the information required under point 3 it will be necessary to delineate the range of each population and to obtain good estimates of the number of bears in the harvested populations. Satellite tracking of a sufficient number of individuals can provide data on population delineation. Multiple-season mark-recapture estimates (or single-season intensive marking and recaptures) can provide information on abundance. In 1991, Greenland and Canada initiated a cooperative study to determine population delineations and population size in the Baffin Bay area.

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TABLE 1. Catch of polar bears and trade and export of polar bear hides in Greenland, 1980–92

Catch	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
W. Greenland pop.													
Avanersuaq (Thule)	0 ¹ (20)	22 (10)	25 (0)	35 (0)	17 (5)	0 (25)	20 ³ (0)	24 ³ (0)	24 ³ (10)	48 ¹ (0)	22 ⁶ (10) ⁴	12 ⁶ (20) ⁴	4 ⁶ (25) ⁴
Upernavik	– (–)	2 (0)	10 (0)	4 (0)	9 (0)	5 (15)	10 ³ (0)	41 (4)	9 ³ (10) ⁴	6 ³ (15) ⁴	0 (20) ⁴	0 (20) ⁴	0 (20) ⁴
Uummannaq-Nuuk	9 (0)	4 (0)	3 (0)	2 (0)	2 (0)	0 (0)	0 (0)	5 (0)	– (5) ⁴	– (5) ⁴	– (5) ⁴	– (5) ⁴	– (5) ⁴
Total W. Greenland	9 (20)	28 (10)	38 (0)	41 (0)	28 (5)	5 (40)	30 ³ (0)	70 (4)	33 ³ (25) ⁴	54 ³ (20) ⁴	22 ⁶ (35) ⁴	12 ⁶ (45) ⁴	4 ⁶ (50) ⁴
E. Greenland pop.													
SW Greenland													
south of Paamiut	1 (0)	1 (0)	13 (0)	7 (0)	1 (0)	0 (2)	2 (0)	3 (0)	1 ¹ (5) ⁴	4 ¹ (0) ⁴	7 ¹ (0) ⁴	4 ¹ (0) ⁴	17 ¹ (0) ⁴
East Greenland													
Ittoqqortoormiit	31 (10)	40 (20)	32 (20)	29 (10)	18 (15)	18 (5)	19 (0)	12 ¹ (40) ⁴	13 ¹ (40) ⁴	40 ¹ (0) ⁴	52 ⁶ (0) ⁴	25 ¹ (20) ⁴	22 ⁶ (25) ⁴
Tasiilaq	20 (0)	51 (0)	67 (10)	50 (0)	42 (5)	5 (5)	7 (0)	44 ⁵ (0) ⁴	24 ¹ (25) ⁴	31 ¹ (20) ⁴	31 ¹ (20) ⁴	82 ¹ (0) ⁴	10 ¹ (40) ⁴
Total E. Greenland	52 (10)	92 (20)	112 (30)	86 (10)	61 (20)	23 (12)	28 (0)	49 (40) ⁴	38 ¹ (70) ⁴	75 ¹ (20) ⁴	90 (20) ⁴	111 ¹ (20) ⁴	49 ¹ (65) ⁴
Total Greenland	61 (30)	120 (30)	150 (30)	127 (10)	89 (25)	28 (52)	68 (0)	119 (40) ⁴	71 (95) ⁴	129 (40) ⁴	112 (55) ⁴	123 (65) ⁴	53 (115) ⁴
Hides traded ²	38	–	135	37	136	45	–	42	42	76	92	121	44
Value (US\$1000)	39.6	–	132.1	22.5	–	–	–	43.9	51.2	112.5	137.8	192.4	71.0
CITES export ⁸							97	65	102	–	59	92	98

Notes:

Figures in parenthesis = estimate given in the source.

¹Traded to the Greenland Trade Co.; ²Hunters' Lists of Game; ³Interviews (Rosing-Asvid and Born 1990); ⁴Estimate (this study); ⁵Interviews (Glahder 1992);

⁶Biological samples (Born unpublished); ⁷Exchange rate, December 1992; US\$1 = 6.04 Danish Kroner; ⁸Whole hides

Source: Greenland Home Rule Administration (Nuuk)

Polar Bears

TABLE 2. Percentage of "independent" (i.e. >2 years-old) polar bears in Scoresby Sound (Central East Greenland) and Avanersuaq/Thule (NW Greenland)

Area	Independent F (%)	Independent M (%)	Young (%)	N	Year
Scoresby Sound (E)	40	48	12	131	1983-91
Avanersuaq	36	50	14	70	1988-91

The samples represent about 29% and 60% of the estimated total catch in Scoresby Sound and Avanersuaq, respectively, during the period.

Source: Born and Rosing-Avid, unpublished data.

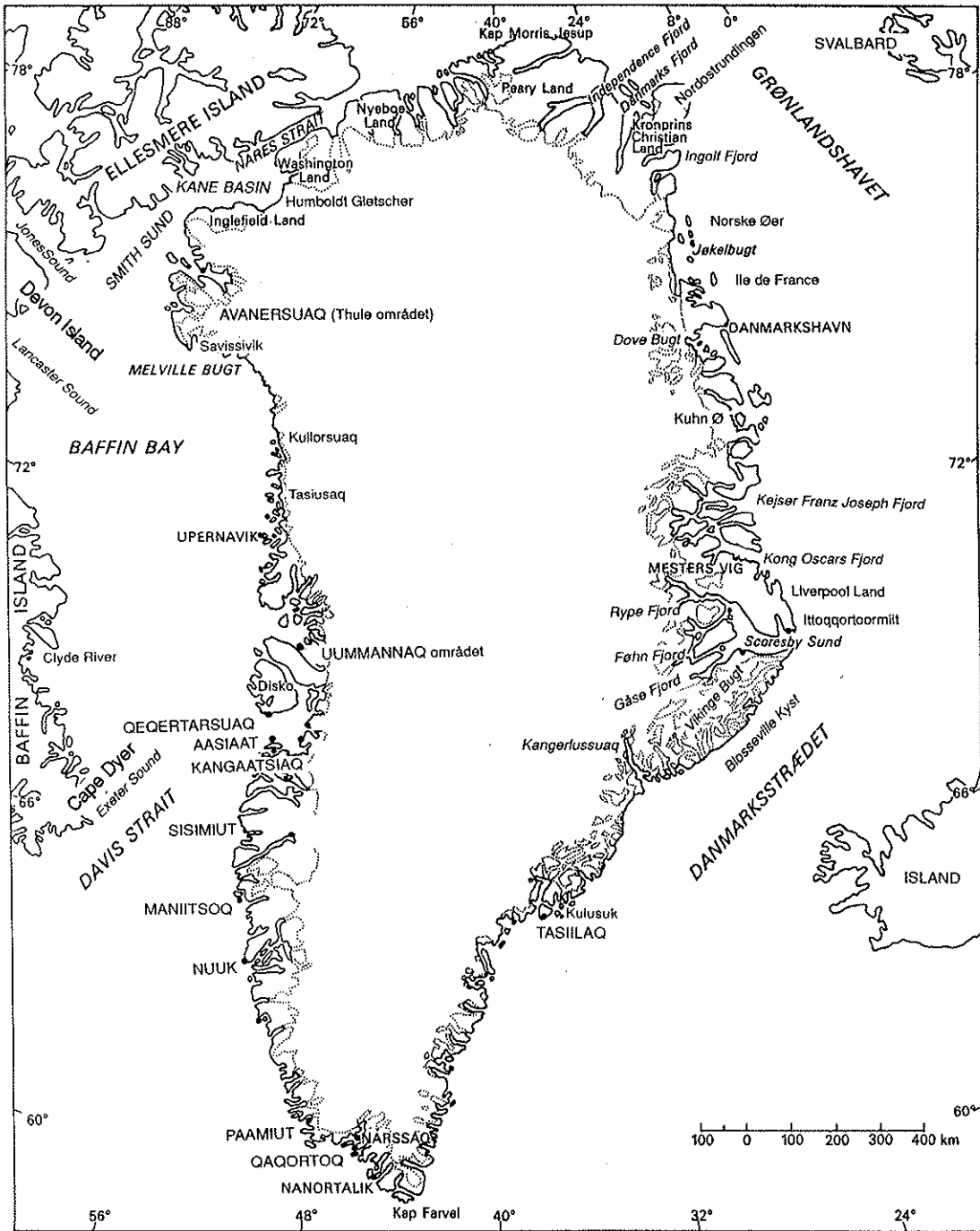


FIG 1. Map of Greenland with names of places mentioned in the text

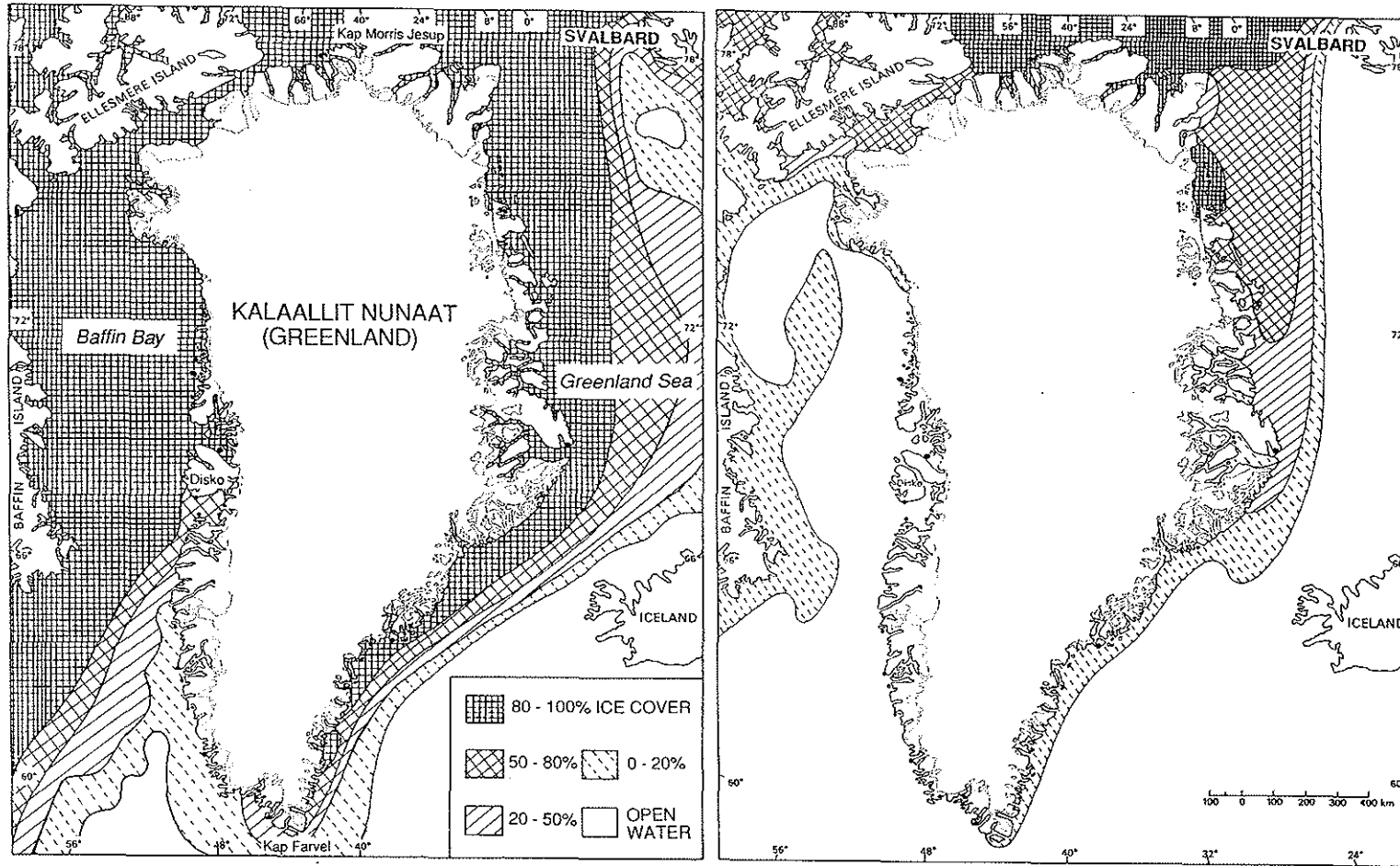


FIG 2. Mean ice concentrations (1972–82) during maximum (mid-March, left) and minimum (mid-September, right) extension of ice cover. *Source:* modified from Anon. 1986. Polar Bears occur regularly in areas with 50%–100% ice cover, except along the northern coast of Greenland (Dietz & Anderson 1984; Dietz et al. 1985; Born & Rosing-Avid 1989)

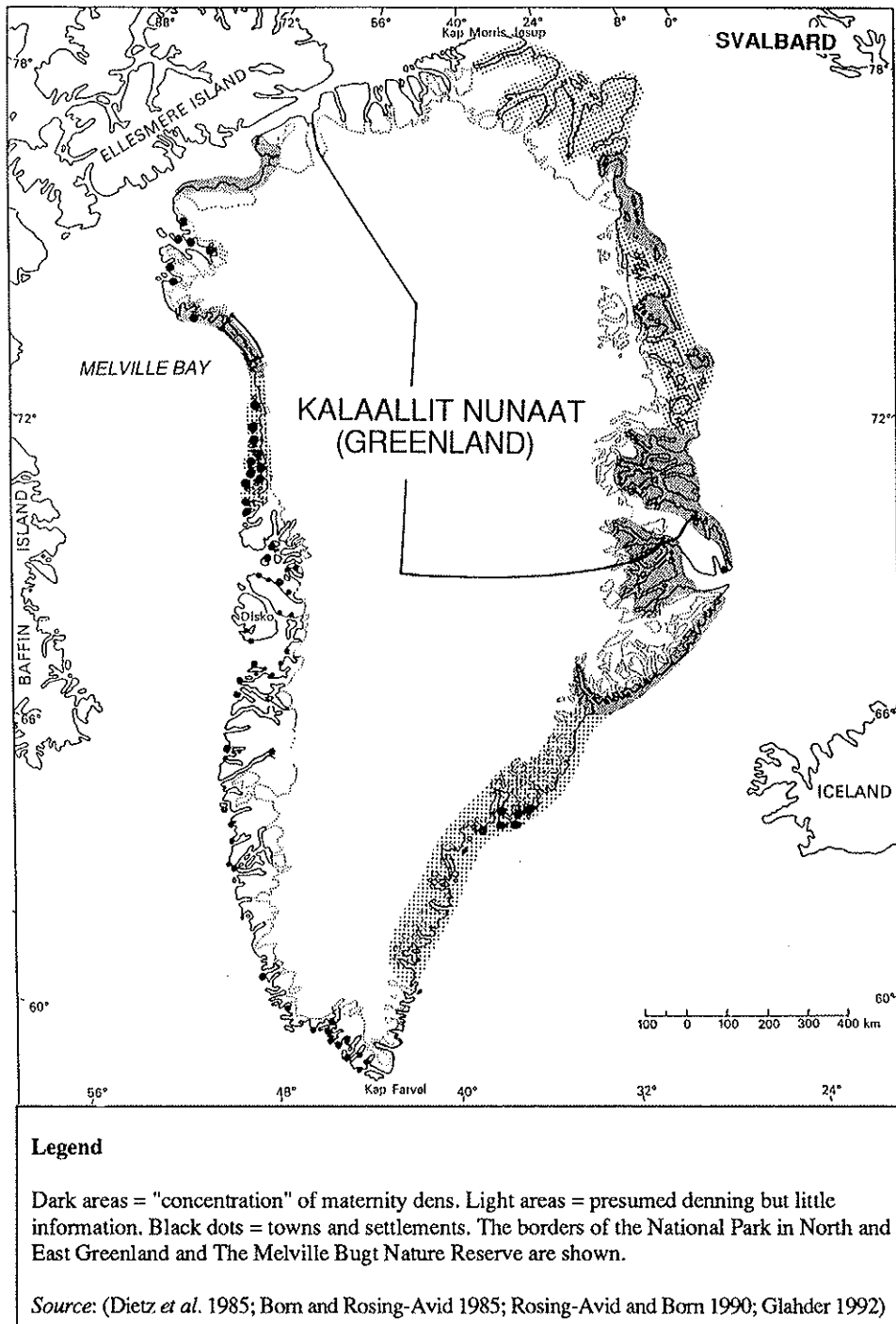


FIG 3. Distribution of polar bear maternity denning areas in Greenland based on observations of maternity dens and/or females with newborn cubs

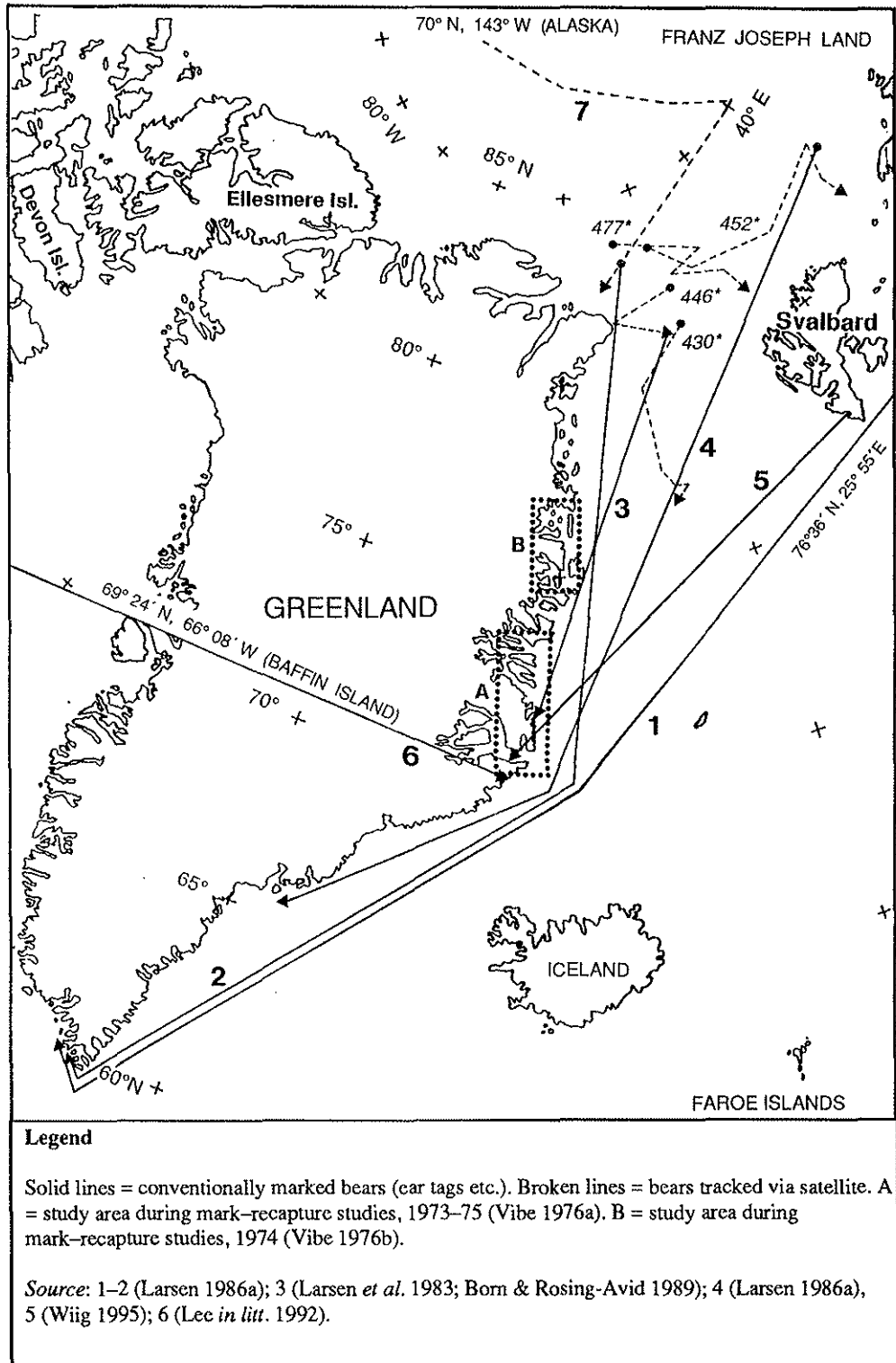


FIG 4. Movement to eastern Greenland of polar bears tagged in other areas of the Arctic

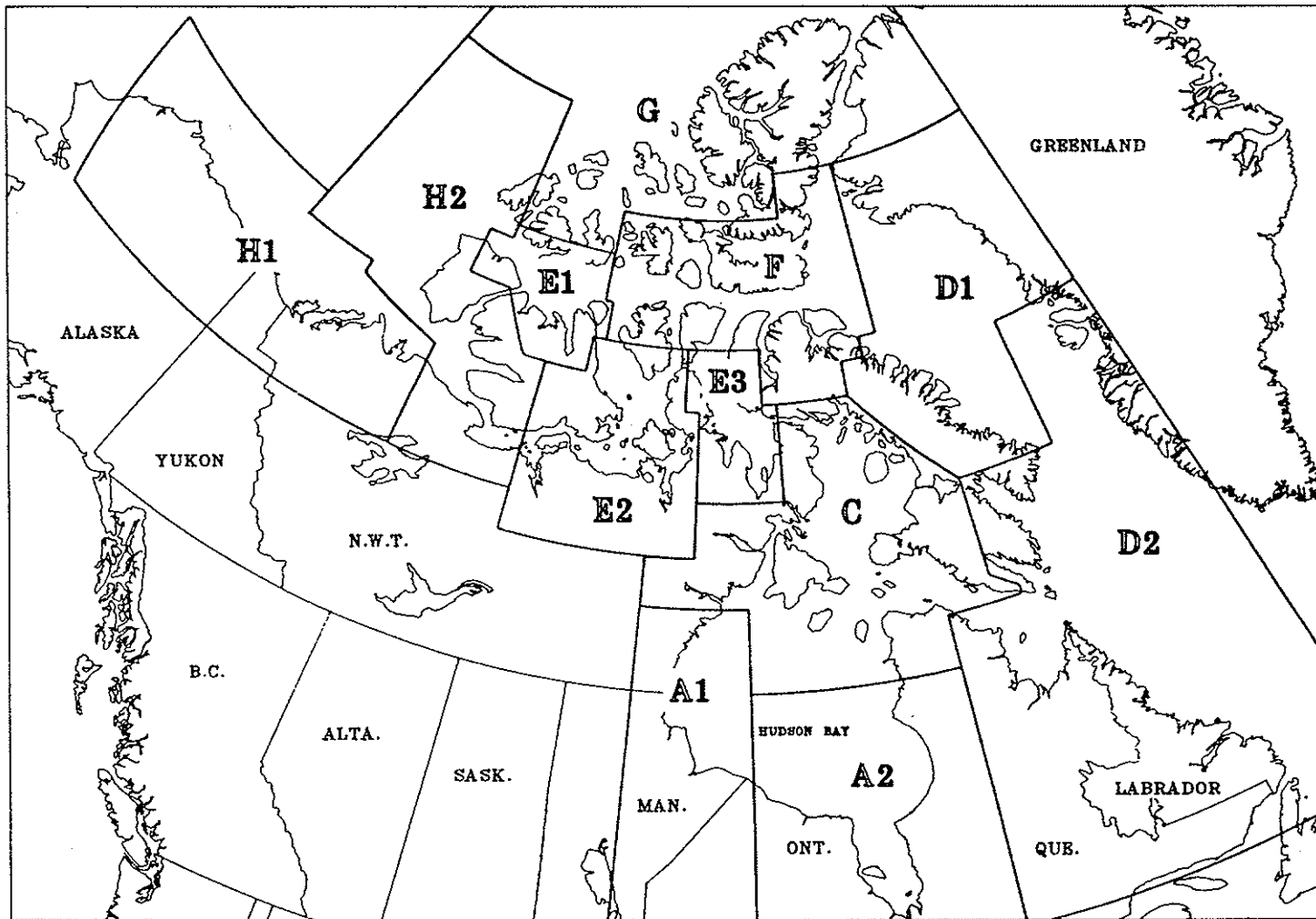


Fig 5. Canadian management zones

Source: Taylor 1992

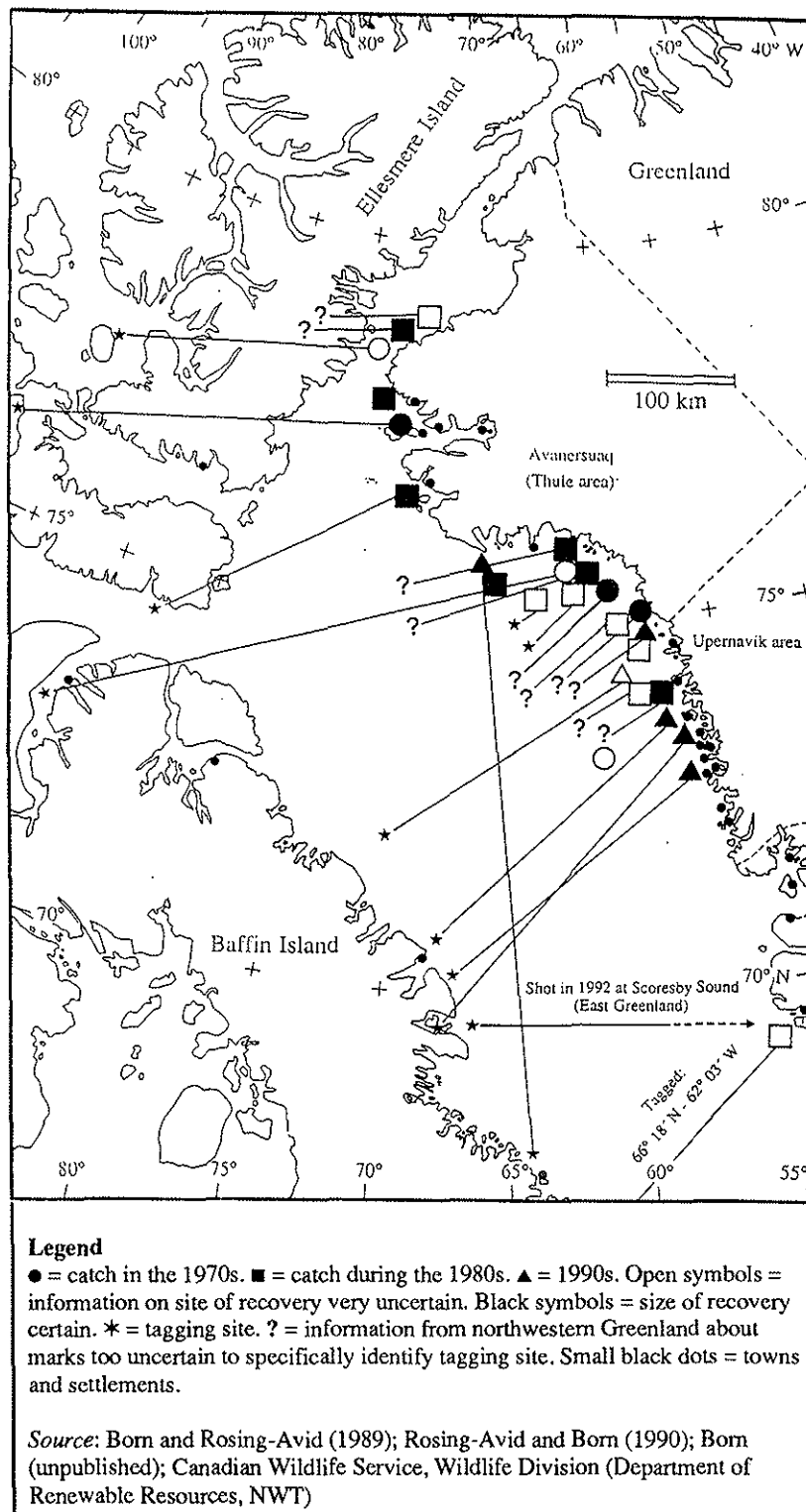


FIG 6. Catch in western Greenland of tagged bears during the period April 1973–November 1992
 Although the information obtained in western Greenland about the marks was often insufficient, it is indicative that during the period at least 28 (29?) marked animals have been caught. Of these, at least 21 were tagged in Canada

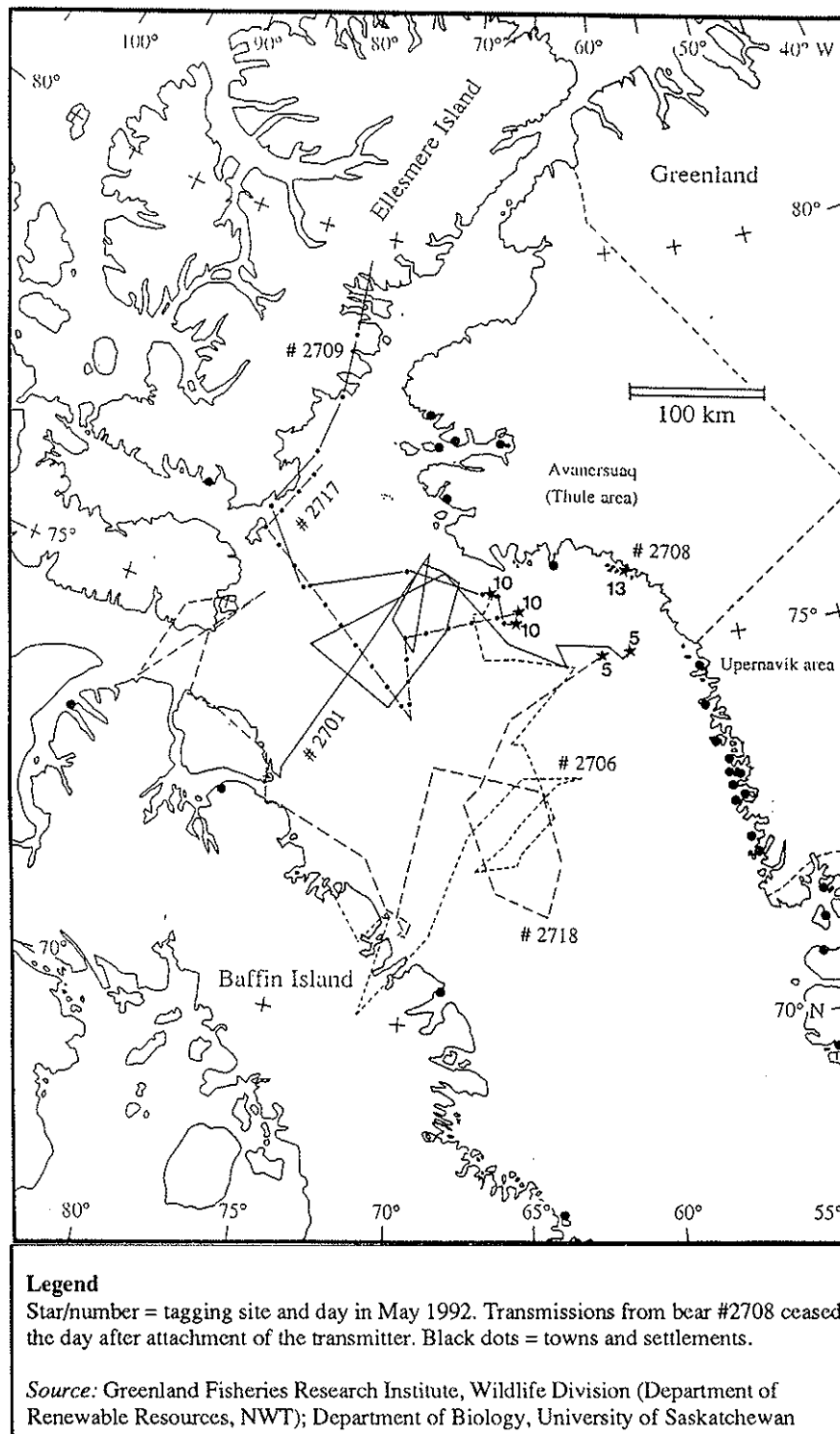


FIG 7. Satellite tracking of six adult female polar bears between first half of May 1992 and 15 September 1992, showing that the bears summered in Canada

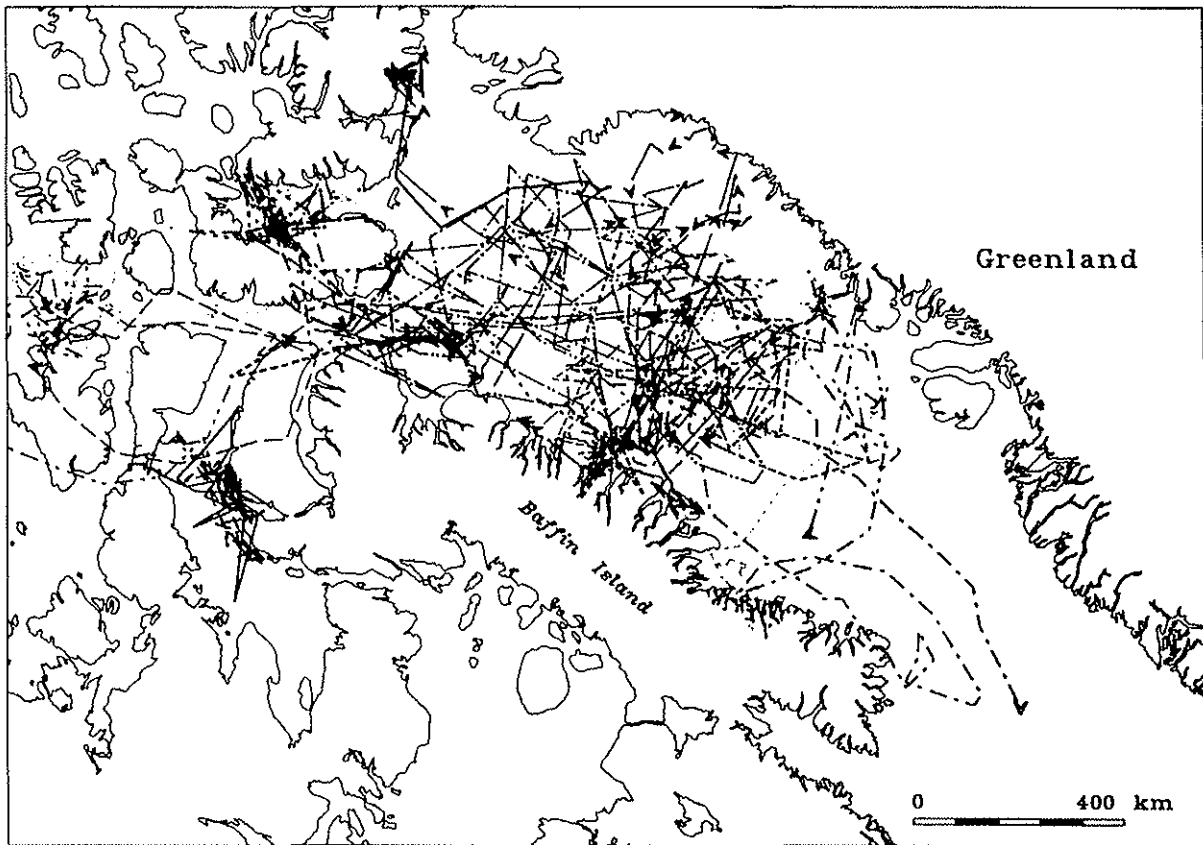


FIG 8. Movement of adult female polar bears with satellite radio-collars in the Baffin Bay and Davis Strait areas, September 1991 to September 1992

Source: Wildlife Division (Department of Renewable Resources NWT); Greenland Fisheries Research Institute; Department of Biology, University of Saskatchewan

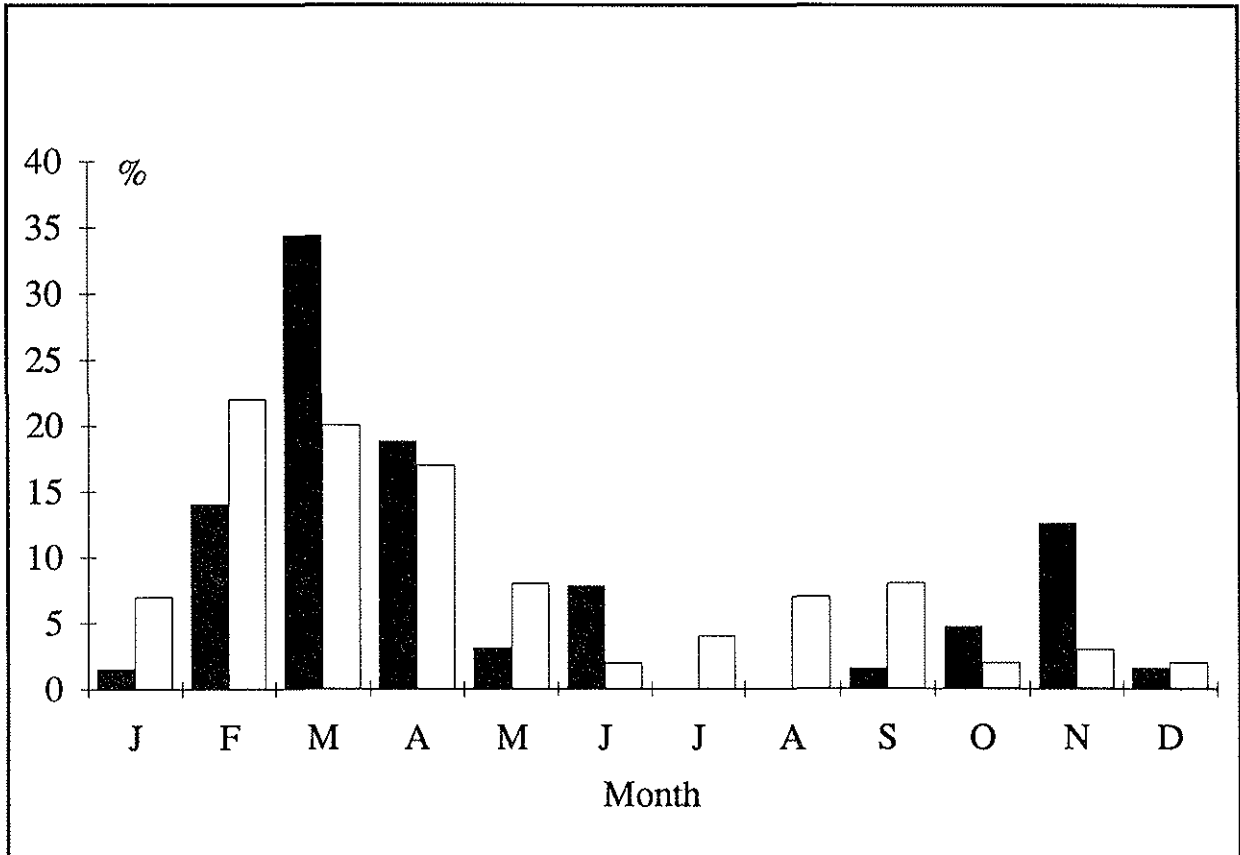


FIG. 9: Seasonal distribution of catch of polar bears in the Ittoqqortoormiit/Scoresby Sound (central East Greenland=white bars; 1983-91. n = 132) and Avanersuaq/Thule areas (NW Greenland=black bars; 1988-91. n = 64)

Source: Born and Rosing-Avid, unpublished data

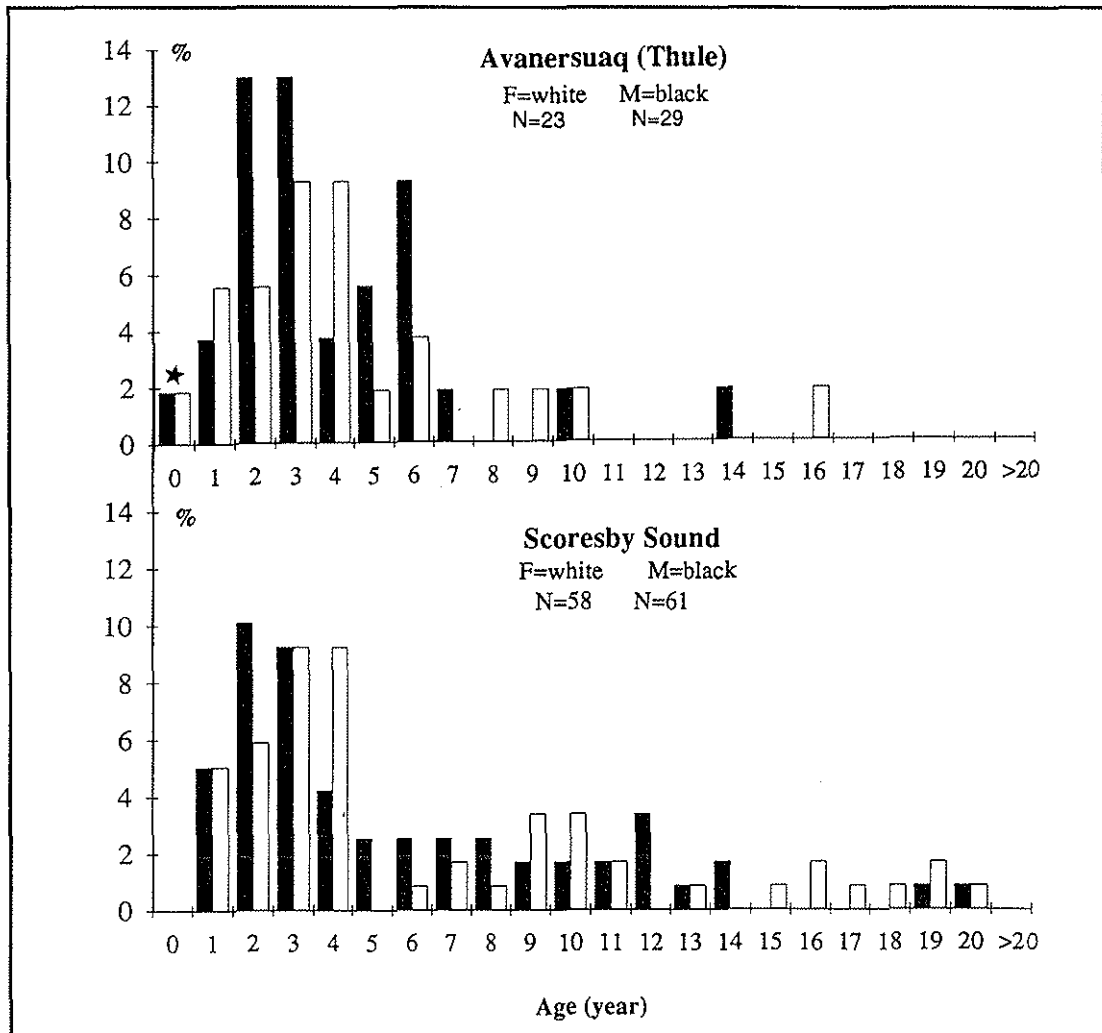


FIG 10. Age distribution of the polar bear catch in Avanersuaq/Thule (1988–91) and Itoqqortoormiit/Scoresby Sound areas (1983–91). Note: *two 11-month-old cubs shot in Thule were reported and the hides confiscated

Source: Born and Rosing-Avid, unpublished data

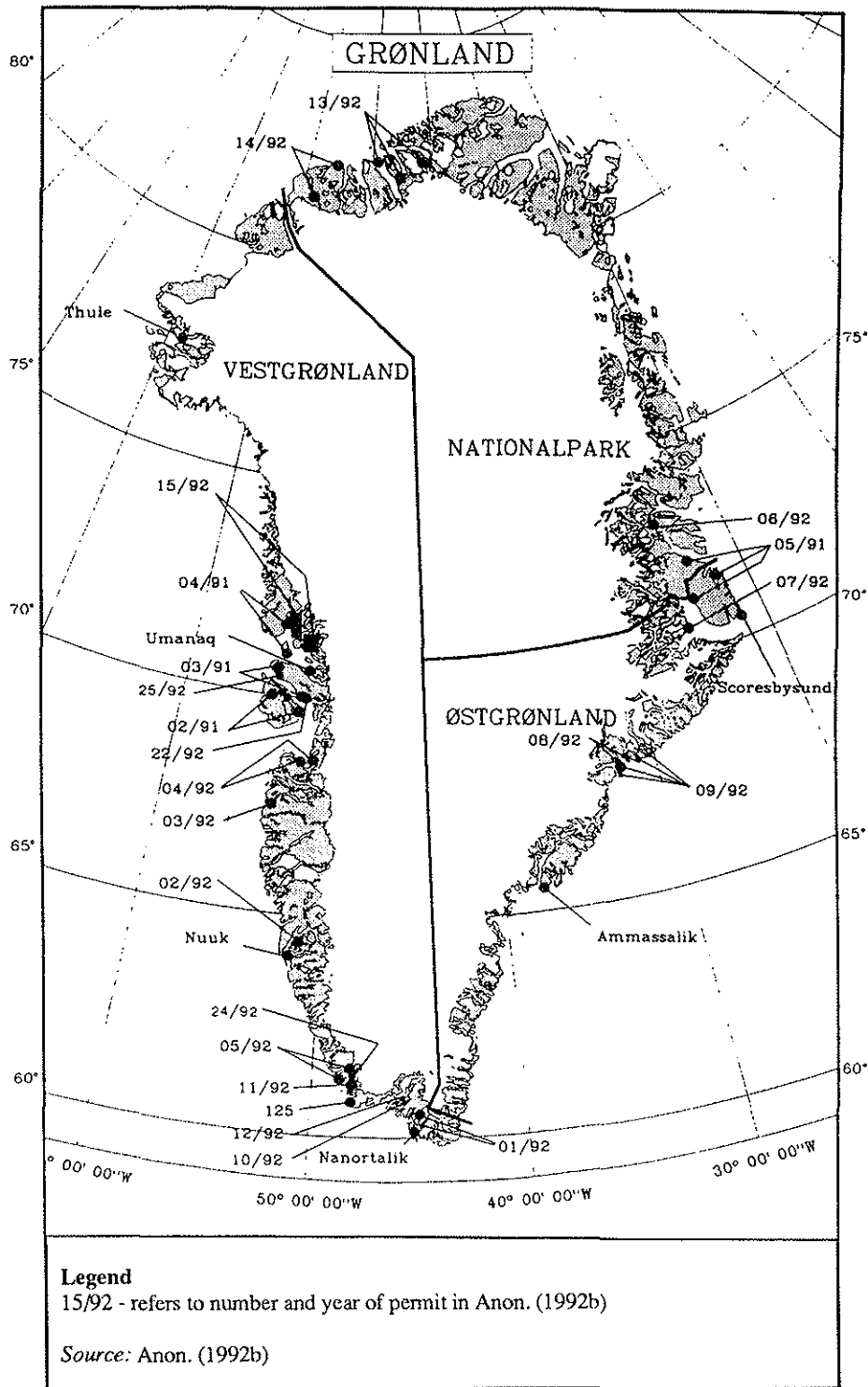


FIG 11. Sites in Greenland where permits for exploration for non-renewable resources

Research on Polar Bears in Greenland, ultimo 1988 to primo 1993

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Introduction

Between 1988 and 1990, polar bear studies were conducted by the Greenland Home Rule Department for Wildlife Management. These studies were made possible by a research grant from a private Danish foundation (Aage V. Jensen Foundation) (Born 1991). Since January 1991, polar bear studies have been conducted by Greenland Fisheries Research Institute (Greenland Home Rule, Ministry for the Environment and Health) as a part of this institute's research of marine mammals.

Monitoring of the Greenland polar bear hunt

Little information is available on the catch of polar bears in Greenland. The Greenland hunters report their catch of polar bears and other wildlife on a voluntary basis, and the system of reporting (The Greenland Hunters' Lists of Game) has not worked reliably for many years. In particular, reporting from the municipalities of Avanersuaq (Thule), Upernavik, Ittoqqortoormiit (Scoresby Sound) and Tasiilaq (Ammassalik), where the majority of polar bears are taken, has been very insufficient (Born and Rosing-Asvid 1989). Hence, in order to provide information on the magnitude, seasonal and spatial distribution of the Greenland polar bear hunt, biological samples have been collected since 1988 from the catch. Between the spring of 1988 and the spring of 1992, samples (various tissues, teeth for age determination and reproductive organs) from a total of 207 polar bears have been obtained. These samples represent about 35% of the estimated total Greenland catch of polar bears in the period. The sampling has been particularly successful in the Avanersuaq (Thule area, NW Greenland) and the Ittoqqortoormiit (Scoresby Sound, Central East

Greenland) areas, two important polar bear hunting areas. To provide additional information on the distribution and hunt of polar bears, hunters living in Avanersuaq (Thule) in 1989, and hunters of the municipality of Upernavik in 1990 were interviewed (Rosing-Asvid 1990; Rosing-Asvid and Born 1990). In connection with exploration of mineral resources in the Kangerlussuaq area (SE Greenland), interviews with hunters were conducted by The Greenland Environmental Research Institute (Danish Ministry for Energy) (Glahder 1992). Information on catches of polar bears in the Ittoqqortoormiit (Scoresby Sound) area is given in (Sandell and Sandell 1991). Analyses of the information on the distribution and composition of the Greenland catch of polar bears, with analyses of age and reproductive organs, have been made for a degree of Master of Science (Rosing-Asvid, University of Copenhagen). Some results are presented in Born (1993).

Laboratory analyses

Studies of the contents of various heavy metals in polar bear tissues have been conducted at the Greenland Environmental Research Institute (Born *et al.* 1990, 1991; Dietz *et al.* 1991; Dietz and Agger 1992; Dietz 1992). As a part of an international study, analyses of chlorinated hydrocarbons in blubber of polar bears from northwestern and eastern Greenland have been conducted by the Canadian Wildlife Service (Environment Canada, Ottawa) (Norstrom this volume). The complete mtDNA of a polar bear from Greenland has been sequenced at the Department of Molecular Genetics (University of Lund, Sweden; Bodin *et al.* this volume). Samples of somatic muscles and diaphragm from about 200 polar bears are being analyzed for contents of *Trichinella sp.* at the Veterinarian Serum Laboratory (University of Copenhagen).

Determination of stock delineation in the Baffin Bay area

A co-operative study of polar bears in the Baffin Bay region was initiated in the fall of 1991 (Greenland Fisheries Research Institute, Department of Renewable Resources, N.W.T., Department of Biology, University of Saskatchewan, Canadian Wildlife Service). The objectives of this study are to delineate the range of the polar bear population(s) in the Baffin Bay, Smith Sound and Kane Basin regions and to determine the number of bears in these areas. In the fall of 1991, Greenland

Fisheries Research Institute participated with personnel and provided some of the satellite radio-collars during tagging of polar bears along the eastern coast of Baffin Island. In May 1992, the Greenland Fisheries Research Institute, with personnel from Canadian Wildlife Service (Edmonton), put satellite radio-collars on six female polar bears in the Melville Bugt area (NW Greenland). During this study a total of 19 polar bears were tagged (Born *et al.* 1992; Born 1995). During this cooperative study, 28 female polar bears have been radio-collared by Department of Renewable Resources on the western side of Baffin Bay.

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Status of Polar Bears in Norway 1993

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Population

Population borders

The Norwegian population of polar bears is found in the area of Svalbard north of the Norwegian mainland. According to Larsen (1986) the polar bear population in the Svalbard area is a part of a population distributed between Eastern Greenland and western Russia. Lønø (1970) pointed out that the distribution of bears in this area was a function of the extent of the drifting pack ice.

The Norwegian Polar Research Institute started a satellite telemetry project in 1988 on polar bears in the Svalbard area in order to get more information on population boundaries. Sixty-nine females and one male have since been tagged. Individuals have been tracked for up to 21 months. Only one bear moved to areas west of Svalbard (Fig. 1). Many of the females have moved into the Russian area but not farther than the western parts of Franz Josef Land; however, those that have been followed after moving to Franz Josef Land have all moved west again towards Svalbard. The general pattern is that female bears tend to return to the same area of Svalbard each spring. Some of the bears even confine their movement to the 100km coastline all year round.

The migratory pattern presented above has not yet been scientifically evaluated. However, it seems appropriate to assume that there is a more or less discrete population of female polar bears in the Svalbard area. Many of these bears move seasonally to Russian territory, but they tend to return to Svalbard to breed.

We do, however, know that there are bears that migrate between Greenland and Svalbard (Larsen 1986). It seems, therefore, correct to conclude that the population of polar bears in the Svalbard area is more discrete than earlier believed.

Population size

Larsen (1986) estimated the population size of polar bears between Eastern Greenland and western Russia to be between 3000 and 6700 in the period 1980–83. These estimates were based on comparisons between ship surveys, and calculations from den counts and estimates of the proportion of denning females in the population. The population size in the Svalbard area alone was estimated to be between 1700 and 2200 bears. No population estimates have been developed since Larsen's work. Based on the new results on migration indicated above it must be concluded that the Svalbard population of polar bears consists of about 2000 bears.

Influence of ecological changes

There are no data on the influence of environmental changes on the Svalbard population of polar bears.

Ringed seals are assumed to be the main food of polar bears. Smith and Lydersen (1982) estimated that about 19,500 ringed seal pups could be born annually in the fast ice of Svalbard. Polar bears might require approximately 50–73 ringed seals per annum for growth and sustenance. There is an obvious discrepancy between the estimated production of ringed seals and number of seals required to sustain a population of 2000 polar bears in the area of Svalbard.

Harvest

The Svalbard population of polar bears is not harvested. However, 26 bears have been killed in the period 1987–92 due to conflict with humans or killed in act of mercy (Gjertz *et al.* 1993). All such cases are considered a police matter and are either investigated by or authorized by the Governor.

Management

Regulations

According to the Spitsbergen Treaty of 9 February 1920, Norway exercises full and unlimited sovereignty over the area. However, citizens of the countries contracting to the Treaty have the same rights as Norwegians to hunt and fish in the area and to conduct all kinds of maritime, industrial, mining and commercial operations, provided that they observe the local laws and regulations.

The main responsibility for the administration of Svalbard lies with the Norwegian Ministry of Justice. Norwegian civil and penal laws, and various other regulations, are applicable to Svalbard as well. The Ministry of Environment deals with matters concerning the environment and nature conservation. The highest local authority in Svalbard is the Governor (Sysselmannen) who exercises jurisdictional, police and administrative authority.

A result of the International Agreement for the Conservation of Polar Bears and their Habitat was that polar bear hunting was forbidden in Norwegian areas. The management of polar bears on Svalbard is regulated by The Royal Decree "Regulations concerning the management of game and freshwater fishes on Svalbard and Jan Mayen" enacted in 1978 (Ministry of Environment 1984).

There is a problem here, however, because the Spitsbergen Treaty applies to land areas and territorial waters within four nautical miles of land. Most of the ice covered part of the Barents Sea is outside this area. Polar bears are therefore not protected outside Svalbard's territorial waters by the Environmental Regulations for Svalbard. Norway claims an economic zone of 200 nautical miles outside Norway. Svalbard is a part of the Kingdom of Norway and Norway, therefore, also claims an economic zone around Svalbard. This has, however, not been accepted by other nations. Based on the Norwegian view the Norwegian Game Law has force within the Norwegian economic zone. According to this law all game are protected if not otherwise stated.

Protected areas

About 50% of the land areas of Svalbard are protected as national parks or nature reserves by the Royal Decree "Regulations concerning conservation of the natural environment on Svalbard" from 1983 (Fig. 2). The

protected areas incorporate most of the important polar bear terrestrial habitats in Svalbard. Several areas within the protected areas are, however, exempt from the regulations on account of established mining rights. The most restricted area in Svalbard in relation to polar bears is Kong Karls Land where it is forbidden to land due to its importance as a denning area.

Use of and trade in polar bear products

There is no trade of polar bear products from Svalbard. The hides of the few bears killed are the property of the Norwegian State and are given away usually to different institutions or sold at a public auction.

Other impacts on polar bear populations

In a Governmental Proposition (Stortingsmelding nr. 40, 1988–89) the Norwegian part of the Barents Sea south of 74° 30'N was opened for exploration activity for hydrocarbons. The northern part of this area coincides with the southern extension of the drifting ice of the Barents Sea. The Norwegian Government is now considering whether to open the northern part of the Barents Sea for oil exploration as well. Before that decision is made an environmental assessment program will be performed. The polar bear is one of the species that might be most affected by such activity.

Norheim *et al.* (1991) analysed the occurrence of heavy metals and chlorinated hydrocarbons in polar bears from Svalbard based on tissue from 24 bears killed in the period 1978–89. The occurrence of PCBs was found to be particularly high with a mean of 31 ppm in fat from seven adults. Peak value was 90 ppm. This is higher than the level assumed to have caused reproductive failure in seals in the Baltic. Similar effects in polar bears cannot be excluded.

Status by population/area

According to Larsen (1986) the Svalbard population of polar bears probably doubled from 1970 to 1980. We do not know the development of the population during the 1980s. Due to its status as totally protected the population might still be increasing. At some point the population must approach the carrying capacity of the area and the population size stabilize. If this has come

to effect in the Svalbard population we do not know. It is therefore suggested to apply the conservative view that the Svalbard population of polar bears be classified as stationary and possibly increasing.

Management in relation to the agreement on the conservation of polar bears

How Norway complies with each Article in the Agreement on the Conservation of Polar Bears (Oslo 1973) is listed below.

Article I:

The taking of polar bears in Norwegian areas is prohibited except as provided under Article IIIa, b, c.

Article II:

Norway has protected the land areas most important for polar bears at Svalbard. Ice-covered areas of the Norwegian part of the Barents Sea is, however, not protected. Norway is now considering whether to open these areas for oil exploration and exploitation activity. Before this is done an environmental impact assessment study will be performed.

Articles III and IV:

There is no take of polar bears at Svalbard. Skins or other items from polar bears taken in self-defense or other reasons are the property of the Norwegian state and are not available for commercial purposes.

Article V:

Norway has signed the Convention on International Trade in Endangered Species (CITES).

Article VI:

Legislation is under the Environmental Regulations for Svalbard and the Norwegian Game Act.

Article VII:

The Norwegian research program on polar bears is performed by the Norwegian Polar Research Institute. The research is coordinated through the IUCN PBSG.

Article VIII:

No comments.

Article IX:

Norway consults with the other Parties through the IUCN PBSG.

In conclusion, Norway complies with most of the articles in the Agreement on the Conservation of Polar

Bears. There are two uncertainties, however. The force of Norwegian law within the 200 nautical mile economic zone around Svalbard is internationally debated. No special protection has been given to important feeding and migration areas outside the four nautical mile zone around land areas at Svalbard.

Identification of major gaps in knowledge

The most important population parameters that must be known to secure a scientifically based management of a population of polar bears are the extent of the population, population size, reproductive rates and survival rates. We also need to know important denning, feeding, and migration areas. In addition, a mathematical model from which we can simulate the probable development of a population when different parameters are altered is needed.

Population borders

For the Svalbard population of polar bears a discussion of extent has been given above. We know quite a lot about the migratory patterns of females from southern parts of Svalbard. We assume the females from other areas are just as philopatric as these. The assumption has to be proved by tagging experiments. We do not know how the males migrate.

Population size

Larsen (1986) was very uncertain whether his figures for population size were correct. Estimating the size of polar bear populations is difficult, and so far no obvious best survey methodology has been suggested. It seems wise, however to concentrate effort in areas that are important in relation to human activity like oil exploration. For the Svalbard population the southern ice border zone in the Barents Sea is such an area (Wiig and Bakken 1990).

Reproductive rates

Larsen (1986) estimated the mean litter size of polar bears at Svalbard to be 1.84 for four-month-old COYS. Reproductive rates were estimated between 0.51 and 0.59. Between 77% and 89% of "available" females in spring was assumed to leave the den with coys next spring. We do not know if these values have changed during the 1980s.

Survival rates

Larsen (1986) estimated the survival rate of polar bears from 0 to 2 years old to be 34% for the Svalbard population after 1976 when the hunting had ceased. For

older bears of both sexes (from three to 12 years old), the survival rate from the period 1977–82 was estimated at $90.6\% \pm 10.0\%$. Rates for older bears were not estimated due to missing data.

Denning areas

According to Larsen (1985) the most important denning areas for polar bears at Svalbard are Edgeøya, Barentsøya, Nordaustlandet and Kong Karls Land. The latter area has been considered as the most important denning area with the highest polar bear den density in the world. Fifteen of the females tagged with satellite transmitters in the period 1988–91 have denned the following winter, but none of them at Kong Karls Land.

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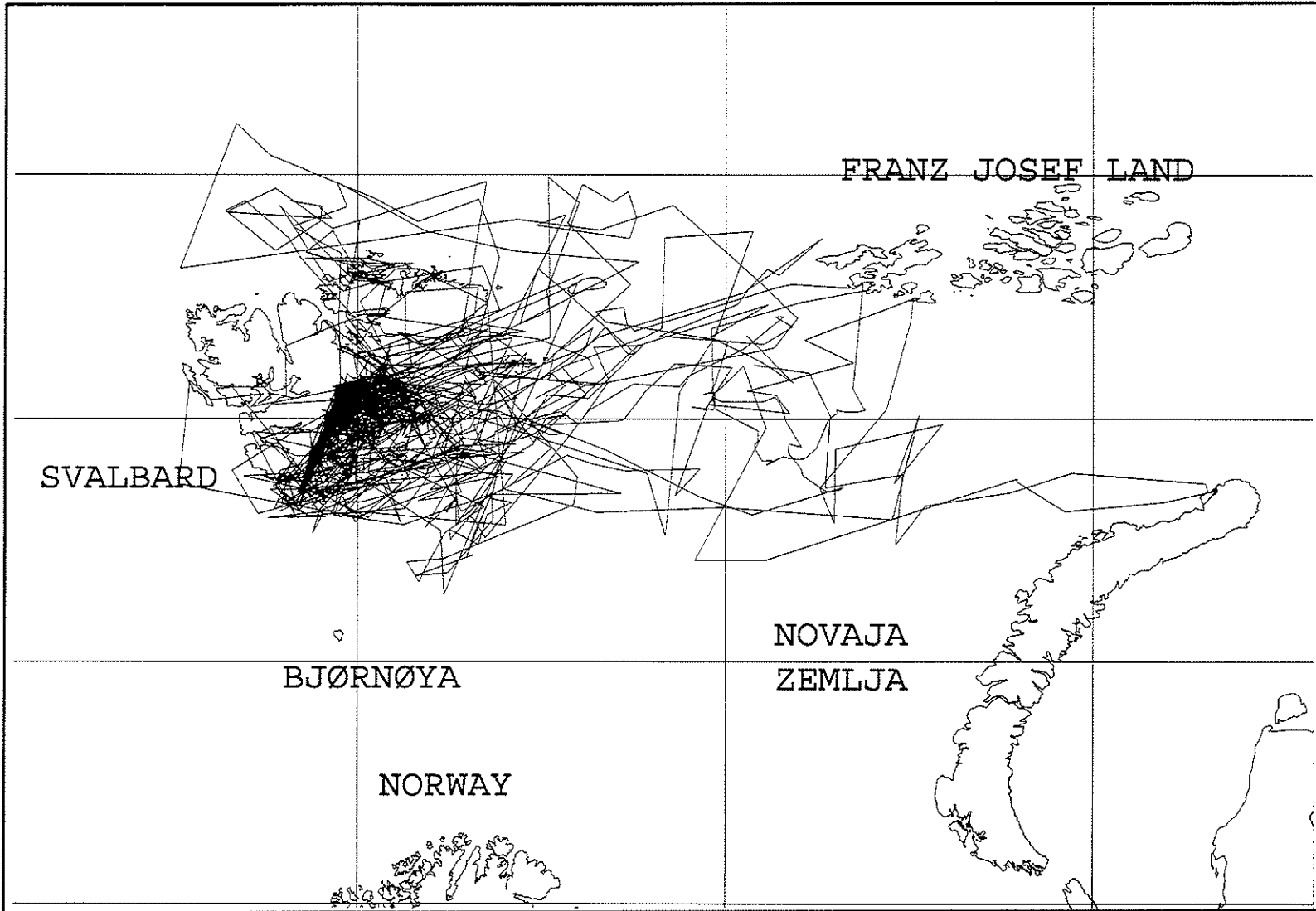


FIG 1. Movements of female polar bears fitted with satellite transmitters in the Svalbard area

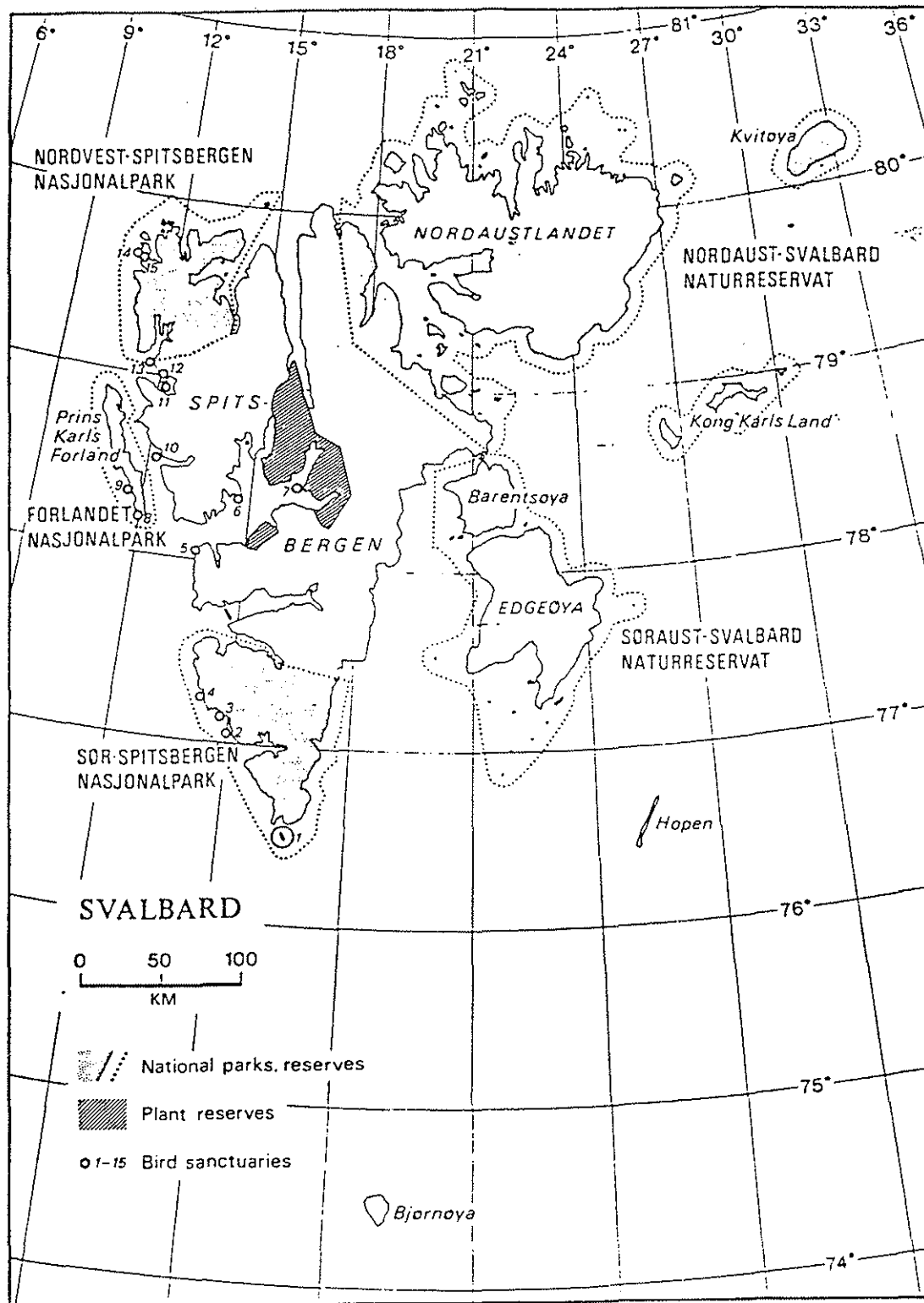


FIG 2. Protected areas at Svalbard

Status of Polar Bear Populations in the Russian Arctic 1993

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Populations: distribution, denning areas, inter-population exchange

Elemental analyses of bone tissues (Uspensky *et al.* 1985) from polar bear skulls obtained in different regions of the Russian Arctic revealed three eco-geographical groupings: western, central and eastern. Based on polar bear distributional data collected during previous aerial surveys of ice conditions and polar bear observations recorded at "North Pole" drifting ice stations over many years (Belikov *et al.* 1982; Gorbunov *et al.* 1987; Belikov and Gorbunov 1991), the three relatively discrete populations were named the Spitsbergen–Novaya Zemlya (Spitsbergen is the Russian name for Svalbard), the Laptev, and the Chukchi-Alaskan populations, respectively (previously referred to as the Wrangel-Alaskan population).

The Spitsbergen–Novaya Zemlya population occupies the Greenland, Barents, and Kara seas. Larsen (1986) believes that this population extends from Greenland in the west, to 70° E in the east. The general ice drift pattern and frequency of polar bear occurrence in the Kara Sea is known (Belikov and Gorbunov 1991), and it is assumed that the eastern border of the Spitsbergen–Novaya Zemlya population extends to the extreme northeastern portions of the Kara Sea. Important foci of polar bear reproduction are Spitsbergen, Franz Josef Land, Novaya Zemlya, and possibly Severnaya Zemlya (Parovshchikov 1965; Belikov and Matveyev 1983; Larsen 1986; Uspensky 1989).

It is assumed that the westward distribution of the Laptev population includes the Severnaya Zemlya Islands and some portion of the extreme northeastern Kara Sea. The eastern border is based on observations of marine mammals and polar bears during aerial surveys of

sea-ice (Belikov *et al.* 1982). This boundary is believed to be in the central East Siberian Sea, where multi-year pack ice often remains throughout the year. The year-round presence of sea-ice in this region is believed to lower survival rates of seals and subsequently hinder polar bear movements across the region.

Dens of breeding females have been recorded in the Novosibirsk Islands (Kishchinsky 1969), Severnaya Zemlya (Belikov and Randla 1987), on the eastern coast of the Taimyr Peninsula, and northern coast of the Laptev and East Siberian Sea. Dens were not abundant anywhere, but recent evidence from hunter questionnaires indicates a slight decrease in the numbers of dens detected annually.

The range of the Chukchi-Alaskan population includes the Chukchi Sea, the northern Bering Sea, and the eastern portion of the East Siberian Sea. The eastward extent of the range in the Chukchi Sea is believed to be near Barrow, Alaska. Data from females fitted with satellite transmitters indicate that movements of polar bears from the Chukchi and Bering seas to the Beaufort Sea and back have a limited character (Garner and Knick 1991). Wrangel and Herald islands are the most important breeding areas (Uspensky and Chernyavsky 1965; Kishchinsky and Uspensky 1973; Belikov 1977), with small numbers of females denning along the Chukchi coast, from the mouth of the Kolyma River in the west to near Laurence Bay in the Bering Straits in the east (Stishov 1991).

In summertime, the southern border of the populations coincides with the southern edge of the drifting ice (Belikov and Gorbunov 1991), while the northern borders lie within the central part of the Arctic Basin and vary widely from year to year. The Barents Sea is an exception to this rule, where the northern limits of the

population range are 100–200km northward from Spitsbergen, Franz Josef Land, and Ushakov Island (Larsen 1986; Belikov and Gorbunov 1991). In summer, some individuals may reach areas adjacent to the North Pole.

By the wintertime most polar bears move to the south. They are often seen along the coast, especially near settlements. Documented occurrences in the tundra and forest-tundra are very rare. In the Chukchi-Alaska population, bears are associated with the seasonal ice cover and they move from the Chukchi Sea through the Bering Straits into the northern Bering Sea. Bears occur in the Anadyr area and along the eastern coast of the Kamchatka Peninsula.

Two estimates of the Spitsbergen–Novaya Zemlya population are available for the early 1980s (Larsen 1986):

- a. 4000–6700 bears were estimated using the number of dens of breeding females and the portion of breeding females;
- b. 3000–5000 bears were estimated using the number of dens and polar bears counted from a ship. The trend for the population is unknown.

The Laptev population estimate is derived from the following assumptions:

- a. the density of polar bears in the Laptev and East Siberian Seas is $3/8$ – $1/2$ the density in the Barents and Kara Seas (Belikov and Gorbunov 1991);
- b. the number of dens in the Laptev range was estimated at 110–160 in the mid-1980s (Uspensky and Belikov 1991), but the estimate was adjusted to 80–120 dens in the early 1990s.

Using these assumptions and calculations similar to those used for the Spitsbergen–Novaya Zemlya population, the population in the Laptev Sea is approximately 800–1200 individuals.

The Chukchi-Alaskan population was estimated using the same methods (den numbers and breeding females). During the early 1980s, Belikov *et al.* (1986) estimated 300–370 dens on Wrangel and Herald Islands. Stishov (1991) estimated about 250 dens on Wrangel and Herald Islands and 50 to 120 dens along the northern Chukotka Peninsula coastline. Stishov (unpublished data) estimates that the annual number of dens on Wrangel and Herald

Islands is 400–500, while Belikov (1992) estimates the annual number of dens at 300–400. The number of dens is believed to represent approximately 10% of the total population; therefore, the Chukchi-Alaskan population estimate is 3000–5000 bears. Certainly, this estimate is only an approximation.

Polar bear observations recorded during the periodic aerial surveys of sea-ice and observational data of polar bears sighted from the "North Pole" drifting stations were examined to evaluate the influence of sea-ice conditions on seasonal distributions and movements of polar bears and their prey (Belikov *et al.* 1982, Gorbunov *et al.* 1987, Belikov and Gorbunov 1991). During winter, polar bears are most often sighted on drifting ice which had leads and cracks, and at a polynya edge. Tracks were often sighted in leads covered with young ice and in hummocks of annual ice, where seals are known to construct lairs. In the Chukchi Sea, polar bear tracks were more often seen in the areas of highly broken ice. In all the seas, polar bears or their tracks were seldom sighted in the shorefast ice. They were also rare in the ice with no open leads or cracks, especially in the closed multi-year ice. In summer and early autumn, most polar bears are distributed along the edge of drifting ice. Bears also concentrate in bays and fjords, where ice remains throughout summer, a condition especially common at Spitsbergen (Larsen 1986). Some bears move into the Arctic Basin. Seasonal distributions and movements are also influenced by local prey abundance and the availability of other food resources, i.e. whales and walrus carcasses, and wastes from commercial hunting and fishery, which can attract polar bears (Belikov and Kupriyanov 1977).

Harvest of polar bears

Hunting polar bears in Russia has been prohibited since 1956, from Spitsbergen to the Chukotka Peninsula. Only "problem" polar bears are allowed to be killed. In the Russian Arctic, 10 (± 5) polar bears are killed annually for this reason. Small numbers of cubs are periodically captured from the Russian populations for restocking purposes of Russian zoos, with the annual maximum of 10 cubs captured in 1985 in Franz Josef Land. Cubs are not captured every year.

The size of the illegal harvest is unknown. However, Russia is currently undergoing economic and political

changes that make control of nature conservation and use ineffective. Information received from local governmental bodies responsible for renewable resources indicate that the pressure of illegal hunting on polar bears is probably increasing. Polar bears from the Chukchi-Alaskan population are harvested by Alaskan natives. In Alaska, the 1980–88 annual average total harvest was 130 polar bears, with an estimated two-thirds of the harvest occurring in the Chukchi and Bering Seas (Schliebe 1991).

Management of populations

In Russia, the Main Administration on Biological Resources of the Ministry of Environment and Natural Resources is responsible for conservation of animals included in the Russian Red Data Book (including polar bear). Regional Committees control the situation at the local level.

In the Russian Arctic, only Wrangel and Herald Islands have special conservation status as a place of high concentration of maternity dens and/or polar bears. Both islands were included in the Wrangel Island State Nature Reserve (zapovednik) in 1976. Special protected areas are proposed in the Russian High Arctic: the Novosibirsk Islands, Severnaya Zemlya, Franz Josef Land, and Novaya Zemlya. Within these areas, conservation and restoration of terrestrial and marine ecosystems and some plant and animal species (including the polar bear) are proposed. Proposals for establishing special protection measures for various regions of the mainland coastline and within the "economic zone" of the Russian Arctic are also being considered.

Use of and trade in polar bear products

As previously noted, the only use of the polar bears in Russia is the periodic restricted capture of cubs for zoo restocking purposes. Hunting of polar bears and trade in products derived from polar bears has been prohibited in Russia since 1956. Russia has implemented the provisions of CITES, which include the polar bear in appendix 2 of the list. There are no data on illegal import of polar bear products in Russia.

Other impact on polar bear populations (current or potential)

Industrial development in the majority of the Russian Arctic where polar bears occur has not been of impact on polar bears to a significant degree. However, there are some local concentrations of human activities in the Arctic ecosystems of the Arctic islands and along the mainland coastline that have the potential to affect local populations of polar bears. A geological survey of the mineral and oil and gas resources of the Barents and Kara Seas continental shelf, some areas of the Arctic coastline, and the Arctic islands is currently being conducted. Those areas where mineral resource extraction occurs are sources of pollution and disturbance for local wildlife populations. Illegal hunting and conflicts between people and polar bears are expected to be more serious in these areas.

Population status

The present trend of the Spitsbergen–Novaya Zemlya population change is unknown. However, the Barents Sea ecosystem has had negative impacts as evidenced by sharp reductions in the capelin and polar cod stocks (due to over-exploitation), which are the important food resources for seals. The polar bear population in the Barents Sea is probably negatively affected by these changes, and the moratorium on polar bear harvesting in the Barents and Kara Seas should be continued as a precautionary measure. The Laptev population's habitat has not been altered greatly in the past 20–30 years. Illegal hunting, changes in habitat conditions, and human-induced disturbance are factors that impact polar bears at some local sites. The Laptev population is believed to occur in low densities with a finite population size. The Laptev polar bear population will remain on the list of rare forms in the new edition of the Russian Red Data Book.

The preliminary analysis of polar bear sightings data received from aerial surveys of sea-ice conducted up to 1992 indicated that the Chukchi-Alaskan polar bear population has increased since the 1970s (Gorbunov *et al.* 1987), and the trend is assumed to be increasing slowly. In general, the population condition is satisfactory, and this population will be recommended for the "restored species/form" category in the new edition of the Russian Red Data Book.

Management in relation to the agreement on conservation of polar bears

In accordance with US legislation, Alaskan natives living in coastal settlements are allowed to kill polar bears without restrictions (ie. age, sex, season, number, etc.), as long as the polar bear population is not depleted. There are currently no data indicating depletion, although the rate of harvest is relatively high. At the same time, killing of females and cubs is contradictory with the terms of the 1973 International Agreement on Polar Bear Conservation. This issue should be included

on the agenda of the forthcoming 1993 Russia-US Polar Bear Management Meeting, which will be devoted to drafting a cooperative management agreement on the Chukchi-Alaskan population.

Information needs and data gaps

This review highlights the general lack of adequate data for all three Russian polar bear populations to estimate population size, structure (sex, age, space, genetic), mortality, reproduction rate, and other important factors.

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Research and Conservation of the Polar Bear in the Russian Arctic 1988–92

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Research on the polar bear in the Russian Arctic during 1988–92 occurred in several phases. One was the Chukchi-Alaskan population project conducted jointly by Russia and the US. Its main purpose was research on current population status and management improvement.

This research began in 1989, and in Russia the project area included Wrangel Island and the northern coast of the Chukotka Peninsula. Project activity included immobilizing and marking maternal females and cubs, collecting biological samples, morphometry, and weighing. This work was conducted by scientists from the Alaska Fish and Wildlife Research Center (US Fish and Wildlife Service), the Russian Research Institute of Nature Conservation and Reserves, and the Wrangel Island State Nature Reserve (the latter two are components of the Russian Ministry on the Environment and Natural Resources). Results of this work are presented in Garner *et al.* (1993).

Aerial counts of the maternity dens of polar bear in the Wrangel and Gerald islands area have been undertaken annually since 1982, and aerial counts of dens have been conducted annually along the northern coast of the Chukchi Peninsula since 1986 (Stishov 1991). In some localities of Wrangel Island, ground counts of dens were also conducted. These surveys showed substantial annual changes in the total numbers of dens detected and numbers of dens in certain localities. In our view, differences in total den numbers may not reflect actual differences in the number of females which den each year, but may reflect differences between survey methods or conditions between years. A uniform den census method is needed before the results

will be comparable between areas and years. Recently, Belikov and Chelintsev (1993) have proposed a standardized den census methodology.

Observations on polar bear behavior have been conducted on Wrangel Island during spring and autumn, and are continuations of bear behavior research begun in the mid-1970s (Belikov and Kupriyanov, 1977, 1979). The spring observations are of maternal females and their young emerging from maternity dens. Autumn observations include the interactions between walrus and polar bears in the Cape Blossom area.

In spring 1991, the International Scientific Expedition to the Soviet Arctic (ISESA) of VNIIPRIRODA immobilized and marked polar bears in the Severnaya Zemlya Archipelago. Cooperating institutions included the All-Russian Research Institute for Nature Conservation and Reserves, Moscow; the Russian Institute for Arctic and Antarctic Research, St. Petersburg; the Norsk Polarinstitutt, Oslo; and the Alaska Fish and Wildlife Research Center, Anchorage. Project activity was similar to that on Wrangel Island. Satellite radio-collars were placed on five adult females, four of which were accompanied by cubs-of-the-year. These marked females moved extensively throughout the eastern Kara Sea, with more restricted movements in the western extremes of the Laptev Sea.

Data on polar bears occurrences obtained during aerial surveys of sea-ice and observations recorded at drifting ice stations ("North Pole") were examined. Preliminary results from surveys in the Wrangel Island area (eastern East Siberian Sea and the Chukchi Sea) indicate increasing numbers of polar bears observed,

which may reflect an increase in the polar bear population. Conflicts between polar bears and people are still a serious problem in the Russian Arctic. Each year several people are killed or seriously wounded as a result of a provoked or non-provoked attack by a polar bear. VNIIPRIRODA prepared and distributed instructions on how to prevent a polar bear attack, to solve this serious problem (M. 1989). This work will not be continued because of the current financial crisis in Russia. In accordance with the recommendations of the Sochi Polar Bear Specialist Group meeting, VNIIPRIRODA issued "Methods on the aerial counts of the polar bear" (M. 1991). Plans to conduct a total count of polar bears in the Russian Arctic in conjunction with the aerial surveys of sea-ice were not realized in the early 1990s, because the IL-14 aircraft used for these surveys are no longer available. A substitute aircraft satisfactory for these aerial surveys has not been developed.

The research on the identification of spatially segregated groups of polar bears based on the analysis of chemicals in the bone tissue has been continued (Uspensky *et al.* 1985; Golovkin *et al.* 1991). The absolute concentration values of 22 elements was determined using plasma spectrometry. Sample size was 192 polar bears (100 males and 92 females) from the Canadian Arctic. Seven area groupings (using six significant elements: K, Co, Fe, Mg, Mo, Sr) have been defined for females, and two groupings (using three significant elements: Ba, Fe, K) for the males. These results are similar to those described by Golovkin *et al.* (1991) using a different analytical method. Using these results, we can distinguish 3–4 groupings of females between 60° W and 120° W, within the polar bear range in Canada. We can also conditionally separate males which dwell in the south (Hudson Bay), the north, and northeast.

Future activity

The joint Russia–US research project on the Chukchi-Alaskan population will be continued. Plans are being developed and tested for a joint Russia–US one-time census of polar bears in the in the Chukchi Sea using a helicopter based on a ship adjacent to the sea-ice edge. Observations of polar bear behavior and ground counts of dens within model plots will be continued in the Wrangel Island State Nature Reserve. If finances are available, the aerial counts of dens will also continue.

The analysis of data on polar bear observations from aerial surveys of sea-ice and drifting ice stations ("North Pole") will be completed soon. If samples of the bone tissue from the other Arctic Nations are received, this research will continue. VNIIPRIRODA has developed proposals for polar bear field research in the protected and central parts of the Russian Arctic, although at the present time, the Institute does not have finances to begin this work.

Population management

Since 1956, polar bear hunting has been prohibited in Russia. Only a limited number of polar bear cubs are captured annually for restocking Russian zoos. For the past several years, approximately 10 cubs have been captured annually for this purpose. In the next one to two years, Russian officials plan to make some changes in the use and conservation strategy of some polar bear populations as proposed by polar bear specialists. They are considering the differences in the current status of the populations, social and economic situations, and existing mutual agreements on population management with contiguous countries.

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The Status of Polar Bears in Alaska 1993

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Population

Population definition

Polar bears occur in all ice-covered seas adjacent to Alaska. The southern extent of their range in winter is the northern Bering Sea, where polar bears are seasonal visitors. From there, they range northerly through the Bering Strait, into the Chukchi Sea, and northeasterly through the Beaufort Sea into Canada. In summer, when the sea-ice retreats to the north, the polar bears go with it, and although they still occur adjacent to the coast in the Beaufort Sea, the Bering and Chukchi Seas are largely devoid of polar bears.

Movements studies, using radio telemetry of polar bears in the Beaufort Sea region of Alaska began in 1981, and continue to the present. Telemetry studies began in the Bering/Chukchi region in 1986. Results have not been completely analyzed, but preliminary assessments suggest that there is one population in the area from Cape Bathurst in Canada to approximately Pt. Barrow, Alaska. In the Chukchi Sea, bears that associate with the Alaska coast migrate seasonally at least as far west as Wrangel Island in Russia. Additional studies as well as analyses of existing data are necessary to evaluate the overlap between the bears of the Beaufort and Chukchi Seas near Barrow, and to determine the western limits of travels by Chukchi Sea bears.

Denning areas

Maternal denning has been studied in northern Alaska since 1981. Over 150 dens have been found throughout the Beaufort Sea and adjacent areas. Of the 90 dens

located and confirmed by radiotelemetry, 53% were on drifting pack ice, 42% were on land and 4% on land-fast ice. The proportion of dens on land was higher after 1986. Bears denning on pack ice drifted as far as 997km while in dens. Differences in production of land and pack ice dens were not detected. Mean entry and exit dates were 11 November and 5 April for land dens and 22 November and 26 March for pack ice dens. Polar bear dens were of ice and snow only. Female polar bears captured in the Beaufort Sea appeared to be isolated from those occurring east of Cape Bathurst in Canada. Movements to den sites west of the Beaufort Sea were more common, but bears captured in the Beaufort Sea seldom denned in Russia. Of polar bears that denned along the mainland coast of Alaska and Canada, 80% denned between longitude 137° and 146° West. Bears followed to more than one den did not reuse sites, and consecutive dens were 20–1304km apart, but radio-collared bears were largely faithful to the substrate and the general geographic area of previous dens.

Preliminary results suggest that many bears occurring seasonally along the coast of western Alaska enter maternity dens on Wrangel Island or the northern Chukotka Peninsula of Russia, and that few bears den on the western Alaska coast. Much work is needed, however, to confirm denning patterns in western Alaska.

Population size

It is presently estimated that there were approximately 2000 polar bears in the Beaufort Sea, and that at least an equivalent number probably occurred seasonally in the Bering and Chukchi Seas. A reassessment of the estimate in the Beaufort Sea is presently under way, but

results are not yet available. Population estimates in the Chukchi Sea still present great difficulties. A major census effort is presently planned for 1993 and 1994. Until those efforts are completed, we must deal with the previous estimates.

Harvest

Number and composition of the harvest

Polar bears may be harvested for subsistence purposes or for creating items of handicraft or clothing by coastal dwelling Natives provided the population(s) is not depleted and the taking is not wasteful. An unquantified portion of the Native subsistence harvest is actually taken in defense of life at hunting camps or within villages. Other types of harvest are prohibited. A single self-defense kill was attributed to offshore oil exploration activities.

The US Fish and Wildlife Service has tagged the skulls and hides of harvested bears and collected harvest information, with the assistance of local individuals, since 1980. The program was voluntary initially, and in October 1988, became mandatory.

The annual harvest of polar bears in Alaskan villages between 1980 and 1992 has averaged 121.6 animals (SD=51.7; 64–296) (Table 1). Great annual fluctuations are noted. Availability of polar bears to Native hunters may be determined by weather, ice conditions, and bear distribution. Hunters from villages harvesting Beaufort Sea stock polar bears accounted for 29.8% of the total state-wide kill, and hunters from villages harvesting from the Chukchi/Bering Seas stock accounted for 71.2% of the kill. Today, average harvest levels have declined from the 1960 to 1972 period when the annual harvest averaged 260 animals (Fig. 1). Recent harvest levels during the last two years have declined below the average (Table 1).

The statewide sex-ratio of the harvest from 1980–1991 was 66:34, males to females (Table 2). Long-term differences in the sex-ratio were not detected for the Beaufort or Chukchi/Bering Seas regions, however annual variation by region was evident. The extreme differences in the harvest sex-ratio occurred in the Beaufort Sea during 1982/1983 when the sex-ratio was 48:52, males to females; and during 1990/91 in the Chukchi Sea region when the sex-ratio was 83:17, males to females.

Statewide, harvests occurred in all months (Fig. 2). The greatest monthly harvest for the period occurred during January (19.1%). The combined months of November to May, when the pack ice is in proximity to shore, accounted for 87.7% of the harvest. The months of June to September, when the pack ice is retreating to its minimum, accounted for only 12.3% of the harvest. Differences in the chronology of the harvest were evident between the Beaufort Sea region and the Chukchi and Bering seas region. The harvest in the Beaufort region was bimodal and favored the October to November (39.9%) and April to May (26.4%) periods. In the Chukchi and Bering seas region the harvest was more evenly distributed through the mid-winter and spring months of December to April (78.4%) (Table 3). The pack ice is generally absent from this area during July to October resulting in low harvests (1.6%) during this period.

Average harvested polar bear ages are presented (Fig. 3, Table 4). Accuracy of age estimations are under evaluation and may change. Long-term trends within sex classes were not detected. Generally, the average age of females exceeded the average age of males. The harvest age class composition during 1980 to 1990 was 26.3% cubs, 26.8% sub-adults, and 46.9% adults (Table 5). Annual variation in age-class composition by region occurred.

The actual harvest is believed to approximate the reported kill, although the reported kill is considered a minimum verified number. Information on the sex and age of harvested animals should be improved. Complete information on the sex of harvested bears was available for 85% of the kill. Age information was available for 69% of the harvest during the 1980 to 1990 period (Table 6). The trend of providing specimens from harvested bears including teeth, has not increased following the mandatory marking, tagging and reporting regulation of October 1988. The validity of hunter-provided sex information will be tested through a protocol to test tissue samples of harvested bears genetically to confirm the sex. The unknown sex category remains a problem if there is a hunter bias against reporting females harvested. Due to insufficient samples, the unknown sex category will not be clarified through genetic analysis during this effort.

The primary mode of transportation used to harvest polar bears is snow machine (71%). Other modes of

transportation include the following: boat (11%), foot (11%), off-road vehicle (4%), pickup (2%), and dog team or airplane (each less than 1%) (Table 7).

Management

Current management regime and hunting regulations

The Marine Mammal Protection Act (MMPA) allows unlimited harvest of polar bears by coastal dwelling Natives for subsistence purposes or for creating articles of handicraft or clothing. Quotas, seasons, or other limitations are not placed on the harvest provided that the population is within optimum sustainable levels, a range between maximum net productivity level and carrying capacity; and provided that the harvest is not wasteful.

Regulations, effective from October 1988, require hunters to present hides and skulls from harvested polar bears to Fish and Wildlife Service (FWS) personnel or local assistants working with the FWS within 30 days of harvest. Skulls and hides are tagged with interlocking nylon-plastic tags. Specimens including teeth, organ tissues, claws, and ear tags and radio-collars of bears marked in research are obtained through this program. Non-compliance can result in a fine up to \$10,000.

A local user group agreement between the Inupiat and Inuvialuit Native people of Alaska and the Northwest Territories of Canada established harvest guidelines for the polar bear population of the Beaufort Sea. The guidelines are based upon scientific data which consider population size, sustainable yield estimates, and the sex-ratio of the harvest. The agreement requires the voluntary compliance of Alaska Native hunters. The guidelines have been adhered to during all years except during the initial year in Alaska.

The MMPA is scheduled for reauthorization in September 1993. The FWS Alaska Region has developed a package of amendment proposals. The proposals are undergoing Washington Office review. The proposed amendments would accomplish the following:

- broaden and make more specific the habitat protection language in the Act;
- provide for US citizens to hunt polar bears in Alaska;

- permit importation into the United States of legal sport-harvested polar bears;
- change the existing incidental (small) takes process to a permit process rather than a rule-making;
- relax existing restrictions in the MMPA to allow additional economic activities for Alaskan Natives, including selling and exporting meat and hides from certain species or stocks of marine mammals and licensing Alaskan Natives as hunting guides for sport hunting of polar bears;
- provide the Secretary with discretionary authority to manage the harvest of marine mammals by Alaskan Natives prior to populations declining below the depleted threshold;
- restrict methods and means to prohibit the use of aircraft or the use of large motorized vessels in taking or attempting to take marine mammals;
- relax import restrictions on marine mammal parts for Alaskan Natives, and for anyone wishing to leave the US with personal items or equipment and then to import those same personal items upon completion of travel;
- allow the intentional take (harassment) of polar bears and lethal take in defense of life (but not defense of property);
- authorize the Secretary of Interior to make grants or provide other financial assistance to Alaskan Native institutions or persons in order to participate in cooperative marine mammal management activities;
- authorize the Secretary to develop information and education materials to further public knowledge and understanding of marine mammals and their habitats; and
- increase the authorization of appropriations during the period of reauthorization.

The result of these proposals cannot be determined at this time.

Protection of polar bear critical habitats

Specific legal authorities to protect polar bear habitat are limited and dispersed among a number of Federal, state, and local agencies. Maternity denning area in Alaska are being identified. Feeding and migration use areas are not adequately identified or understood. Parts of the Arctic National Wildlife Refuge are used by

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denning polar bears. This area is subject to FWS management, but future demand for oil and gas exploration and the authorization to conduct these activities may be considered by the United States Congress.

The MMPA enacted a general moratorium on taking of polar bears, including takes by harassment. Activities which disturb polar bears are illegal and subject to prosecution. The incidental (small) takes provision, Section 101(a)(5) of the MMPA provides some authority to protect polar bear and habitat. Incidental and accidental takes of polar bears are permitted conditional to specific letters of authorization. A finding by the FWS that the activity would have a negligible impact on polar bear populations or their availability to subsistence users is required before development of regulations. This provision may offer some protection of polar bear habitat while authorizing prescribed levels of non-lethal take.

The need for more effective habitat protection authorities are identified in the preceding section and proposed as amendments to the MMPA.

Use of and trade in polar bear products

Use of products

Natives use polar bears primarily for their meat and for their hides. A substantial amount of meat is salvaged and used for personal consumption. Some meat which is salvaged may be used for dog food. It is legal for polar bear meat to be sold in Alaskan Native villages, although it occurs infrequently. Hides which have been substantially altered and converted into clothing or handicrafts may be sold to non-Natives.

Trade

It is illegal to sell unaltered hides to non-Natives. Unworked hides may be traded, bartered, or sold among other Natives. A limited number of hides are sold or traded between Natives for groceries, fuel, snow machines or snow machine parts, seal oil, etc. Some hides are given as presents to relatives or friends. It is illegal to import polar bear products into the United States, unless the importing countries apply for and are granted a waiver. Export of handicrafts, clothing or polar bear products may be authorized with a Convention on

International Trade in Endangered Species (CITES) permit. Most CITES permits are for transport of specimens obtained through scientific research. Increased travel of Native peoples between Russia and the United States has increased demands to import and export marine mammal products between these countries. Trends to import or export for other purposes are not detectable.

There is very limited information concerning illegal taking of polar bears by non-Natives. If illegal taking occurs it is believed to be at a very low level. However, illegal trade of unworked or unsealed hides has been documented through law enforcement action. The first case involving the illegal sale of polar bear gall bladders documented by law enforcement agents occurred during 1992.

Other impacts on polar bear populations

Industrial activities

The effect of human activities, such as shipping, seismic exploration, drilling, hard mineral mining offshore or onshore, and transport of oil, in polar bear habitat is not precisely known. Also, contamination of ice, water, food species, and bears themselves by oil and other toxins may increase as human activities increase in the Arctic. Acute exposure to oil and other chemicals can be fatal to polar bears. Long-term effects of lower levels of exposure to oil are not known.

Offshore oil and gas exploration has ceased in the Chukchi Sea region. In the Beaufort Sea, offshore and onshore exploration and development continues at a pace reduced from previous years.

Human activities in the Arctic, particularly those related to oil and gas exploration and development, pose risks to polar bears and other wildlife, although oil exploratory activity is declining in Alaska's Arctic. A 1990 workshop on measures to assess and mitigate the adverse effects of Arctic oil and gas activities on polar bears noted the following ways by which polar bears and their habitat could be affected: 1) death, injury, or harassment resulting from interactions with humans; 2) damage or destruction of essential habitat (the Arctic National Wildlife Refuge is the only known denning

area over which the FWS has direct management control); 3) contact with and ingestion of oil from acute and chronic oil spills; 4) contact with and ingestion of other contaminants; 5) attraction to or disturbance by industrial noise; 6) harassment (disturbance) by aircraft, ships, or other vehicles; 7) increased hunting pressures; 8) indirect food chain effects due to the impacts of oil and gas-related activities on the food web upon which polar bears depend and are a part; and 9) mortality, injury, and stress resulting from scientific research to determine possible effects of oil and gas activities on polar bears and other species. Available information is not sufficient in many cases to accurately assess and determine how to avoid or mitigate possible direct and indirect effects of industrial activities. Use of non-lethal deterrents and harassment of problem bears could reduce bear-human conflicts by aversive conditioning of bears to avoid humans.

Another concern is introduction of radioactive wastes into the Arctic marine ecosystem. Experimental nuclear testing and dumping of nuclear wastes into offshore waters by Russia has recently become common knowledge. Near Cape Thompson, Alaska, low level nuclear waste was buried at the completion of a test project. Distribution of radioactivity within the polar basin and its possible effects on the food web supporting polar bears have not yet been determined.

Status of populations

Preliminary assessments indicate that the status of the polar bear population in the Beaufort Sea is good. The population is high and appears to be increasing slowly. Several characteristics, when compared to those of the previous two decades indicate a population nearing K-carrying capacity. The polar bear population in the Chukchi and Bering Seas area is also thought to be higher than in previous years, but data with which to assess it are more limited.

Harvest data indicate that the ages of polar bears taken by subsistence hunters, throughout Alaska, has generally increased from the levels which occurred during the late 1960s and early 1970s. All age classes are now present within the population. Previously the older age class (more than 10 years old) was noticeably under-represented. Traditional knowledge offered by Native elders and hunters indicates that today polar

bears are more frequently observed in near-shore areas. All coastal villages have experienced increased encounters with polar bears and some encounters occur within the communities. In 1990 a predacious polar bear attack resulted in the death of one individual.

The magnitude and frequency of Native-killed polar bears has increased from the 1960s. Hunters from villages which harvest polar bears infrequently during the past, such as Gambell and Savoonga, are harvesting an average 10 to 20 bears per year. Hunters from other coastal villages are experiencing similar situations.

Management in relation to the agreement on the conservation of polar bears

The International Agreement on the Conservation of Polar Bears became effective in 1976. Article VI of the Agreement states that contracting parties shall enact and enforce such legislation and other measures as may be necessary to give effect to the Agreement. The United States has not specifically enacted implementing legislation or regulations. When the Agreement was initially provided to the Senate for advice and consent and prior to Presidential signature, it was thought that the MMPA provided adequate authority to implement all provisions of the Agreement. This appears not to be the case, however, and specific implementing legislation or regulations may be necessary to allow the United States to more fully comply with all provisions of the Agreement. The MMPA's lack of definitive authority to protect polar bear habitat, regulate the harvest and methods and means of harvesting are topics of contention. The United States Department of State has recently taken an interest in this issue.

Article I:

The taking of polar bears is prohibited except as provided in Article III. Under the MMPA limited takes are allowed for scientific research purposes, public display, incidental (small) takes by United States citizens, and for Native subsistence, handicraft, or clothing purposes. The definition of "taking" covers hunting, killing, and capturing. In the United States the MMPA considers harassment or disturbance, knowing or unknowing, to be a form of taking. Authority to authorize, regulate, and prohibit these forms of incidental taking are provided. For example passive denning disturbances could

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pose significant threat to individual animals and if prevalent on a wide scale, it could pose significant threat to cohorts or stocks of animals.

Article II:

Instructs parties to the Agreement to protect the ecosystem of which the polar bears are a part and provide special attention to specific habitat components. It seems that the ecosystem terminology means something larger than the individual habitat types. In either event, some clarification may be warranted.

Specific measures to protect polar bear habitat in the United States have been limited. The difficulties with protecting offshore habitats which appear and disappear annually are great. Unusual problems in identifying important polar bear habitat result from the polar bears' mobility and widespread occurrence on sea-ice. Stipulations to protect known or observed polar bear den sites have been incorporated into exploration permits and guidelines. Spatial and temporal restriction on activities are appropriate for certain terrestrial habitats. Broad authorities to protect habitat may be found in other national laws such as the Coastal Zone Management Act, Federal Water Pollution Control Act, National Environmental Policy Act, and the Outer Continental Shelf Lands Act.

Article III:

Native hunting of polar bear is permitted for subsistence purposes or for purposes of creating handicrafts or clothing, as authorized by the MMPA. Harvests are not restricted provided populations are not depleted and the taking is not wasteful. The harvest of female bears with cubs and their cubs, and occasionally of bears moving into denning areas or in dens occurs in deference to Annex X, Resolution on Special Protection Measures, to the Agreement. Amendments proposed from FWS Alaska Region would partially resolve this issue. These amendments, if adopted, may also authorize a regulated system of Native-guided sport hunting or possibly, the regulated sale of hides, and relaxation of import/export provision.

Article III (1)(d) allows for taking by "local people using traditional methods in the exercise of their traditional rights and in accordance with the laws of that party." Does this broadly worded phrase override the Resolution on hunting females and cubs and bears entering or in dens?

Article III(1)(e) provides an exception "wherever polar bears have or might have been subject to taking

by traditional means by its nationals." Does this allow any taking so long as it is conducted by traditional means? Does the term nationals restrict take by non-residents of the country?

Article IV:

The MMPA does not restrict Native subsistence hunting methods or means of harvesting polar bears. The Agreement excepts the prohibition on use of aircraft or large vessels by stating that it applies, "except where the application of such prohibition would be inconsistent with domestic laws." Infrequently, polar bears have been harvested by Alaska Native hunters using aircraft. Amendments proposed from the FWS Alaska Region, would prohibit the use of aircraft or large motorized vessels in harvesting polar bears.

Article V:

The United States is party to the CITES convention.

Article VI:

The United States has chosen the MMPA to implement the Agreement. Amendments from the Alaska Region, FWS, are proposed.

Article VII:

Cooperative research and management programs are underway. A protocol with Russia was signed October 1992 to develop a cooperative management/allocation agreement in the future (previously discussed). An agreement between the Inupiat of Alaska and the Inuvialuit of Northwest Territories on the cooperative management of polar bears in the Beaufort Sea is supported by the FWS. The Alaska Department of Fish and Game, Canadian Wildlife Service, Renewable Resources of the Northwest Territories, and the FWS are technical advisors to the user agreement and meet annually to review progress of the management program. A five-year evaluation will occur in 1993.

Information needs and data gaps

The conservation of polar bears depends primarily upon two things. First, we must insure adequate space for the critical life functions of feeding and reproduction is available. Significant habitats must be protected or managed in order to ensure their continued availability for polar bear use. Second, manage human activities that can directly or indirectly alter numbers or welfare of polar bears must be managed.

Space issues

Denning habitats

Throughout most of their life cycle, polar bears are extremely mobile. While in maternal dens, however, they are stationary, and theoretically vulnerable to many natural or anthropogenic perturbations. Recent studies have described the distribution of polar bear dens in northern Alaska, but the distribution of dens in western Alaska is still largely unknown. Also, although the distribution of denning is known in northern Alaska, explanations for that distribution are not. Thus, there is a need for "explanatory" as well as continuing "descriptive" studies of denning in Alaska.

Feeding habitats

Little is known about polar bear feeding ecology. Likewise, polar bears are very mobile, and movements to certain areas at certain times can be predicted. How-

ever, the reason for those movement patterns is unclear. Therefore, detailed studies of polar bear feeding ecology and relationships to sea-ice conditions and movements are needed.

Population size and trend

Population size

As indicated above, methods are needed to determine numbers of polar bears in western Alaska, where mark and recapture methods are not practicable.

Population trend

Knowledge of recruitment and survival of polar bears is limited and current population models are hampered by the lack of accurate estimates of these parameters. Additional data on these subjects are critical to continuing efforts at polar bear management.

TABLE 1. Number and sex of polar bears killed by village each harvest year (1 July–30 June)

Village	1980/81			1981/82			1982/83			1983/84			1984/85			1985/86			1986/87			1987/88			1988/89			1989/90			1990/91			1991/92			Total					
	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U			
Atkasuk*																												1	1								1	1				
Barrow*	1	3	4	5	1		5	5	4	18	5	4	12	14	5	1	2	10	4	9	8	9	2	3	20	1	9	10	4		10	1		14	9		109	56	47			
Brevig Mission										2	3		1															1									3	4				
Diomede	1			1	1	1				6	4		5			3	3	1	3	4	1	12	7		5	4		4	3		3			5	1		48	27	3			
Emmonak				1																																	1					
Gambell	3	4		1			3	2	1	20	6		1	1	2	11	3	3	10	11		12	12		3	10		6	3		9	2		3	2		82	56	6			
Golovin																			1																		1					
Hooper Bay																																								1		
Kaktovik*	4	6	13	1			1			1						1	3	1	1	2	3	3			5	2	3		1	1		2		1	19	13	23					
Kiana																1																					1					
Kivalina				1						3			2			1			2			3	2		1			4	1		1	2		2			13	6	7			
Kotzebue										1	1					1			3									1	2								6	2	1			
Nome										1																											1	3				
Nuiqsut*	1			1									1	1	1	2			3	1	1				1	2								1	1	7	3	7				
Point Hope	4	3	2	4	1	2	9	6	6	13	11	6	11	3	3	9	3	4	10	2	2	4	5	1	5	3		10	5	9	12	2	10	4	2	1	95	46	46			
Point Lay		1		1	2					5	3					2	3	2				1	1		1	2		1		1	1	1	1	1	1	13	8	8				
Savoonga	11	5		12	9		6	3		31	17		5	2		13	5	3	4	1			7	5	10	4		7	3		9	3		2	4		117	61	3			
Shishmaref	15	11	3	13	7	3	7	5	1	49	22	11	10	2		11	8	1	6			9	2	1	19	7	3	13	2		6			3			161	66	23			
Wainwright*	4		2	8	2	4	5	7	4	15	7	11	9	6	3	5		3	8	2	3	7	2		9	2	4	6		1	4	2		2	3		82	33	35			
Wales	7	1		5	6		6	1		10	10		7	4	4	6	4	1	5	2		4	3	2	3	6		2	1		3			2			60	38	7			
Sub Total	51	34	24	52	27	14	42	29	16	172	88	36	62	32	23	66	33	31	59	33	18	71	46	9	84	41	19	64	26	11	58	12	13	37	23	4	818	424	218			
Annual Total	109			93			87			296			117			130			110			126			144			101			83			64			1460					

*Villages harvesting polar bears from the Beaufort Sea stock

TABLE 2. Sex ratio of polar bear harvest, 1980–1991.

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	Total
All Alaska	60:40 (85)	66:34 (79)	59:41 (71)	66:34 (260)	66:34 (94)	67:33 (99)	64:36 (92)	61:39 (117)	67:33 (125)	71:29 (90)	83:17 (70)	66:34 (1241)
Beaufort Sea 53:47	82:18 (19)	48:52 (17)	74:26 (23)	51:49 (46)	71:29 (91)	57:43 (14)	73:27 (28)	86:14 (26)	76:24 (43)	82:18 (21)	67:33 (17)	(324)
Chukchi Sea	62:38 (66)	61:39 (62)	65:35 (48)	64:36 (214)	77:23 (53)	66:34 (85)	67:33 (64)	57:43 (91)	57:43 (82)	70:30 (69)	83:17 (53)	65:35 (917)

Total number of bears in parentheses

TABLE 3. Monthly harvest of Polar Bears in the Beaufort, Chukchi and Bering Seas (1980–1992).

	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
Beaufort Stock*	10	16	17	85	85	32	27	9	23	30	84	13	431
(%)	(2.3)	(3.7)	(3.8)	(19.7)	(20.2)	(7.3)	(6.3)	(2.1)	(5.2)	(7.0)	(19.4)	(3.0)	(100)
Chukchi/ Bering Sea	11	1	0	4	84	143	249	110	183	113	98	21	1017
(%)	(1.1)	(.1)	(-)	(.4)	(8.3)	(14.1)	(24.5)	(10.7)	(18.0)	(11.1)	(9.6)	(2.1)	(100)
Total	21	17	17	89	169	175	276	119	206	143	182	34	1448
(%)	(1.5)	(1.2)	(1.2)	(6.1)	(11.7)	(12.1)	(19.1)	(8.2)	(14.2)	(9.8)	(12.6)	(2.3)	(100)

*Beaufort Sea Stock harvest communities include Kaktovik, Nuiqsut, Barrow, Wainwright and Atkasuk.

TABLE 4. Mean age by sex of polar bears harvested in Alaska, 1980–1991.

Sex	1980/81			1981/82			1982/83			1983/84			1984/85			1985/86			1986/87			1987/88			1988/89			1989/90		
	N	\bar{x}	SD	N	\bar{x}	SD	N	\bar{x}	SD	N	\bar{x}	SD	N	\bar{x}	SD	N	\bar{x}	SD	N	\bar{x}	SD	N	\bar{x}	SD	N	\bar{x}	SD			
SOUTHERN BEAUFORT SEA																														
Male	(3)	6.3	2.5	(5)	7.2	4.0	(7)	3.3	2.9	(25)	6.6	4.4	(14)	4.8	4.1	(7)	3.0	1.0	(6)	6.5	5.1	(10)	9.0	6.3	(18)	8.1	5.3	(8)	7.0	4.9
Female	(6)	11.6	3.7	(3)	8.0	5.6	(6)	5.6	3.1	(9)	7.1	3.9	(13)	9.6	5.4	(3)	14.3	1.5	(8)	7.6	3.4	(4)	3.5	1.0	(3)	8.0	1.0	(1)	3.0	
Unknown	(4)	3.0	0.8	(0)			(0)			(0)			(0)			(5)	4.0	1.2	(2)	4.0	2.8	(0)			(1)	4.0		(0)		
CHUKCHI SEA																														
Male	(38)	5.9	3.6	(28)	6.0	4.7	(25)	4.4	2.1	(128)	7.0	4.5	(30)	8.4	6.6	(48)	7.0	4.8	(37)	6.4	4.3	(50)	6.5	5.5	(41)	5.8	4.5	(38)	5.8	4.6
Female	(22)	10.3	6.3	(21)	8.1	4.6	(14)	6.2	4.0	(66)	7.3	4.6	(9)	8.6	3.8	(28)	7.5	5.4	(21)	6.8	4.8	(34)	7.5	3.8	(31)	8.2	4.8	(18)	8.5	4.1
Unknown	(1)	4.0		(1)	2.0		(1)	5.0		(4)	3.3	0.5	(0)			(3)	3.6	1.2	(0)			(1)	9.0		(0)			(0)		

a) Harvest season extends from July 1 to June 30.
 N = Number of known/age bears. \bar{x} = Mean age. SD = Standard Deviation.

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TABLE 5. Age class of polar bear harvested in Alaska, 1980–1990

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	Total
Cubs (%)	22 (29.7)	14 (24.1)	22 (41.5)	49 (21.1)	16 (24.2)	31 (33)	18 (24.3)	25 (25.3)	22 (23.4)	20 (30.8)	239 (26.3)
Subadults (%)	12 (16.2)	11 (19)	16 (30.2)	72 (31)	17 (25.8)	26 (27.7)	23 (31.1)	24 (24.2)	24 (25.5)	19 (29.2)	244 (26.8)
Adults (%)	40 (54.1)	33 (56.9)	15 (28.3)	111 (47.9)	33 (50)	37 (39.3)	33 (44.6)	50 (50.5)	48 (51.1)	26 (40)	426 (46.9)
Total	74	58	53	232	66	94	74	99	94	65	909

Cubs = 3rd year of life, harvested before May.
 Subadults = 3–5 year olds.
 Adults = 6 years or greater.

TABLE 6. Complete information on the sex and age of harvested polar bears in Alaska, 1980-90

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89*	1989/90	Total
No. of bears for which sex and age information complete	74	58	53	232	66	94	74	99	94	65	907
Total size of harvest	109	93	87	296	117	130	110	126	144	102	1323
(%) Complete	(67)	(62)	(61)	(78)	(56)	(72)	(61)	(78)	(65)	(64)	(69)

*88/89 mandatory marking, tagging and reporting program went into effect.

TABLE 7. Modes of transportation used to harvest polar bears in Alaska from 1980/81 to 1991/92

	Airplane	Boat	Dog team	Foot	Off road vehicle	Pick-up	Snow machine
N	3	100	2	97	39	19	641
(%)	(0.33)	(11)	(0.22)	(11)	(4)	(2)	(71)
N = Number							

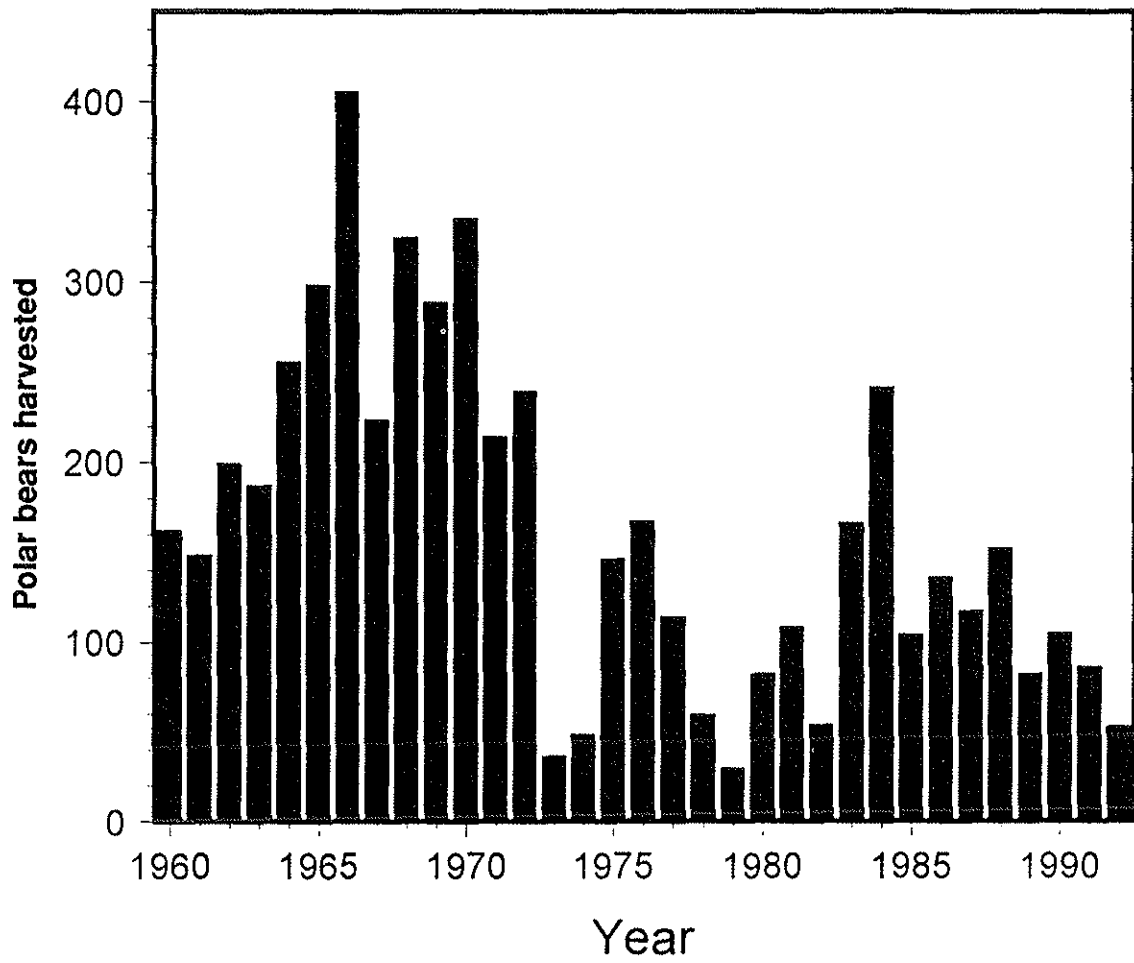


FIG. 1. Annual Alaskan polar bear harvest (1960–92). The Marine Mammal Protection Act went into effect in 1973

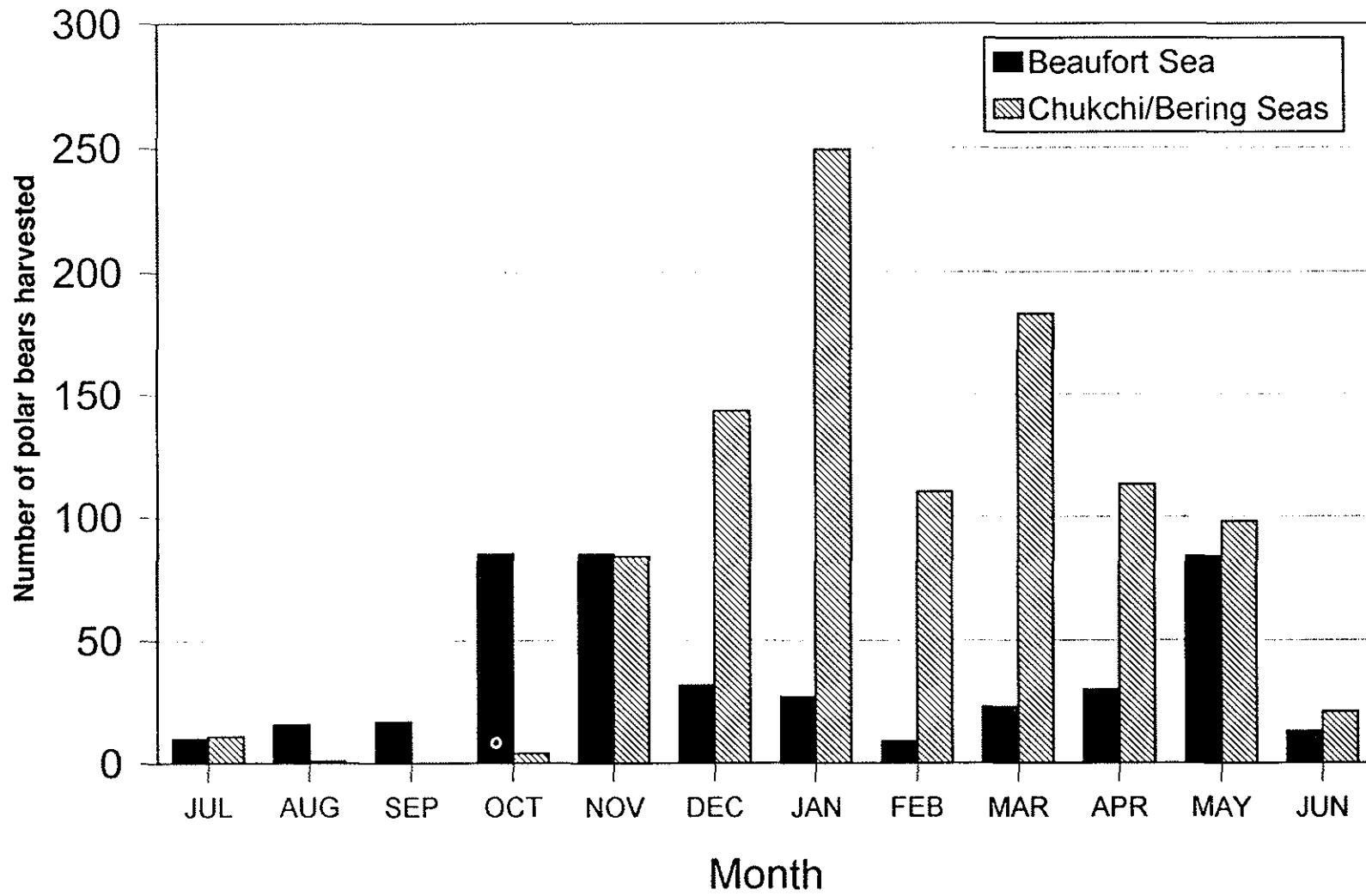


FIG 2. Monthly harvest of polar bears in the Beaufort and Chukchi/Bering Seas (1980-92)

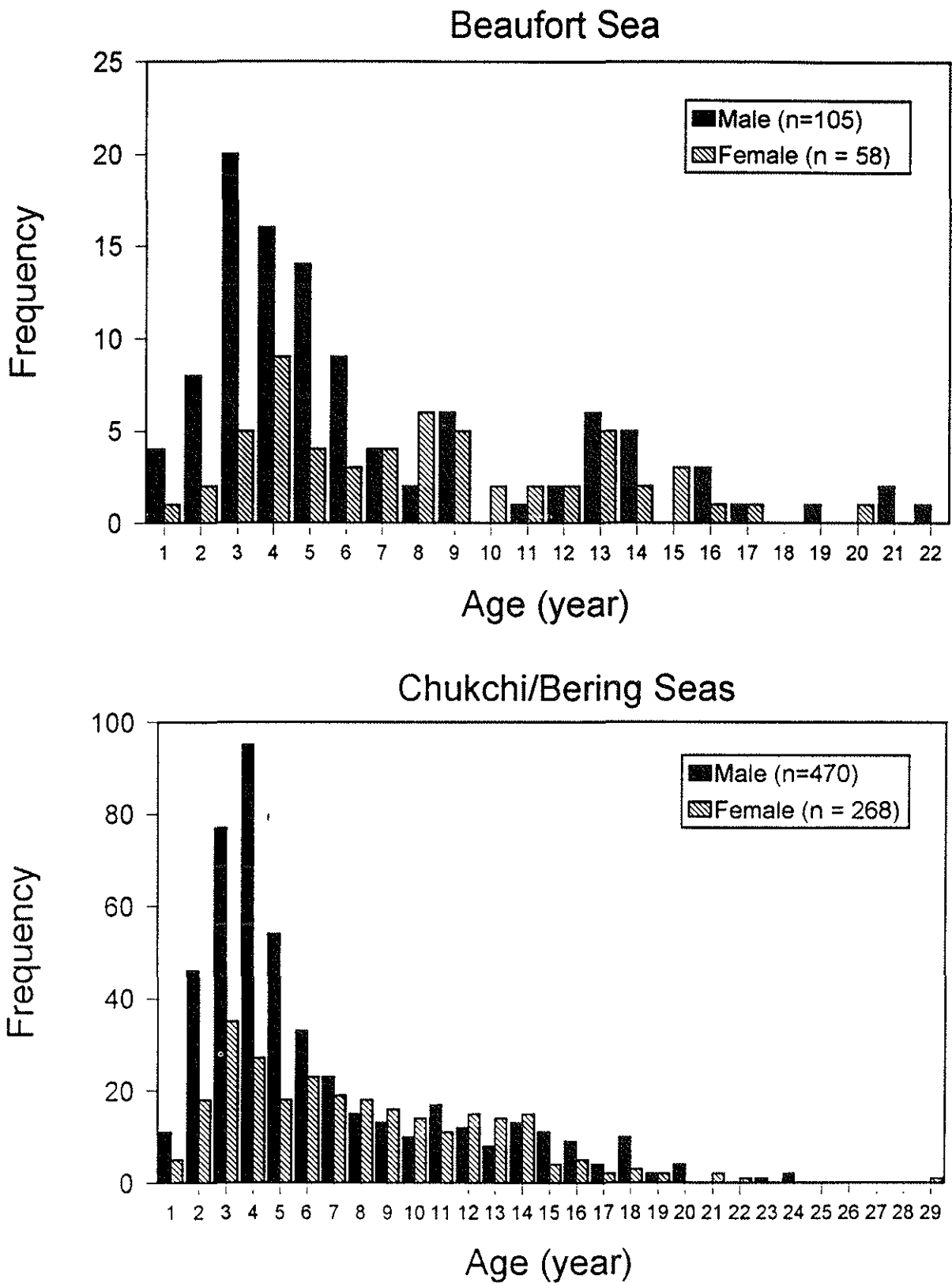


FIG 3. Age frequencies of harvested polar bears, Beaufort and Chukchi/Bering Seas (1980–90)

Polar Bear Management in Alaska 1988–92

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Management changes

The Marine Mammal Protection Act (MMPA) provides the framework for management activities pertaining to polar bears. The MMPA has been reauthorized numerous times since its passage in 1972, the most recent in 1988. Procedures for reviewing the status of marine mammal populations and for making depletion determinations were added in 1988. The new section elaborates on the development of conservation plans particularly for those species which are depleted. The MMPA provisions governing scientific research and public display permits were also amended in 1988 and a new permit category was created which allows the Fish and Wildlife Service (FWS) to authorize activities designed to enhance the survival or recovery of marine mammal populations. These changes were implemented so that animals which were pregnant or nursing or less than eight months old when taken may be imported for public display if the importation is for the protection or welfare of the animal. The existing requirements for public display remain in effect.

Following the last meeting of the Polar Bear Specialist Group, mandatory marking, tagging and reporting regulations (October 1988) went into effect. The new regulations provided standards for tagging skulls and hides and recording harvest data.

Polar bear kills

Number and composition of the harvest

The MMPA allows polar bears to be harvested for subsistence purposes or for creating items of handicraft or clothing by coastal dwelling Natives, provided the

population(s) is not depleted, and the taking is not wasteful. The Native subsistence harvest includes kills at hunting camps or within villages which may be more appropriately considered defense kills. All other types of harvest are prohibited. A single defense of life kill was attributed to offshore oil exploration activities during 1990.

The total Alaska harvest of polar bears from July 1988 to June 1992 was 392 animals. The annual harvest of polar bears in Alaska villages during this period has averaged 98 animals (SD=51.2; range: 64–144) (Table 1). Hunters from villages harvesting Beaufort Sea stock (Northern Area) accounted for 28.4% of the total state-wide kill, and hunters from villages harvesting from the Chukchi/Bering seas stock (Western Area) accounted for the remaining 71.6% of the kill. Harvest levels during the last two years have declined below the average of 98 animals for the four-year period between 1988 and 1992. Today, average harvest levels have declined from the 1960–72 period when the annual harvest averaged 260 animals. The sex-ratio of the harvest from 1988–91 was 72:28, males to females (Table 2). The sex-ratio for the Chukchi Sea region approximated the long-term 2:1, male:female ratio; while the Beaufort Sea region more closely approximated a 3:1, male to female, ratio. Complete information on the sex of harvested bears was available for 85% of the kill.

Average ages and age classes of harvested polar bears are presented in Tables 3 and 4, respectively. Accuracy of age estimations are under evaluation and may change. The harvest age class composition during 1988 to 1990 was 26.4% cubs, 27.0% subadults, and 46.6% adults (Table 4).

Polar Bears

Age information was available for 65% of the harvest during the 1988–90 period.

The true harvest is believed to approximate the reported kill, although the reported kill is considered a minimum verified number. Information on the sex and age of harvested animals should be improved. The trend of providing specimens from harvested bears including teeth, has not increased following the mandatory marking, tagging and reporting regulation of October 1988. The validity of hunter-provided sex information will be verified through a genetic test of tissue samples of harvested bears. Due to insufficient samples of unknown sex category animals killed in the past, genetic analysis will not clarify this issue.

Specimens from harvested bears continue to be collected. Claw samples are being evaluated for isotopic carbon/nitrogen ratios by Dr Donald Shell of the University of Alaska, Fairbanks. Collection of samples for monitoring organochlorines and heavy metals will be continued.

North Slope Borough/Inuvialuit Game Council Hunters Agreement

A local user group agreement between the Inupiat and Inuvialuit Native people of Alaska and the Northwest Territories of Canada, modeled after the International Agreement, establishes harvest guidelines for the polar bear population of the Beaufort Sea. The guidelines are based upon scientific data which consider population size, sustainable yield estimates, and the sex-ratio of the harvest. The agreement requires the voluntary compliance of Alaska Native hunters. The guidelines have been adhered to during all years except during the initial year in Alaska.

The Agreement is precedent setting, and in the United States establishes conditions which are more stringent than Federal guidelines under the MMPA. The long-range success of the Agreement will depend upon several factors but primarily upon compliance of local hunters, as it lacks legal status and does not provide for enforcement or penalties in Alaska.

In 1988 the annual sustainable harvest guidelines were established at 76 bears per year: 38 bears each for the Canadian and Alaskan sectors of the Beaufort Sea. The sustainable yield estimate was based on existing

sex-ratio of the harvest and a 1.5% annual sustainable removal rate for females. The hunting season in Canada is 1 December to 31 May, and in Alaska it is September 1 to May 31. This protects pregnant females prior to denning in Canada, but not in Alaska.

During the initial harvest year, 1988–89, Alaskan hunters in the area governed by the Agreement took 58 bears, exceeding harvest guidelines. The Canadian harvest of 32 was below the allocation guideline. During 1989–90 the Alaskan harvest of 24 and the Canadian harvest of 34 were both less than the allocation guideline of 38 bears per jurisdiction. It is believed that the reduced take in 1989–90 resulted from recognition of terms of the Agreement through distribution of informational brochures and posters and an extensive communications effort. Harvest during the 1990–91 and 1991–92 seasons were also less than the allocation guidelines: 19 from Alaska and 15 from Canada in the former, and 30 from Alaska and 32 from Canada in the latter.

Bear–human interaction

The first human mortality caused by a polar bear attack of recent time occurred on December 8, 1990, within the village of Point Lay. The predacious attack occurred in the dark of the early morning hours. The bear was located and killed. A necropsy was conducted by personnel of the North Slope Borough. The bear was extremely lean and no remarkable physical problems were observed. The victim was consumed by the bear.

The increased frequency of polar bear visits to coastal communities has caused public concern for human welfare in recent years. During the fall and early winter of 1992/93, favorable weather and ice conditions and a successful bowhead whaling season, contributed to attracting up to 40 polar bears to the vicinity of Barrow. Potentially serious human safety problems were averted by the actions of the North Slope Borough agencies, Alaska Department of Fish and Game and US Fish and Wildlife Service. In certain instances local polar bear monitors have been employed to conduct community polar bear patrols.

The potential for an excessive bear kill existed but did not occur due to the vigilance of the North Slope Borough's Department of Wildlife Management and hunter restraint in complying with the harvest guidelines

contained in the agreement with the Inuvialuit Game Council, Canada.

Industry and polar bear regulations

Industry has petitioned the FWS to develop incidental (small) take regulations for permissible types and levels of "taking" of polar bears in two geographic regions: Chukchi Sea and Beaufort Sea. Types of "taking" are primarily incidental, non-intentional forms, including non-lethal disturbance (harassment). In order for regulations to be developed the FWS must first find that the aggregate total of taking in the specified activity will have a negligible impact on the species or stock and will not have an unmitigable adverse impact on the availability of the species or stock for subsistence uses. If this finding is made, the FWS issues the regulations which include specify monitoring and reporting programs necessary to measure the effect of the subject activity. Individual Letters of Authorization provide further details on operational requirements.

To date, regulations for exploratory activities in the Chukchi Sea during the open-water season have been developed. Regulations for exploratory and production activities in the Beaufort Sea will be developed by May 1993.

The first recorded lethal take of a polar bear directly associated with industry activity occurred during January 1990. Oil and gas companies operating in the Beaufort Sea are keenly interested that future polar bear-human interactions be minimized and have taken the initiative to implement polar bear interaction plans prior final development of incidental take regulations. FWS and Alaska Department of Fish and Game (ADFandG) representatives have provided training to numerous operators on detecting and avoiding encounters with polar bears. Operator site-specific polar bear interaction plans have been developed and reviewed for completeness and consistency with conditions of the MMPA. Further, FWS and ADFandG employees contributed to an informational video for employee environmental orientation.

The US Minerals Management Service has contracted development of a reference manual for industrial operators working in polar bear country. A host of agencies and individuals contributed to the development of the manual, scheduled for completion during 1993.

Management planning

A draft management plan for polar bears in Alaska has been developed (copies available). The draft management plan is being considered for approval by the FWS. It was prepared with the assistance of the Marine Mammal Commission and the Polar Bear Management Plan Advisory Team. The Advisory Team comprised of individuals or representatives from a wide spectrum of interests including the following: Alaska Native hunters; North Slope Borough; Bering Strait region; Northwest Alaska Native Association; National Wildlife Federation; Audubon Society; Greenpeace; Defenders of Wildlife; Safari Club International; Alaska Professional Hunters Association; US Minerals Management Service; Alaska Department of Fish and Game; ARCO Alaska Inc.; BP Exploration; Marine Mammal Commission; and FWS. The development of this plan recognized the different ideologies and philosophies in conserving and managing polar bears and sought consensus through a cooperative venture. Because of the diversity of opinion it is unlikely that the final plan will represent a consensus for all individuals or organizations involved in its development.

The Management Plan for the Polar Bear in Alaska (Plan) has been developed by the Fish and Wildlife Service (FWS) for a number of purposes.

- Support terms of the International Agreement on the Conservation of Polar Bears.
- Support the policies outlined in the MMPA including maintaining populations within optimum sustainable ranges, protecting the environment, and providing for specific uses of polar bears. Support amendments to the MMPA to improve the abilities of the FWS to wisely manage and protect polar bear populations for the public benefit or intrinsic values.
- Support management programs based on sound, objective biological information.
- Support cooperative management and research programs at local Native hunter, state, national, and international levels.

The plan is organized into six sections: 1) preface explaining the purpose and process of the plan and involvement of key individuals and organizations in its development; 2) background section providing information on the historical and contemporary uses of polar bears, their management, and the legal framework

Polar Bears

which guides the actions of the plan; 3) polar bear biology; 4) conservation issues; 5) conservation plan, a step-down outline and narrative of the goals and objectives (tasks) of the conservation plan; and 6) implementation plan comprised of; a) the schedule for completing the tasks in the conservation plan, and b) management options, including the preferred alternative.

The public availability of this plan was announced on 28 December 1992 in the Federal Register. The plan is subject to change during and as a result of the public comment period from 15 January 1993, to 28 February 1993. Meetings were conducted in coastal villages and Anchorage. Public comment will be evaluated during March 1993 and a revised final plan will be published in April 1993. The final plan is also subject to change as a result of annual review by the advisory team, new findings, change in population status or stocks, or research findings.

The plan may be revised at any time as appropriate. The life of the plan is anticipated to be five years. Modification may be required as dictated by emerging resource issues, amendments to the MMPA, or shifts in FWS policies and public directives regarding polar bear management.

Marine Mammal Protection Act reauthorization

The MMPA is scheduled for reauthorization in September 1993. The FWS, Alaska Region, has developed a package of amendment proposal. A formal FWS and Department of Interior position has not been determined for the proposed amendments. As of March 1993 they addressed the following areas or issues: broaden and make more specific the habitat protection language in the Act; provide for US citizens to hunt polar bears in Alaska; permit importation into the United States of legal sport harvested polar bears; change the existing incidental (small) takes process to a permit process rather than a rule-making [see also previous section on industry developments]; relax existing restrictions to allow additional economic activities for Alaskan Natives, including selling and exporting polar bear meat and hides and licensing Alaskan Natives as hunting guides for sport hunting of polar bears; provide the Secretary with discretionary authority to manage the harvest of polar bears by Alaskan Natives prior to population

declines below the depleted threshold; restrict methods and means to prohibit the use of aircraft or the use of large motorized vessels in taking or attempting to take polar bear; allow a regulated import or export of polar bear parts; authorize financial grant assistance to Alaskan Native institutions or persons participation in cooperative polar bear management activities; and emphasize the development of information and education materials to further public knowledge and understanding of polar bears and their habitats.

Cooperative projects with Russia

The polar bear population occupying the Chukchi and Bering seas is mutually shared between Russia and Alaska. A very high frequency of denning of bears from this stock occurs in Russian territories; and polar bears spend a greater proportion of their time in Russian territories than in Alaskan territories. At the Polar Bear Specialist Group meeting in 1988, polar bear management biologists within the former Soviet Union expressed a desire to renew hunting. Hunting of polar bears in the Russian Arctic has been prohibited since 1956.

In Alaska, Native subsistence hunters harvest approximately 100 bears annually from this population. Harvests at this level are considered sustainable, although precise estimates of population size and sustainable yield limits are not available.

Additional demands on this stock of polar bears requires a unified management approach. Resource agency and Native representatives of both countries met in October 1992 and signed a protocol of intention to develop a cooperative management plan. The protocol states that Native peoples from both countries will be involved in the development of the ultimate management plan as partners with the management agencies. The agreement will describe exchange of scientific information, regulation of uses, endorsement for bio-monitoring and joint field research, coordination of conservation and management activities, and exchange of information on environmental legislation. The foundation for future management or allocation agreement will be sound biological information. The management protocol urges each country to establish a working group and to convene a meeting of the working groups during 1993 to draft the initial management agreement.

The need to control and account for the total take of polar bears from the Bering/Chukchi seas population will be central to an allocation agreement. The current ability of the FWS to regulate harvests is limited to when populations decline below OSP. Independent voluntary restraint in harvesting polar bears has recently been demonstrated by North Slope hunters conforming to terms of the Inupiat and Inuvialuit management agreement for polar bears of the Beaufort Sea. However, it is not certain whether voluntary restraint, such as demonstrated by the Inupiat, provide adequate protective assurances for Russian managers entering future hunter agreements for the western Alaska region.

A sound estimate of population size and biologically allowable removal rate are priority management needs. To this end the FWS polar bear management program has supported Dr Garner *et al.* in a review of census methodologies which lead to the Protocol: Pilot Polar Bear Survey Beaufort Sea, 1993. The management program will be cooperating in the 1993 test of census methodologies designed to be applied in the Chukchi Sea during the fall of 1994.

TABLE 1. Number and sex of polar bears killed by village each harvest year, 1988–92

Village	1988/89			1989/90			1990/91			1991/92			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U
Atqasuk**	1	1											1	1	
Barrow**	20	1	9	10	4		10	1		14	9		54	15	9
Brevig Mission					1									1	
Diomede	5	4		4	3		3			5	1		17	8	
Gambell	3	10		6	3		9	2		3	2		21	17	
Kaktovik**	5	2	3		1	1			2			1	5	3	7
Kivalina		1		4	1		1	2		2			7	4	
Kotzebue				1	2								1	2	
Nuiqsut**	2										1	1	2	1	1
Point Hope	5	3		10	5	9	12	2	10	4	2	1	31	12	20
Point Lay	2			1			1		1		1	1	4	1	2
Savoonga	10	4		7	3		9	3		2	4		28	14	
Shishmaref	19	7	3	13	2		6			3			41	9	3
Wainwright**	9	2	4	6		1	4	2		2	3		21	7	5
Wales	3	6		2	1		3			2			10	7	
Subtotal	84	41	19	64	26	11	58	12	13	37	23	4	243	102	47
Annual total	144			101			83			64			392		

* Harvest year is from 1 July to 30 June

**Villages harvesting polar bears from the Beaufort Sea stock

TABLE 2. Sex ratio of polar bear harvest, 1988–91

	1988/89	1989/90	1990/91	Total
All Alaska	67:33 (125)	71:29 (90)	83:17 (70)	72:28 (285)
Beaufort Sea	86:14 (43)	76:24 (21)	82:18 (17)	83:17 (81)
Chukchi Sea	57:43 (82)	70:30 (69)	83:17 (53)	68:32 (204)

Total number of bears in parenthesis

TABLE 3. Mean age by sex of polar bears harvested in Alaska, 1988–1990

Sex	1988/89			1989/90		
	N	\bar{x}	SD	N	\bar{x}	SD
SOUTHERN BEAUFORT SEA						
Male	(18)	8.1	5.3	(8)	7.0	4.9
Female	(3)	8.0	1.0	(1)	3.0	
Unknown	(1)	4.0		(0)		
CHUKCHI SEA						
Male	(41)	5.8	4.5	(38)	5.8	4.6
Female	(31)	8.2	4.8	(18)	8.5	4.1
Unknown	(0)		(0)			

The harvest season extends from 1 July to 30 June

N = Number of bears of known age. \bar{x} = Mean age. SD = Standard Deviation

TABLE 4. Age class of polar bears harvested in Alaska, 1988–90

	1988/89	1989/90	Total
Cubs	22	20	42
(%)	(23.4)	(30.8)	(26.4)
Subadults	24	19	43
(%)	(25.5)	(29.2)	(27.0)
Adults	48	26	74
(%)	(51.1)	(40)	(46.6)
Total	94	65	159

() = %

Cubs = 3rd year of life, harvested before May

Subadults = 3–5 year old

Adults = 6 years or greater

Polar Bear Research in the Beaufort Sea

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Current research is designed to determine the status of the polar bear population in the Beaufort Sea and adjacent areas. One goal is to determine how polar bears are distributed relative to each other and habitat features, and to define population boundaries. Another goal is to determine the population size and trend, and assess how present and future management issues may affect the trend. Specific objectives of the research include the need to:

1. Determine the movements of individuals comprising the polar bear population that uses the Beaufort Sea. Determine how movements vary by season and by year, and whether they can be modeled so as to allow meaningful census and mitigation efforts.
2. Improve estimates of size of the Beaufort Sea population relative to the capacity of the environment to sustain it.
3. Determine factors regulating the rate of recruitment of new bears into the population.
4. Determine the distribution of polar bear dens in northern Alaska and whether denning habitats may be a limiting factor on reproductive success.
5. Determine the timing of den entrance and emergence.
6. Determine the relative success rates (thus the reproductive significance) of dens in various locations.

This report summarizes the progress toward those objectives that has been made since the last meeting of the PBSG in 1988.

Methods

We captured polar bears by injecting immobilizing drugs (Tiletamine HCl plus Zolazepam HCl [Telazol®,

Warner-Lambert Co.]) with projectile syringes fired from helicopters. Bears were captured throughout the Beaufort Sea, which extends from Pt. Barrow, Alaska, at approximately 157°W, to Cape Bathurst, Northwest Territories, Canada at approximately 127°W, and in bordering areas to the east and west. We used logistics bases at Kaktovik, Prudhoe Bay, and Barrow, Alaska. Canadian cooperators captured and radio-collared bears (for us to radio-track) in the Canadian Beaufort Sea, along the east coast of Banks Island, and in Amundsen Gulf.

We attached very high frequency (VHF) radio-collars to polar bears between 1981 and 1985 and relocated them using aircraft. After autumn 1985, and throughout the time since the last meeting of this group in 1988, we mostly deployed ultra high frequency (UHF) transmitters that were relocated by satellite. Satellite radio-collars or Platform Transmitter Terminals (PTTs) communicated the animal's location, temperature of the sensor within the collar, and two indices of activity. A short-term activity counter recorded the number of seconds of movement during the minute prior to transmission. A long-term activity counter recorded the proportion of time the bear was moving in the 72 hours prior to transmission. PTTs also had VHF beacons that we located using aircraft. We located radio-collared polar bears with satellite position fixes, aircraft radio-tracking, and visual sightings.

Blood samples were collected routinely from captured bears, and tissue was collected where possible. These specimens were subjected to modern molecular genetics techniques to examine geographic variation among polar bears, phylogenetic relationships among North American bears, and to test a new method of determining the sexes of animals from which only tissues or blood were available.

Results and discussion

Mark and recapture and radiotelemetry continued to be the mainstays of northern Alaska polar bear research during and after 1988. Between 1988 and 1992 inclusive, 639 polar bears were captured. We captured or recaptured 128 bears with the assistance of radio-telemetry. Of the 511 bears captured by normal helicopter searching methods, 146 (29%) were previously marked. Associated with captures we deployed 93 PTTs and 40 VHF radio-collars. We relocated the VHF collars 106 times, mainly as part of efforts to confirm production and survival of cubs. PTTs provided 7479 location fixes from collared polar bears during this period. The above number represents only one high quality location per day of transmission. In most cases, there were several such locations per day, so the total number of position fixes recorded was actually far greater.

Maternal denning studies

Although we will continue to collect information on maternal denning as we can, the 1991 season marked the end of formal studies unit on denning. Two manuscripts describing the findings of denning studies in detail are presently under review by professional journals. One has been submitted to the *Journal of Wildlife Management*, the second to *Arctic*. Synopsis of the findings reported in those manuscripts follows:

Between 1981 and 1991, radio-collared polar bears were followed to 125 suspected maternity dens in land or sea-ice habitats. We confirmed 90 of those dens and evaluated success for 59. During the same time interval, we located 31 suspected incidental dens, confirmed 26 and evaluated success for 17. Of 90 dens located by radiotelemetry, 53% were on drifting pack ice, 42% were on land and 4% on land-fast ice. Bears we followed to more than one den did not reuse sites and consecutive dens were 20–1304km apart, but radio-collared bears were largely faithful to the substrate and the general geographic area of previous dens. The numbers of dens found on land in the Beaufort Sea area increased during the study, suggesting an increasing frequency of land denning relative to pack ice denning. We examined 14 dens on the ground. All were constructed of ice and snow only, and both single and multiple chambered dens were observed. Half of examined dens, and many others were in areas of minimal topographic relief, where denning might not have been suspected without the aid of radiotelemetry. Mean

entry and exit dates were 11 November and 5 April for land dens and 22 November and 26 March for pack ice dens.

Substantial denning occurs in the Beaufort Sea region of northern Alaska and adjacent Canada, and the distribution of those dens raises management questions. Most bears that denned on land selected sites in the northeastern corner of Alaska or adjacent Canada where oil and gas exploration has occurred or is likely. Fidelity to denning substrata means that recovery from perturbations that unequally affect either denning component will be slow. On the other hand, the absence of site fidelity among denning polar bears indicated that denning habitats are not limiting. Further, the chronology of denning was predictable. Therefore, temporal and spatial management of hunting and industrial developments should mitigate many human impacts on denning bears.

Movements, distribution, and population definition

Collection of data on movements of polar bears has continued since 1988, and this phase of the Beaufort Sea research project is also coming to completion. Initial analyses have corroborated observations, made earlier, that polar bears are extremely mobile animals perhaps the most mobile of all non-aquatic mammals excepting some species of bats. Some individual polar bears that were monitored for a period of at least one year had activity areas (minimum area polygons) exceeding 300,000km².

Most bears have maintained activity areas in the Beaufort Sea and adjacent areas. Fig. 1 illustrates rather typical spring–autumn movements of a bear captured in the central Beaufort Sea. Fig. 2 illustrates the seasonal activity areas of a typical bear monitored over the course of one year.

Activity areas continue to grow, to some extent, even after a full year, and our many years of radiotelemetry data continue to emphasize the need for long-term studies to understand these long-lived animals. Fig. 3 illustrates the boundaries of annual activity areas occupied by a bear wearing a satellite collar for four consecutive years. It is clear from that figure that researchers following her for only one or two years could have had a much different picture of how she used her habitat.

Despite seasonal and annual variation in areas occupied by polar bears, most bears captured in the Beaufort Sea have either stayed within the Beaufort Sea, or if they left, they returned. Table 1 summarizes the maximum and minimum longitudinal values of relocations of polar bears captured at various logistical bases. Note that the eastern extremes of activity areas of bears captured clear across the Beaufort Sea mainland coast are very similar. To date, there has only been one bear radio-collared west of Cape Bathurst that has spent significant time in Amundsen Gulf. Furthermore, this bear remained there for only two months, and then returned to the Beaufort Sea. Western extremes of movements were more variable.

Movement data have not yet been analyzed, but some trends are clear. Polar bears are most dispersed in winter and spring, and it is in these seasons that we have seen the greatest movements beyond the bounds of the Beaufort Sea. Through summer and autumn, bears appeared to concentrate in the mainland coastal area of the Beaufort Sea. This pattern could be tied entirely to the condition and distribution of the sea-ice, because in many years the ice breaks up first at the eastern and western fringes and erodes progressively toward the central Beaufort Sea. Bears captured in Barrow have a greater dispersion than bears captured at other localities during every season. We feel this indicates that bears accessible from Barrow represent both Chukchi and Beaufort Sea populations, whereas bears captured in more easterly locals only represent Beaufort stocks.

If any process is studied long enough, exceptions are sure to surface. In spring 1992 the exception to our hypothesis about integrity of the Beaufort Sea population surfaced. In late May, 1992, we captured an adult female polar bear with two cubs-of-the-year within sight of Prudhoe Bay. She was instrumented and released at the site of capture like all other bears we caught, but upon recovering from the effects of the drugs, she headed north. This bear continued her northerly trek until she reached northeast Greenland, via an over the pole route (Fig. 4). Unfortunately, her radio failed prematurely, and chances of recovering her or even resighting her are slim.

Population dynamics

Analyses of the data relevant to population dynamics of bears in the Beaufort Sea are just beginning. A few

patterns appear to be emerging, however. Preliminary analyses of age structure information have indicated that the Beaufort Sea population is closer to the carrying capacity of the environment than at times past. Data collected after 1981 indicate lower numbers of litters produced and smaller litter sizes than prior to that date. The age structure appears older now. Survival of young animals to the age of maturity is lower and survival of old animals appears higher than for the period 1967–80. We are continuing to use the 1986 estimate of approximately 2000 animals as a working figure but analyses leading to revised population size estimates are under way.

Molecular genetics studies

Since 1988, personnel of both western and northern Alaska polar bear projects have continued to examine molecular genetics methods for helping to differentiate stocks. Mitochondrial DNA (mtDNA) of polar bears from Alaska and Canada were analyzed for intraspecific variation. We also compared mtDNA of polar bears with that of brown bears and black bears in order to help understand phylogenetic relationships. The results of these comparisons were published in a 1991 paper "Interspecific and intraspecific mitochondrial DNA variation in North American bears" (Cronin, M. A., Amstrup, S. C., Garner, G. W., and Vyse, E. R., 1991, *Can. J. Zool.* 69:2985–2992). A brief summary of those findings follows.

Six mtDNA haplotypes were identified in black bears, five haplotypes in brown bears, and four haplotypes in polar bears. The six black bear haplotypes occurred in two major groups. Within each group, mtDNA sequence divergence's were low relative to the divergence between groups. Haplotypes of one group were distributed among all locations. Also, divergent haplotypes from both groups occurred together in the same areas of Montana and Oregon.

Low to moderate divergences were identified among the five mtDNA haplotypes of brown bears. The two morphological forms of *U. arctos*, grizzly and coastal brown bears, did not cluster as distinct mtDNA lineages. Haplotypes of some coastal brown bears were more similar to haplotypes of grizzly bears than to one haplotype of other coastal brown bears. Further, one haplotype was actually more similar to the polar bear haplotypes than it is to the other brown bear haplotypes.

Four mtDNA haplotypes with low sequence divergences were identified in polar bears. One comprised

73–79% of the haplotypes in each of the three areas (Chukchi and Beaufort Seas of Alaska, and NWT of Canada) sampled. Another haplotype also occurred in all three areas. The third haplotype occurred only in the two Alaskan locations and the fourth only on Ellesmere Island in the extreme north of the Canadian high Arctic. The distribution of polar bears differs from those of black bears and brown bears because they are continuously distributed across their range with no geographic barriers or disjunct populations. Polar bears are highly mobile and our studies have shown there is the potential for gene flow across the entire range of the species. The occurrence of the same haplotypes across the sampling locations may reflect this.

Perhaps the most interesting finding was that one grizzly bear haplotype clustered with polar bears, separate from the other brown bear haplotypes. This indicates that brown bears are paraphyletic with respect to polar bears in mtDNA phylogeny. That is, some brown bears share a more recent common ancestral mtDNA with polar bears than they do with other brown bears. That brown bear haplotype and the four polar bear haplotypes probably represent descendants of one mtDNA variant which occurred in ancestral populations.

Although mtDNA phylogeny of brown and polar bears is paraphyletic, polar bears have many derived morphological characters which identify them as a monophyletic group. This relationship of brown bears and polar bears is an example of a mtDNA phylogenetic tree which is not the same as a species tree, and points out some of the dangers in broad interpretations of molecular genetics data without benefit of morphological or ecological knowledge.

Sex determination from DNA

The technique for determining sex of animals from which tissue or blood samples were derived was described in

a manuscript that has been submitted to the *Canadian Journal of Zoology*. A brief summary of the findings follows. We amplified X and Y chromosome DNA with the polymerase chain reaction using oligonucleotide primers developed from known sequences for mice and humans. The primers amplify homologous segments of DNA on the X and Y chromosomes. The amplified DNA segment extends from exon 3 (primer 333) to exon 6 (primer 332).

Amplification with primers 332 and 333 yielded 1950 base pair (bp) segments of both X and Y chromosomes. An initial screening of samples of known sex had shown that digestion of the 1950 bp DNA segment with the restriction enzyme HaeIII, resulted in five distinctive fragments for males and four fragments for females. These fragments appeared as bands, corresponding to size, on electrophoretic gels. The four bands in females indicated that both X chromosomes have HaeIII restriction sites where the DNA is cut into four fragments of 950, 450, 400, and 150 bp. The fifth band in males represented a 1950 bp DNA fragment and indicated the HaeIII restriction sites present on the X are absent on the Y chromosome. A schematic of the amplification and restriction process is shown in Fig. 5. We extracted DNA from all samples, and amplified DNA fragments from 101 (84%) of the 120 samples available. We correctly determined sex from all samples we amplified.

Future plans

Existing data on movements and population structure will be analyzed in spring 1993. Objectives for 1993 are to complete those analyses and submit manuscripts for publication before autumn. Upon completion of those analyses, the future directions of the Beaufort Sea polar bear research program will be charted. We are anxious for input from all members of PBSG regarding suggestions of needs for future research.

TABLE 1. Eastern and western extremes of movements of radio-collared polar bears captured at various logistical bases within the Beaufort Sea

Area	N	Eastern extreme	Western extreme
Barrow	31	127.4° West	166.1° East
Barter Isl.	29	127.4° West	175.6° West
Canada ^a	9	127.5° West	167.1° West
Prudhoe	46	123.6° West	173.4° East

^arepresents captures of bears along the mainland Beaufort Sea coast, west of Cape Bathurst

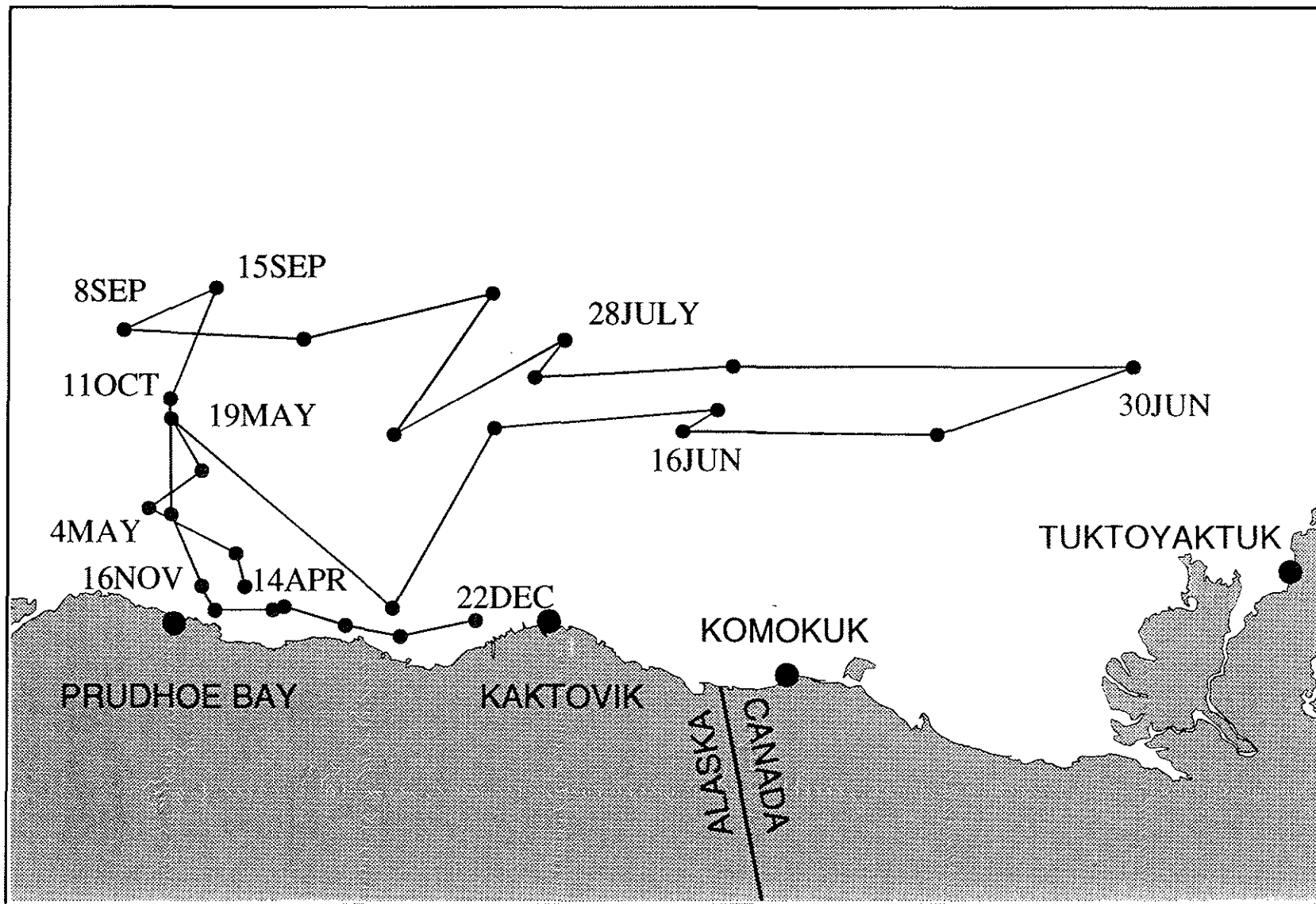


Fig 1. Spring to autumn movements of a typical radio-collared polar bear in the Beaufort Sea

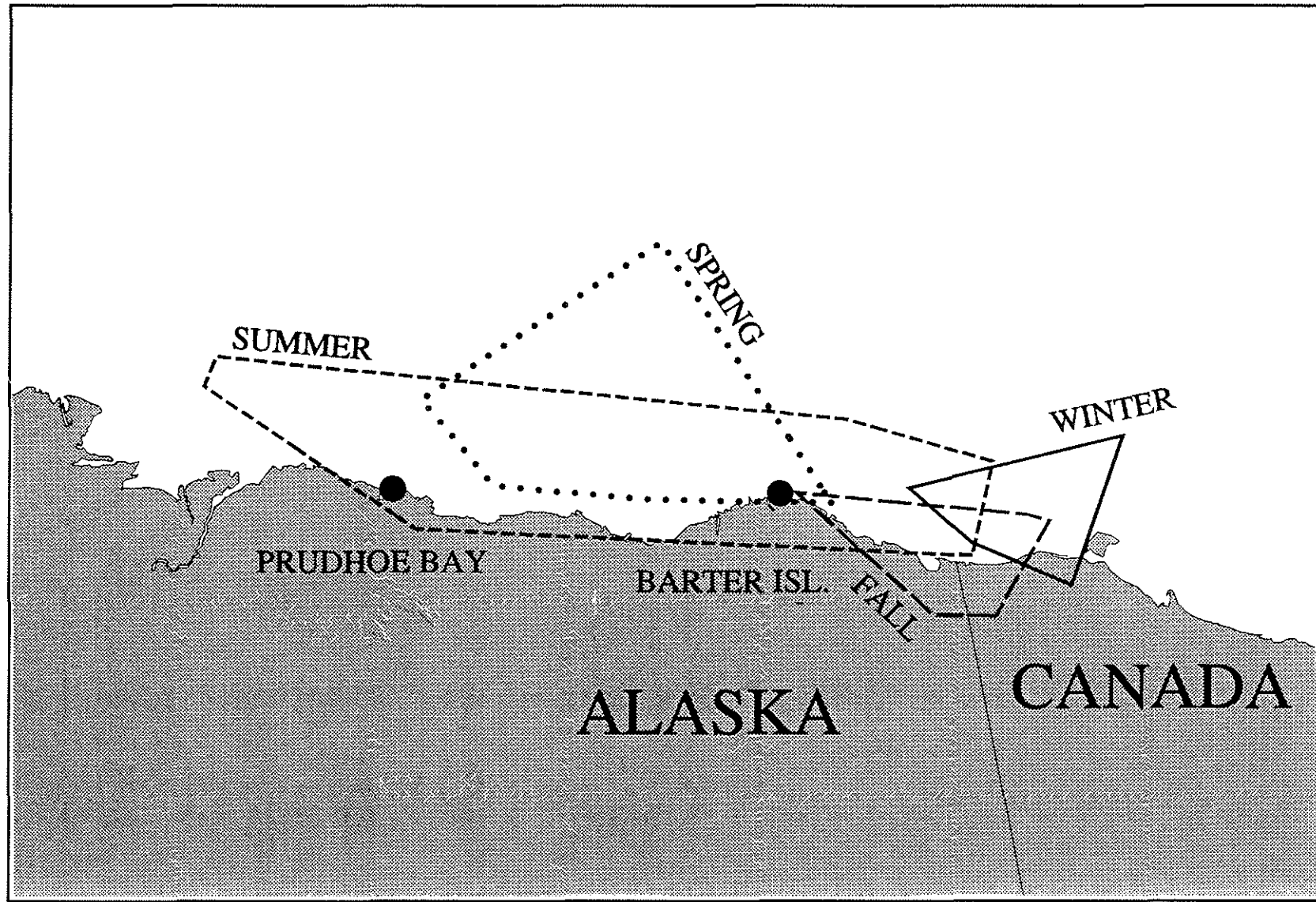


FIG 2. Movements of a PTT-equipped polar bear in the eastern Beaufort Sea over a one-year period

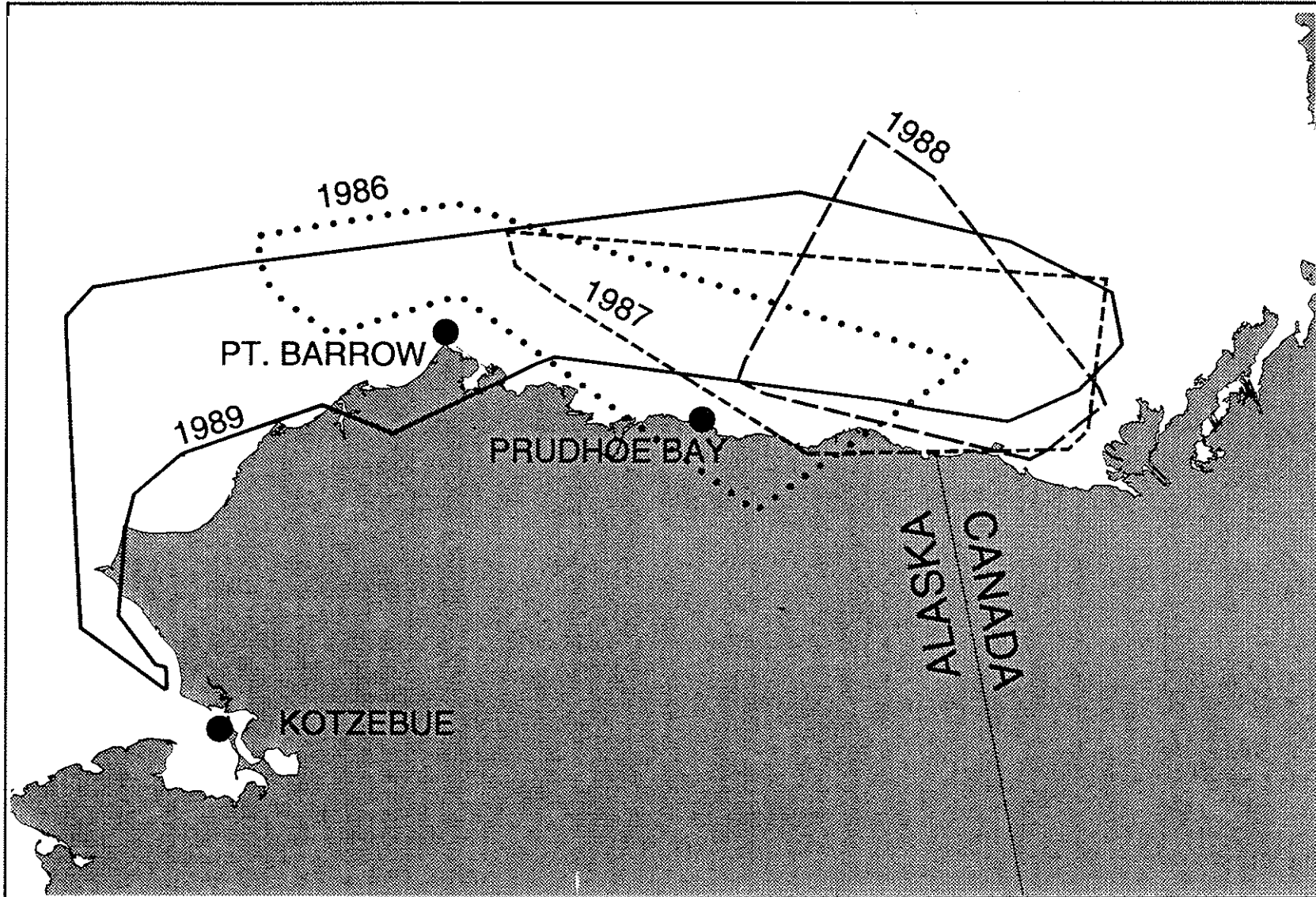


FIG 3. Annual activity areas used by bear #1734 between 1986 and 1989. Annual variation in areas, determined by the minimum convex polygon method, verifies the need for long-term studies of polar bears

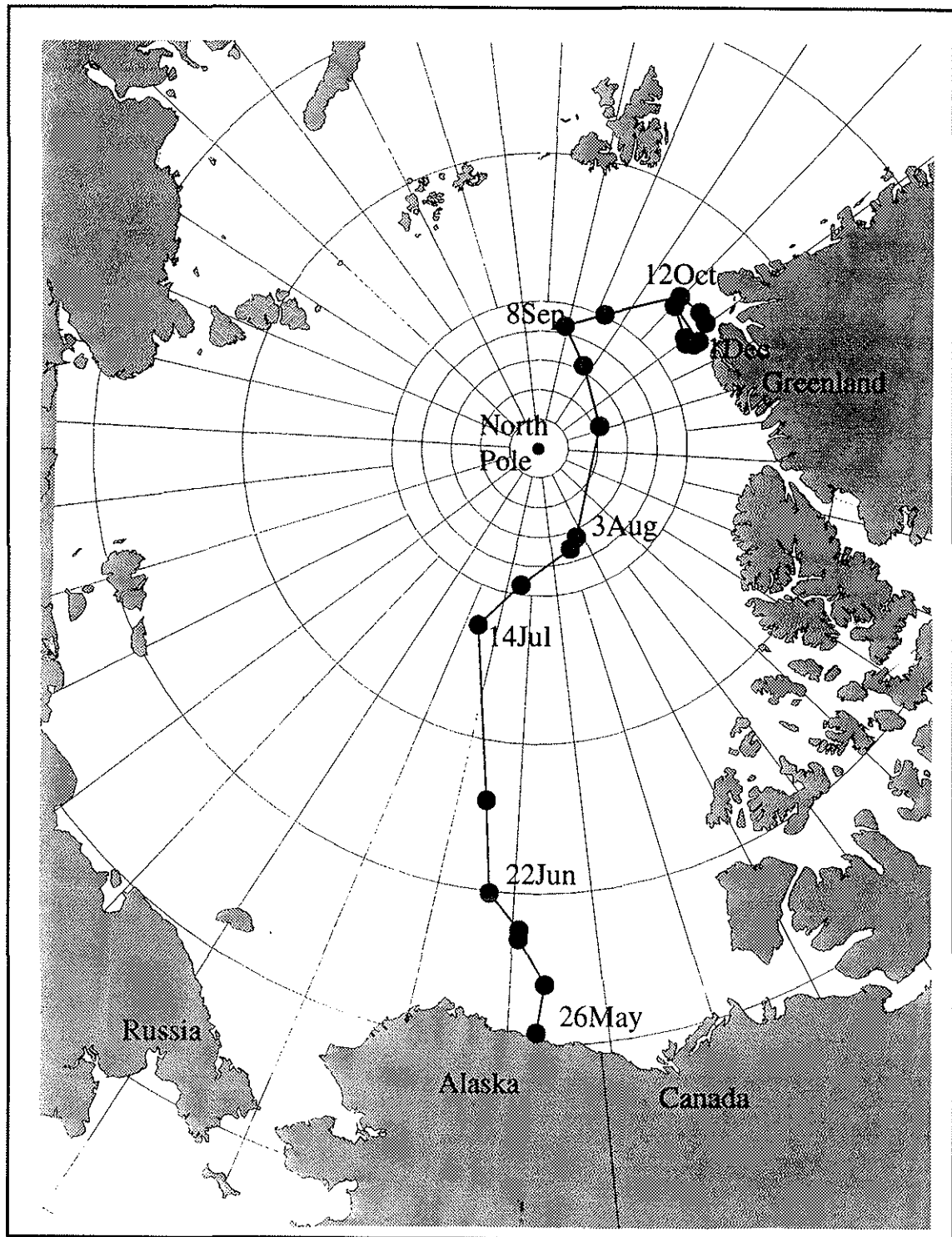


FIG 4. Unusual movements of a PTT-equipped polar bear between May and December, 1992. The first observed emigration from the Beaufort Sea in 12 years of radio-telemetry

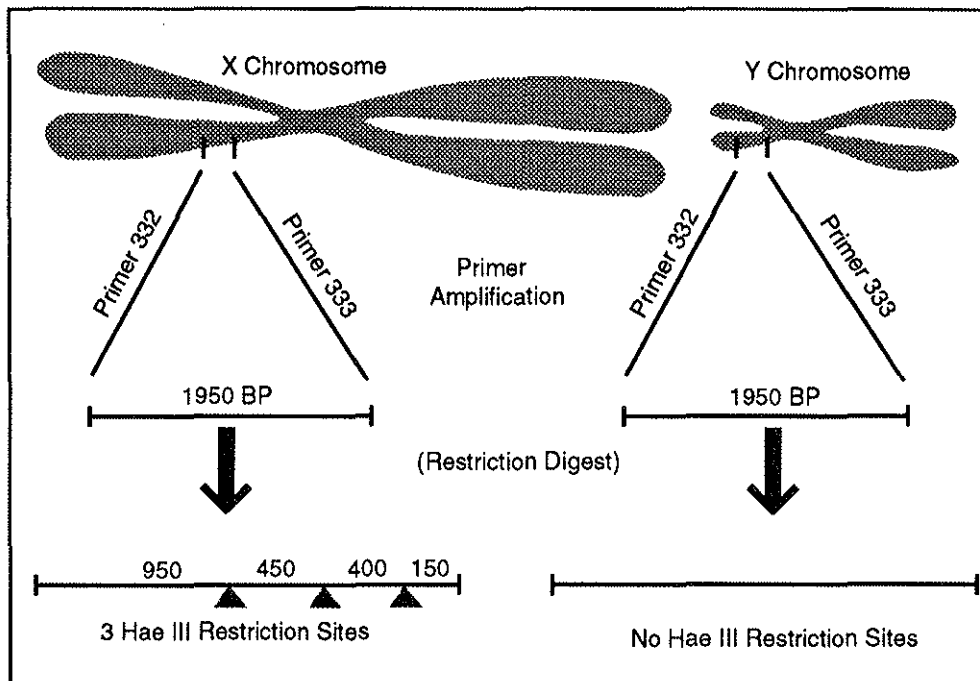


FIG 5. Schematic diagram of the process of amplifying homologous portions of X and Y chromosomes and digesting them to reveal differential patterns that are reflected on electrophoretic gels

Research on Polar Bears in Western Alaska and Eastern Russia 1988–92

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A research project on polar bears (*Ursus maritimus*) that seasonally occur in waters of western Alaska was initiated in spring 1986 with the capture and the fitting of satellite telemetry collars on ten adult females. A major impetus for the project was the fact that approximately 75% (range 57–81%) of the 1980–88 average annual subsistence harvest of 128 polar bears in Alaska (range 89–292) had occurred in western Alaska (Schliebe 1986, 1990). This population was undefined and no population estimates were available to evaluate the effects of the subsistence harvest. The primary objective of this project is to determine the population size and status of polar bears that occupy the Chukchi and Bering Seas.

Capture and marking activities were limited to western Alaska from 1986 through 1989, but were expanded into a cooperative research program with Russian scientists in 1990 when it became apparent from satellite tracking data that the bear population was shared with Russia (Garner *et al.* 1990; Garner and Knick 1991). A total of 130 different female polar bears have been captured and fitted with satellite collars between 1986 and 1992. Capture activities have extended from south of Saint Lawrence Island in the northern Bering Sea to the vicinity of Barrow at the western edge of the Beaufort Sea, and into Russian territory including Wrangel and Herald islands and west into the East Siberian Sea (Fig. 1). Satellite telemetry has provided data on polar bears movements in western Alaska that was impossible to collect prior to the development of this technology (Fancy *et al.* 1988; Harris *et al.* 1990).

Inherent failure rate of the collars is approximately 10% (Garner *et al.* 1989).

A total of 79 litters of cubs of the year (COY), 29 litters of yearlings, and 19 litters of two-year-olds were observed/captured during the period. Average litter size was 1.87 for COYs, 1.69 for yearlings, and 1.53 for two-year-olds. Of nine family groups accompanied by 19 COYs captured on Wrangel Island during spring 1990 whose fate is known by recapture, resighting, or evident denning the following winter, only three COYs (15.8%) survived to one year of age (Table 1). This low survival of cubs may be related to the poor physical condition of many of the maternal females captured on Wrangel Island during spring 1990. Fourteen of 20 maternal females captured during spring 1990 were classified as being in poor or very poor physical condition (Garner *et al.* In press). Uspenski and Kistchinski (1972) and Belikov *et al.* (1977) reported that maternal females sometimes killed and ate their cubs when food sources were not readily available.

The determination of physical condition prior to spring 1992 relied upon an ocular assessment of the condition of the bear and an arbitrary classification of its physical condition into one of five categories. In an attempt to quantify this determination, Alaskan researchers became involved with Dr Charles Robbins and graduate student Sean Farley of Washington State University in an effort to extend their work on determination of body condition of black and brown bears to polar bears. Other cooperators included Drs. M. Ramsay and M. Taylor of Canada. The methodology being developed is the

estimation of percent body fat based upon the inverse relationship between percent body water and fat content. A field sampling procedure using bioelectrical impedance (BIA) technology was developed for use on polar bears.

The BIA procedures were used on all adult female bears captured during spring 1992 and the results of the percent fat determinations were compared to the ocular estimates of body condition (Table 2). Mean percent fat for the four ocular estimate classes of body condition were different (ANOVA, $F = 7.48$, $df = 3,31$, $P = 0.007$). The Fisher LSD multiple comparison test indicated that the ocular estimates of condition classes 1, 2 and 3 were inconsistent. Ocular estimates of class 4 had a mean percent fat content that was larger than the other ocular classes. No bears in excellent condition (class 5) were captured during spring 1992. The BIA procedure appears to offer a more quantitative estimate of physical condition than the ocular estimates; however, the classification of those estimates into several categories of physical condition corresponding to the five ocular estimated condition classes is questionable.

Marked polar bears move extensively in the northern Bering Sea and throughout the entire Chukchi Sea (Garner et al. 1990, in press). A daily rate of movement was calculated from the movement data by dividing the distance between consecutive locations for a bear by the time interval in hours. Polar bear movements in the Chukchi and Bering Seas are greatly influenced by sea-ice distributions and types (Garner et al. in press). The movement data for the five collared bears were categorized into four periods relating to major periods of sea-ice activity. These four periods for the Bering and Chukchi Seas are depicted in Fig. 2. The periods are defined as follows: maximum sea-ice 1 January–30 April; receding sea-ice 1 May–15 August; minimum sea-ice 16 August–15 October; advancing sea-ice 16 October–31 December.

Rates of movement were expected to be low during minimum and maximum sea-ice periods and higher during periods of advancing and receding sea-ice. The rates of movement during maximum, receding, and minimum sea-ice periods were very similar (Table 3), but the rate of movement during the advancing ice period was higher than the other three periods. Polar bears in this region move long distances to maintain contact with the sea-ice throughout the year. This movement is particularly rapid when ice is forming during the autumn.

Sera from blood samples of the 191 polar bears captured in western Alaska and eastern Russia (Fig. 3) were screened using a neutralization test for antibodies of canine distemper virus (CDV) to determine the potential for incidence of phocine distemper virus (PDV) in polar bears. The PDV cross-reacts to a certain degree with CDV (Ross et al. 1992); therefore, an initial screening was done using the CDV test. A total of 68 bears were positive for the CDV (Table 4). The annual proportion of tested animals that were positive ranged from 23.2–46.2 percent. The distribution of the bears that tested positive for CDV was widespread throughout the study area (Fig. 4). The implication of this positive reading awaits further analyses of those sera that tested positive to CDV test. The second phase of the research will determine if the positive antibody titer to CDV is actually PDV. In cooperation with the northern Alaska polar bear research project, the next step will be to test the sera collected from bears captured in the Beaufort Sea. Cooperators at the University of Alaska, Fairbanks and the Washington Animal Disease Diagnostic Laboratory are interested in pursuing a research program to determine the epidemiology of the disease (CDV and/or PDV) in northern Alaska.

The major goal of the research in western Alaska and eastern Russia is to determine population size and status of polar bears that occur in the Bering and Chukchi Seas. As part of that effort, several versions of a census protocol that might be used in the Chukchi Sea have been developed (Garner et al. 1992a, 1992b) and an extensive review of the literature on census methodologies that might be applicable to polar bears in the Chukchi Sea was completed (Garner et al. 1992c). The draft protocol was reviewed by a peer group of statisticians and biologists and a protocol for field testing during fall 1993 in the Beaufort Sea was finalized (Garner et al. 1993a, 1993b). The protocol for a joint US/Russian census of polar bears in the Chukchi Sea during fall 1994 will be developed following the completion of the test effort in the Beaufort Sea.

Other aspects of the research conducted in the Chukchi Sea include genetics studies to determine the degree of separation between polar bear stocks in the Chukchi and Beaufort seas, and research to develop a method for determining the sex of polar bears from tissue and blood samples. The progress on these research topics is included in the report on research on polar bears in northern Alaska and will not be repeated here.

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TABLE 1. Apparent survival to one year of age for nine litters of cubs of the year COYs captured on Wrangel Island, spring 1990

Animal number	Age	No. of COYs	Tracking Period		Comments
			Start date	End date	
6864	11	2	25 Mar 90	06 Feb 91	lost COYs, denned 91
6871	18	2	27 Mar 90	31 Mar 91	lost COYs, denned 91
6872	11	2	27 Mar 90	29 Mar 91	1 yrlg, shot Mar 91
6875	9	2	28 Mar 90	31 Mar 91	lost COYs, recap 91
6876	6	2	29 Mar 90	28 Mar 91	lost COYs, recap 91
6878	12	2	29 Mar 90	24 Dec 90	lost COYs, denned 91
6879	10	3	29 Mar 90	24 Mar 91	lost COYs, denned 91
6881	9	2	30 Mar 90	31 Mar 91	2 yrlg, recap 91
6882	10	2	1 Apr 90	31 Mar 91	lost COYs, shot Mar 91

TABLE 2. Percent body fat determination using bioelectrical impedance analysis of adult female polar bears captured during spring 1992

Condition class (code)	n	Mean % body fat	SE	LSD class codes ¹			
				A	B	C	D
1 (A)	7	19.92	1.68	.	.	S ²	S
2 (B)	11	22.69	1.34	.	.	.	S
3 (C)	12	26.15	1.29	S	.	.	S
4 (D)	5	31.28	1.99	S	S	S	.

¹Least significant difference (LSD) multiple comparison test with P = 0.05

²S indicates that this mean is significantly different from the mean whose code is above it.

TABLE 3. Comparison of mean daily rates of movement within sea-ice condition categories for female polar bears in the Chukchi and Bering seas, 1986–92

Sea-ice condition (code)	n	Movement (km/24h) Mean	SE	LSD class codes ¹			
				A	B	C	D
Max ice (A)	7	11.92	0.58	.	.	.	S ²
Rec ice (B)	7	13.04	0.70	.	.	.	S
Min ice (C)	7	12.33	0.71	.	.	.	S
Adv ice (D)	7	15.39	0.27	S	S	S	.

¹Least significant difference multiple comparison test with P = 0.05

²S indicates that this mean is significantly different from the mean whose code is above it.

TABLE 4. Proportion of polar bear blood sera samples from western Alaska and eastern Russia with positive antibody titers for canine distemper virus 1986–92

Year	No. tested	No. positive	Proportion (%)
1987	13	6	46.15
1988	42	11	26.19
1989	26	11	42.31
1990	44	13	29.55
1991	26	10	38.46
1992	40	17	42.50
Total	191	68	35.60

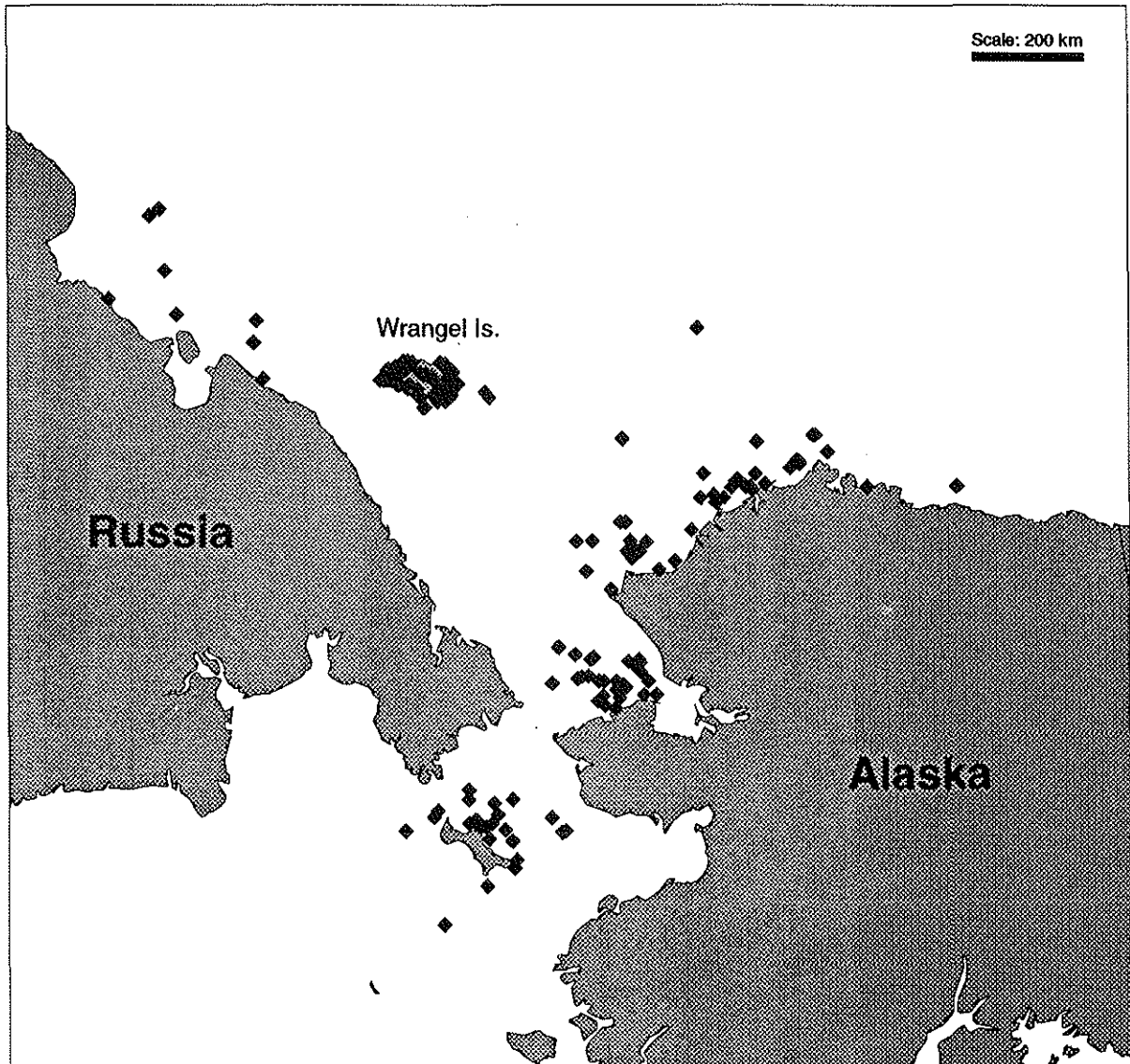


FIG 1. Capture locations for 130 adult female polar bears in western Alaska and eastern Russia, 1986-92

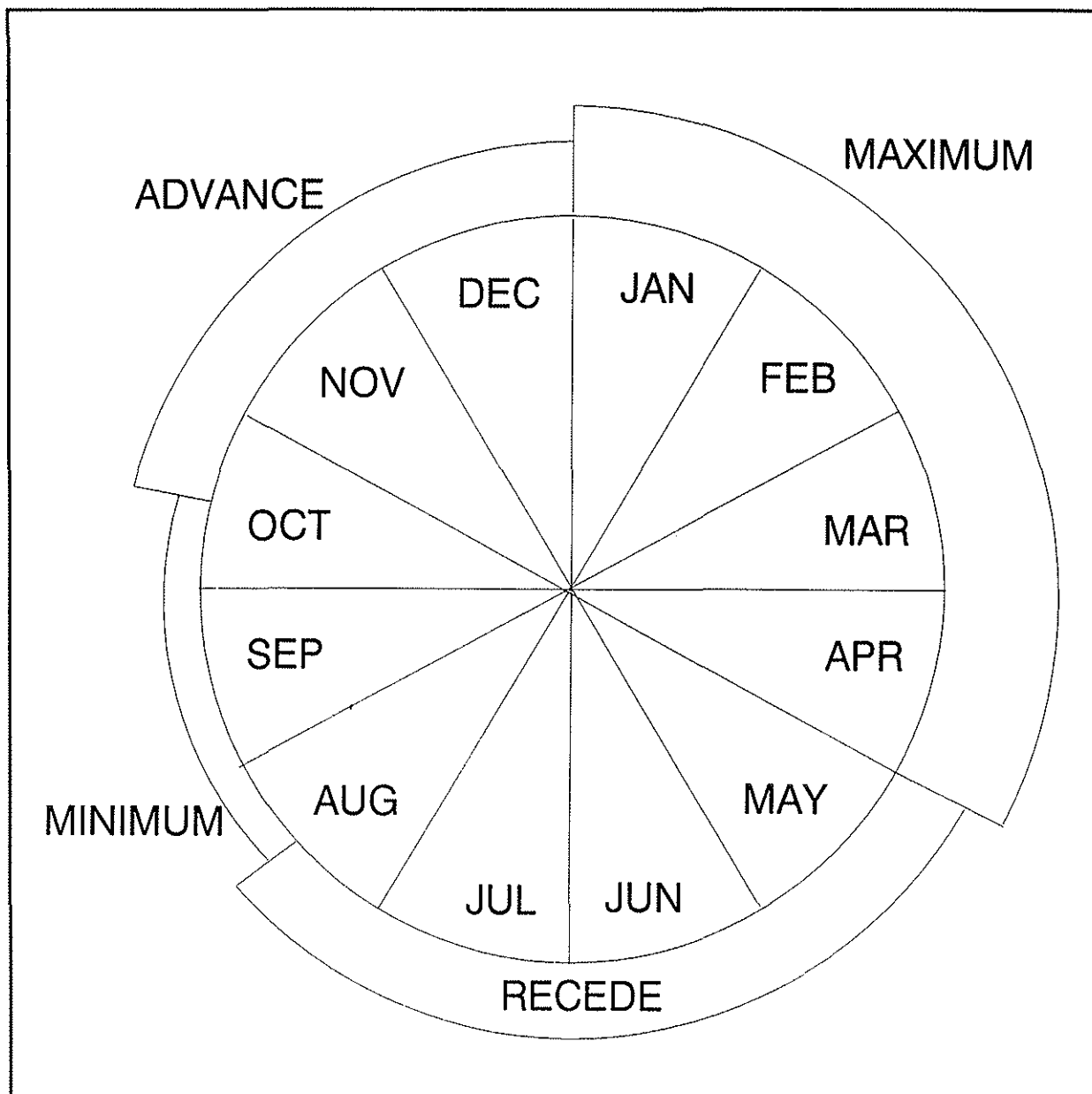


FIG 2. Seasonal ice designations for Chukchi Sea

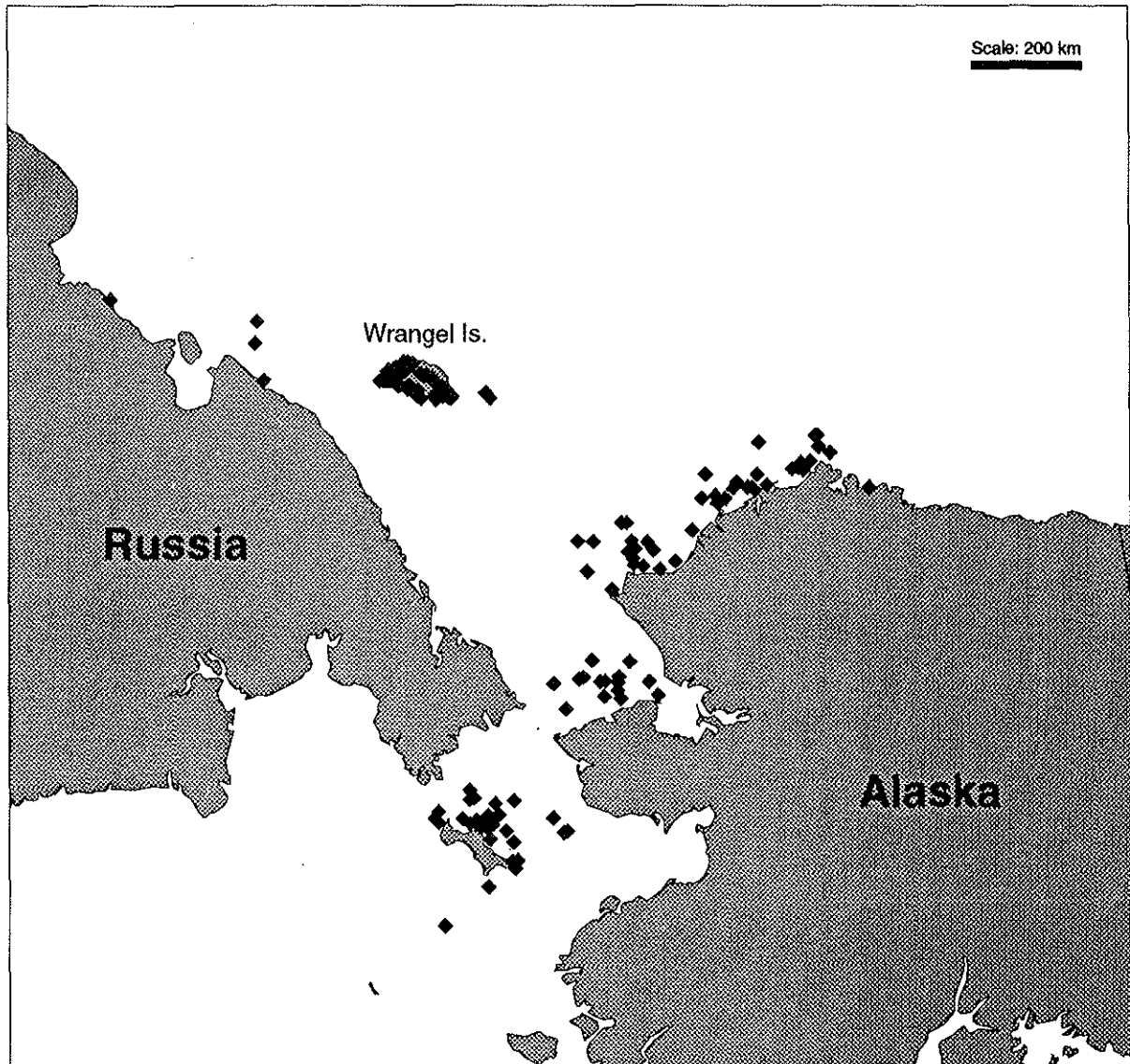


FIG 3. Capture locations for 191 polar bears captured in western Alaska and eastern Russia that were tested for canine distemper virus, 1987–92

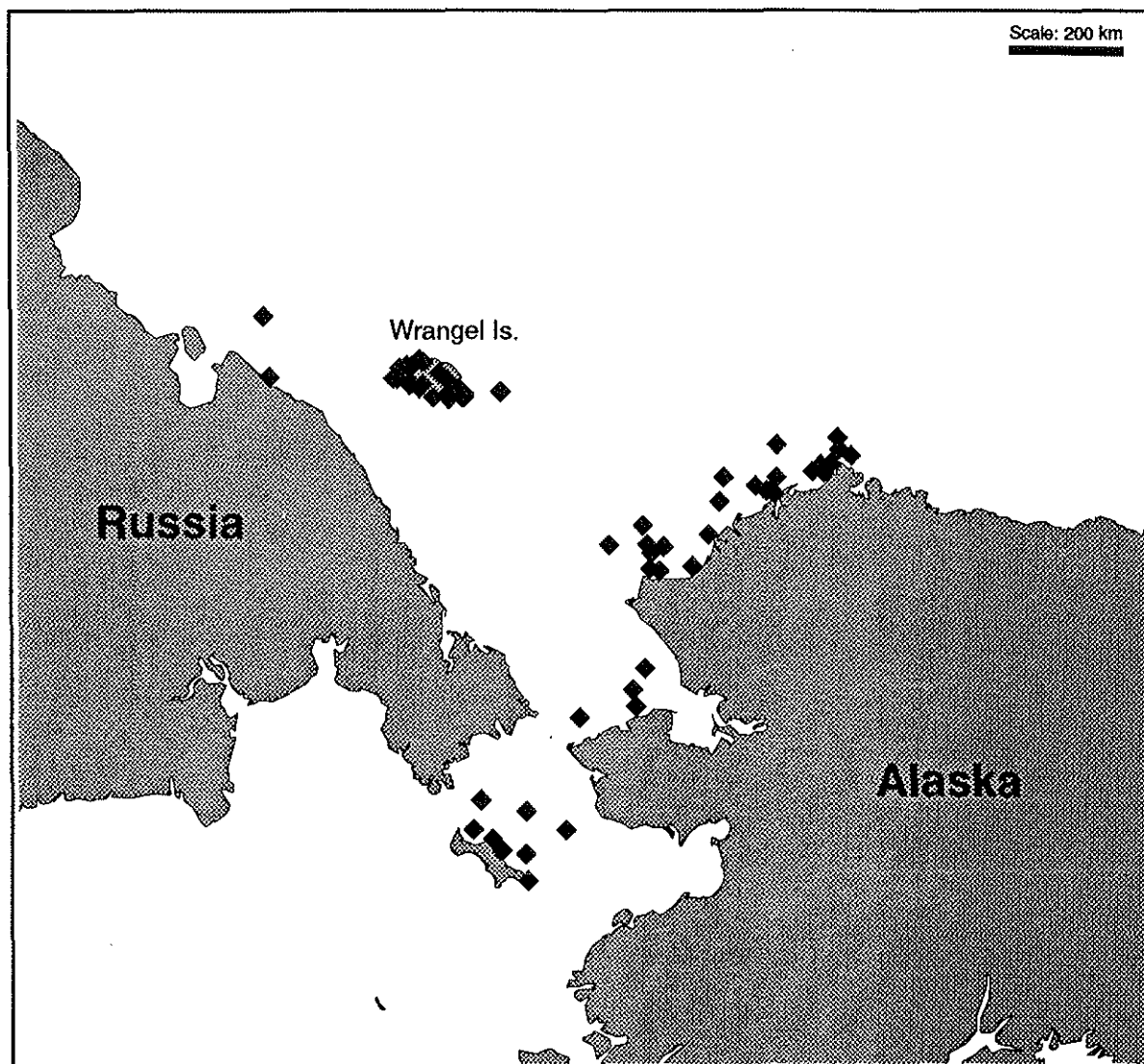


FIG 4. Capture locations for 68 polar bears captured in western Alaska and eastern Russia that had positive antibody titers for canine distemper virus, 1987-92

Miscellaneous Reports

Research on Polar Bears in Severnaya Zemlya (Russia) 1991–92

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A joint research project between Russian, Norwegian, and American scientists on polar bear ecology in the Severnaya Zemlya Islands of the east-central Russian arctic was initiated during May 1991 when 15 bears were captured and five adult females were fitted with satellite collars (Table 1). Two bears were collared near the southwestern region of the Severnaya Zemlya Islands, while the remaining three bears were collared farther south near the Russian mainland (Fig. 1). Bear densities were low with a total of 23 bears sighted during 59 hours and 20 minutes of aerial searching. Average litter size for the four observed litters was 1.5 (SE = 0.29) cubs of the year.

Two satellite collars failed soon after deployment (<10 locations), but three units functioned for an extended period of time (>45 locations) following deployment (Fig. 2 A–E). Bears N7980 and N7982 had collars that transmitted on a five-day duty cycle, while the remaining three bears' collars (N7984, N7986, N7988) transmitted on a six-day duty cycle. The majority of the movements were confined to the eastern Kara Sea, but one bear (N7988) did move into the western Laptev Sea before returning to the eastern edge of the Kara Sea near Cape Chelyuskin, where the collar apparently failed. One bear (N7980) had a very restricted movement pattern that was closely associated with the western two islands in the Severnaya Zemlya group (Komsomolets and Pioner islands). The combined locations for the five collared bears depict an overall range that is centered in the eastern Kara Sea south of the Severnaya Zemlya Islands (Fig. 3).

Minimum estimates of distances travelled for three bears with more than 45 locations averaged 3051 km (Table 2). A daily rate of movement was calculated

from the movement data by dividing the distance between consecutive locations for a bear by the time interval in hours. These daily rates of movement for the study period varied between bears, but ranged between 5 and 8 km per day, with the exception of one animal with few locations. Sample sizes are small, therefore no effort was made to determine the statistical significance of the variation in total movement.

Polar bear movements in other regions are greatly influenced by sea ice distributions and types. The movement data for the five collared bears were categorized into four periods relating to major periods of sea ice activity. These four periods for the Severnaya Zemlya area are depicted in Fig. 4. The periods are defined as follows: maximum sea ice 16 October–31 May; receding sea ice 1 June–15 July; minimum sea ice 16 July–15 September; advancing sea ice 16 September–15 October. Rates of movement were expected to be low during minimum and maximum sea ice periods and higher during periods of advancing and receding sea ice. The rate of movement during minimum sea ice period was the lowest for the four periods (Table 3), but rates of movement for the other three periods were very similar. Polar bears in this region of Russia do not move long distances to maintain contact with the sea ice, in contrast to polar bears in the Chukchi Sea in eastern Russia which move over a large area to maintain contact with the sea ice throughout the year.

One other item of note, serum from blood samples of the five adult females was screened using a neutralization test for antibodies of canine distemper virus (CDV) as part of a larger survey to determine the potential for incidence of phocine distemper virus (PDV) in polar

bears. It is known that PDV crossreacts to a certain degree with CDV (Ross *et al.* 1992); therefore, an initial screening was done using the CDV test. Surprisingly, one of the five females captured near Severnaya Zemlya was positive for the CDV (Fig. 1). The implication of this positive reading awaits further analyses of those sera that tested positive to the CDV test. The second phase of the analysis will test specifically for the PDV.

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TABLE 1. Characteristics of bears captured and marked near the Severnaya Zemlya Islands, Russia during May 1991

Animal #	Age/sex	Weight (kg)	Length ¹ (cm)	Chest girth (cm)	Location		Date
					Latitude	Longitude	
N7980	adult F	148	218	119	79°37N	91°05E	10 May
N7981L	COY ² M	10	79	50	79°37N	91°05E	10 May
N7981R	COY M	9	74	44	79°37N	91°05E	10 May
N7982	adult F	160	207	116	79°06N	92°10E	11 May
N7983	COY F	14	70	48	79°06N	92°10E	11 May
N7984	adult F	185	194	122	76°40N	92°32E	14 May
N7985	COY M	20	105	65	76°40N	92°32E	14 May
N7986 ³	adult F	192	193	128	75°33N	88°48E	15 May
N7987R	COY F	28	112	66	75°33N	88°48E	15 May
N7987L	COY M	32	112	66	75°33N	88°48E	15 May
N7988	adult F	160	174	116	76°49N	89°51E	15 May

¹Length for adults is straight line; length for COYs is total length

²Cubs of the year

³Positive antibody titer to the canine distemper virus

TABLE 2. Movement characteristics of female polar bears near the Severnaya Zemlya Islands, Russia 1991–92

Animal #	n	Total distance (km)	Mean movement km (SE)	Mean rate of movement km/24h (SE)
7982	60	2,634	43.9 (6.9)	8.08 (0.85)
7984	10	944	94.4 (22.4)	5.87 (2.37)
7986	06	617	102.8 (17.4)	12.59 (4.22)
7988	47	3,031	64.5 (10.4)	8.03 (1.01)

TABLE 3. Seasonal rates of movement for female polar bears near the Severnaya Zemlya Islands, Russia 1991–92

Ice season	n	Movement (km)		Rate of movement (km/24h)	
		mean	range	mean	range
Recede	23	52.1	(0.9–179.2)	8.49	(0.86–29.61)
Minimum	102	31.8	(0.4–382.9)	6.23	(0.00–95.74)
Advance	47	77.5	(1.7–440.8)	9.06	(0.71–31.44)
Maximum	60	43.8	(1.2–198.7)	8.96	(1.14–34.43)



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FIG. 1. Capture locations and incidence of positive (black diamond) and negative (triangles) antibody titers to canine distemper virus for five female polar bears in east-central Russia, May, 1991

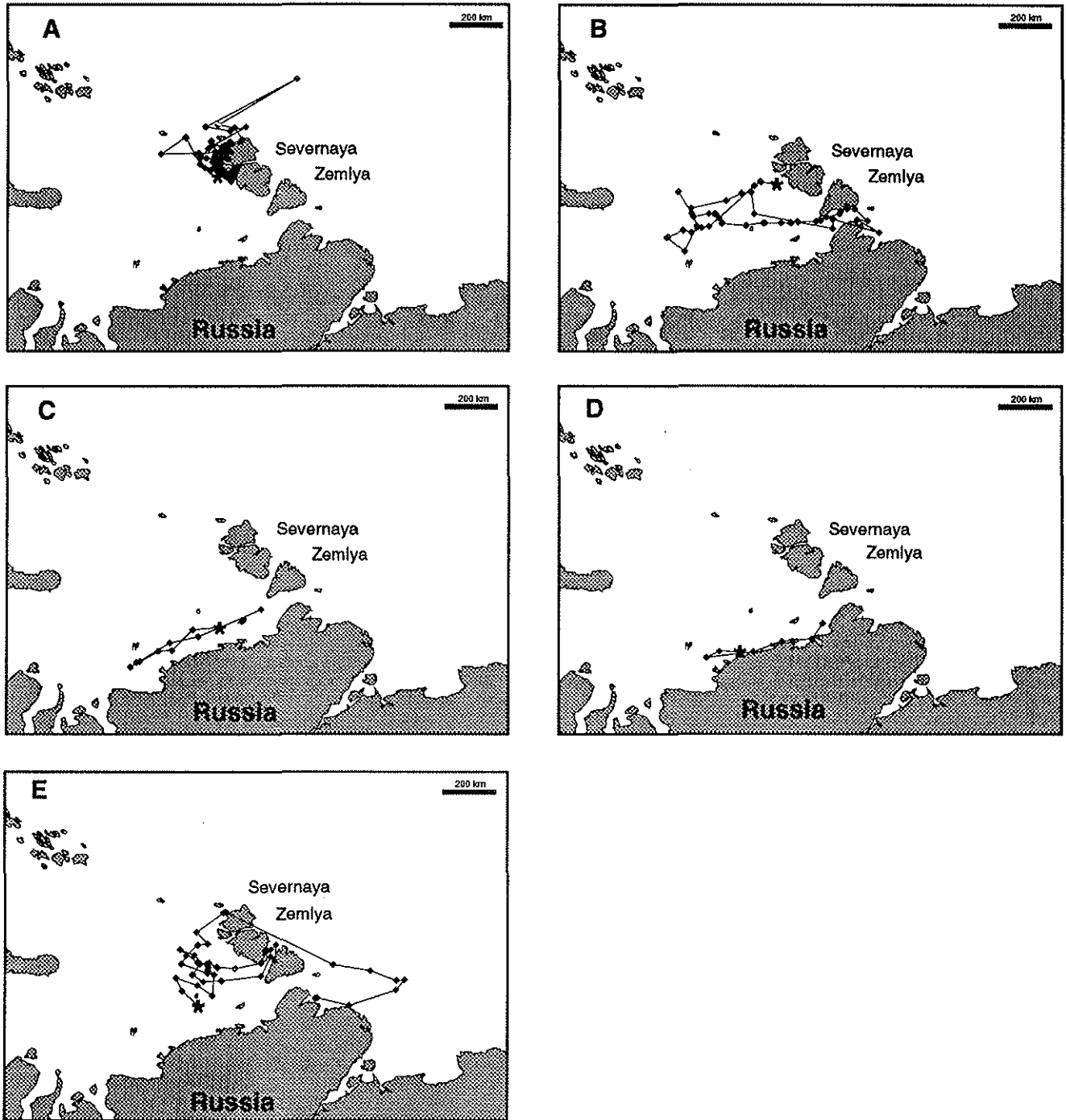


FIG 2. Movements of five satellite collared female polar bears in the east-central Russian arctic, May 1991–November 1992. (A through E denote individuals; asterisks indicate capture locations)

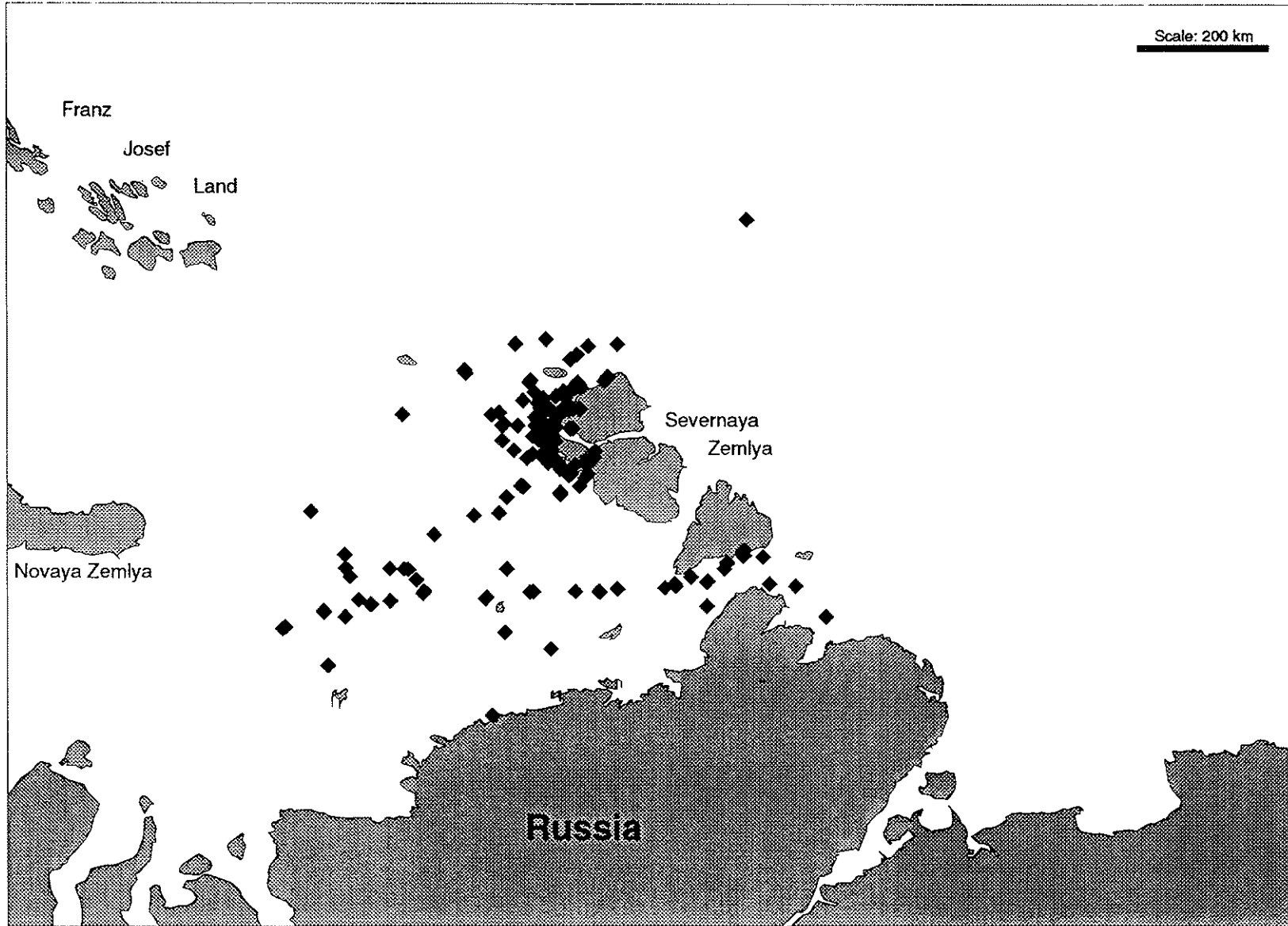


FIG 3. Geographic distribution of locations of five female polar bears in east-central Russia, 1991-92

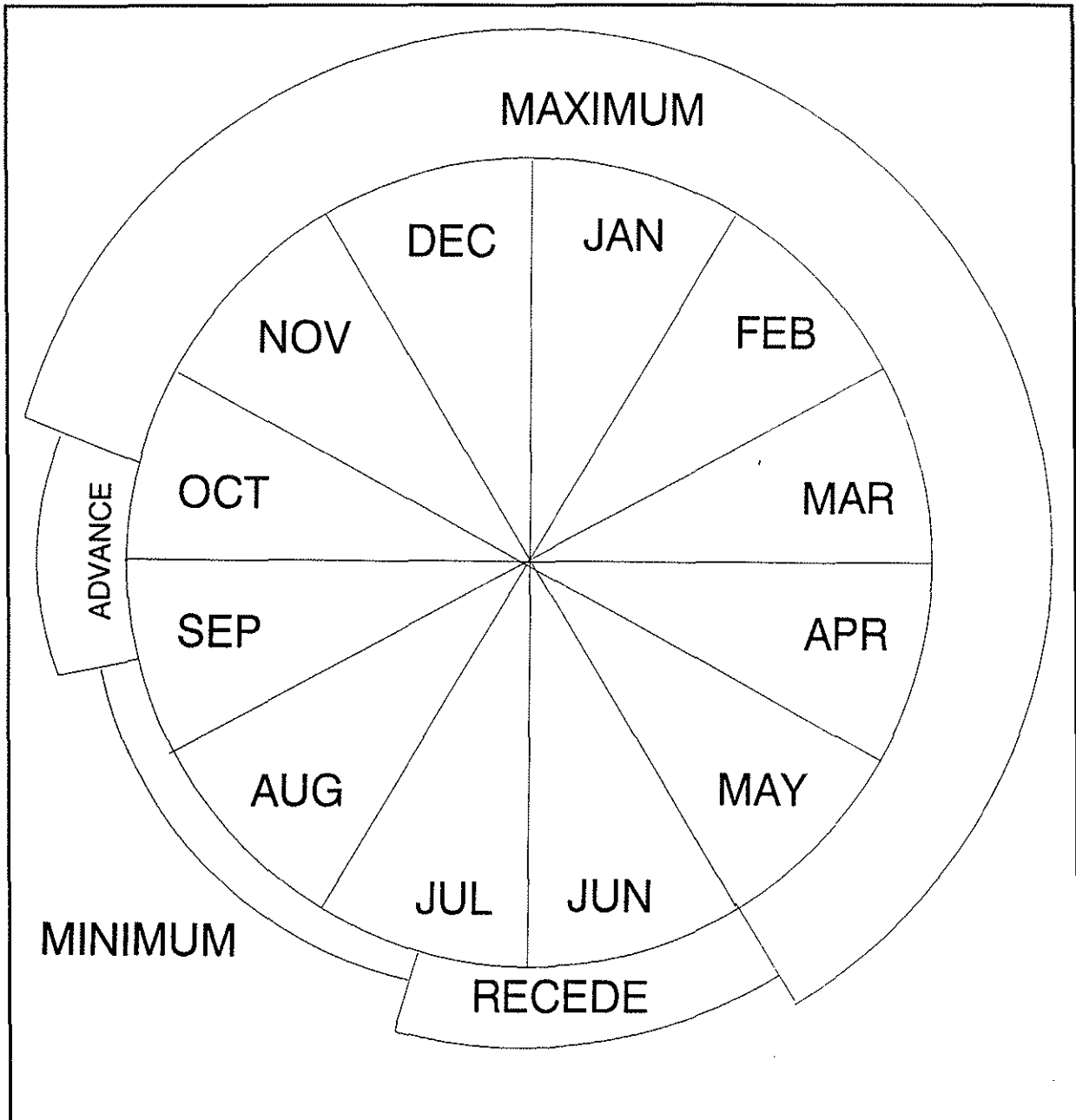


FIG 4. Seasonal ice designations for Severnaya Zemlya, Russia

Sequence Analysis of the Mitochondrial DNA Molecule of the Polar Bear

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The complete mtDNA molecule of the polar bear was sequenced. The length of the type sequence is 16,725 base pairs. The organization of the molecule conforms with that of other mtDNAs that have been sequenced in their entirety. The polar bear study is part of a phylogenetic project with the aim of elucidating the mtDNA relationships between the pinnipeds, and between pinnipeds and terrestrial carnivores. This study is based on comparisons of complete mtDNA sequences

in a limited number of species, one of which is the polar bear. The study will also comprise comparisons based on a selected gene in a larger number of species. The present sequence information makes it possible to construct PCR primers that have complete complementarity with the mtDNA of the polar bear. The availability of primers of this kind will facilitate the amplification of regions that may constitute primary choices for population study based on mitochondrial DNA.



Summary of Status Report for North Baffin Polar Bears

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On the basis of the movement data available to date, it appears that the boundary between management zones F and D1 is not warranted. The majority of the bears from these two Zones appear to be intermixed on the pack ice in Baffin Bay and then spend the ice-free season (late summer and fall) on land along the east coast of Baffin Island north of Cape Dyer, the north coast of Baffin Island, and the south-eastern coast of Devon Island. Bears regularly move back and forth between Baffin Island and Greenland. Individual animals are likely to show a high degree of seasonal fidelity to particular coastal areas, and segregation of subpopulations may occur during the ice-free season. A small, but undetermined, number of polar bears also remain along the coast of West Greenland during the summer, particularly in the region of Melville Bay. Most maternity denning in this population appears to occur in Canada although some has also been recorded in Melville Bay in Greenland.

The population estimates for Zones F and D1 are 2000 and 470 respectively. The present Canadian quotas are 105 (F) and 50 (D1) while the average harvest of polar bears in West Greenland is estimated to range from 40 to 60, making an annual total of 195 to 215. Thirty-one percent of the total harvest is female. Application of the generalized formula suggests a sustainable harvest of only 118. Consequently, on the basis of the available data, the possibility of an over-harvest must be considered.

However, before recommending any changes to polar bear management for this area, several points should be considered. The population inventory studies on which the above estimates are based were not able to ensure comprehensive sampling of the entire area. Good information on polar bear movements in the

offshore areas has only recently been acquired using satellite radio-collars. The boundaries proposed for these populations were developed in the early 1970s without the benefit of either scientific or traditional knowledge. Elimination of these limitations is the focus of the current cooperative research program.

The population estimate for Zone F is based on an under-funded study in which the sampling design varied in different years, the results of which are now 14 years old. The original estimate of 1647 was believed to be an underestimate and was increased to 2000 by the Canadian Polar Bear Technical Committee. The revised estimate of 2000 is considered to be conservative.

The methodology used to estimate the population size in Zone D1 seems to have fewer flaws than that used in Zone F. Although the capture effort was restricted to the shore-fast ice and floe edge, the movement data collected by satellite telemetry suggest this would not violate the assumption of equal catchability. The extensive movements recorded so far do not support the idea of segregated coastal and offshore populations. However, the appearance of a large number of unmarked animals in the last year of the study indicates that the distribution of these polar bears is not completely understood.

The northern boundaries currently indicated for area F were drawn using very limited reconnaissance data. These borders are likely to be altered as more information on movements is obtained.

In 1979, on the basis of 183 polar bear sightings during aerial surveys for marine mammals, a large population of polar bears was estimated for an area comprising approximately the western half of the northern Baffin Bay polar bear habitat adjacent to both

Polar Bears

Canada and Greenland. At the same time, a large population of ringed seals in the offshore ice was also identified. Although these observations cannot be directly interpreted in relation to the population estimates, it is consistent with the perception of a substantial population of polar bears in the offshore pack ice that is shared between Canada and Greenland.

Lack of knowledge on the distribution and movements of polar bears in the North Baffin area make it difficult to provide an unambiguous estimate of population numbers. Additionally the harvest records from Greenland are incomplete and irregular, so the total and average kill from this area is uncertain. The status of this population cannot be stated with certainty because of these difficulties. However, if the polar bears are being

over-harvested over the total study area, the population is sufficiently large to suggest that it will not be significantly depleted during the time needed to obtain a more comprehensive understanding of the population. We believe adequate funding and technology are in place to facilitate a study of adequate scope and depth to resolve the distribution and movement questions, and this should be completed before management options are reviewed by all the parties. Although we do not recommend reductions in the present quotas, we do recommend that hunters in all areas try to reduce the kill of females by being more selective for males. In addition to the ongoing cooperative research program, we recommend that the Greenland polar bear harvest be monitored and recorded.

Basic Concepts of Polar Bear Maternity Den Census

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Experience in censusing polar bear dens indicates that three variants of maternity den census are possible: 1) ground census only; 2) aerial census combined with ground survey; 3) aerial census only.

Ground census only

This observation variant can be conducted on foot, by dog, or snowmobile. The sample area should equal 15–20% of the total area deemed suitable for polar bear maternity dens. The number of detected maternity dens should equal 20–30% of total number of reproducing females that denned within the total denning area.

Almost all maternity dens within the sample area can be detected by ground survey. The total number of reproducing females in the total denning area is estimated by extrapolating the density of maternity dens over the sample area to the total denning area of corresponding stratum. Estimation algorithms developed by Jolly (1969) and Chelintsev (1977, 1980, 1992) can be used.

The following rules should be applied when planning the ground survey:

- a) The number of sample plots in each stratum must exceed two;
- b) The sample plot(s) within a given stratum must correspond to the habitat condition of the entire area of stratum;
- c) For each stratum, the ratio of sampling area to total stratum area must be approximately proportional to the square root of maternity den density in a given stratum to minimize the statistical error.

A ground survey is conducted by 5–10 specialists over a two–three week period. The observations are often complicated by arctic conditions. The standard error of the reproducing female population estimate depends on the size of sample area and degree of asymmetry in den placement throughout the sample area. Relative standard error may reach 20–30%.

Aerial census combined with ground survey

The combined aerial survey and ground survey method of den census was first used on Wrangel Island during spring 1973 by S.M. Uspensky and S.E. Belikov. Ground surveys of the model plots (sample plots) should correspond to den opening dynamics of the total denning area of the corresponding stratum. If den opening dynamics differ in different parts (regions) of the total denning area, corresponding model plots are selected in each part (e.g. west and east parts of Wrangel Island or shore and center of island).

The ground survey crew determines the total number of maternity dens within each model plot by careful observation of plot area during the entire period of den opening. The aerial survey is conducted on the model plots and sample areas of each stratum. On Wrangel Island, the area of the aerial sample comprised 50–70% of the high den density stratum area, while the area of the aerial sample within the low den density stratum comprised 30–40% of the total area in that stratum. Aerial surveys of each model plot and sample areas were conducted once in 1973 and twice in 1976 during the den opening period.

Aerial surveys should be conducted when the majority of dens are open and can be readily detected from the plane. The detectability coefficient of open den must be

identical for the entire stratum and the corresponding model plot(s). The width of aerial census strips on stratum territory and corresponding model plot(s) must be the same, so that den detectabilities of these two areas do not differ.

The estimation of the number of maternity dens is accomplished in two steps (Chelintsev 1977):

a) "Spatial extrapolation":

For each stratum (and each part of the denning area with different dynamics of den opening) the spatially extrapolated number of open dens (F) is calculated based on the data from the aerial survey of the sample area. If aerial survey transects are not evenly spaced throughout the the stratum area, Chelintsev's method of bisecting the stratum area into smaller zones with two quasi-samples in each zone may be used (Chelintsev 1980, 1992; Belikov *et al.* 1991).

b) "Temporal extrapolation":

The estimate of the number of maternity dens (N) within each stratum area is calculated using the following formula:

$$N = FK_1 \quad (1)$$

where F is spatial extrapolated number of open dens on the aerial survey day (days). The stratum corresponding coefficient K₁ is estimated by the following formula:

$$K_1 = M/A, \quad (2)$$

where M is the total number of maternity dens on model plot(s) of the corresponding stratum; A is the number of open dens (maternity and temporary) which are detected on the same model plot(s) during the aerial survey.

The statistical (standard) error of the estimate of N is caused in the first place, by the values M and A. In 1973 on Wrangel Island, M was equal to 33 and A was equal to 12 (for one aerial survey day). In 1976, M was equal to 13 and A was equal to seven (for two aerial survey days). The relative standard error of the estimate K₁ for the given values of M and A approaches 30–40% and exceeds the relative error of the spatial extrapolation (Chelintsev 1977). To decrease the standard error of the estimate of K₁, a model plot must be increased.

The above estimation procedure (Method 1) differs from the method (Method 2) described in Garner *et al.*

(1991). According to Method 2, the coefficient K₂ is calculated by following formula (using our symbols):

$$K_1 = MH/SB, \quad (3)$$

where S is the total lifetimes of den openings (in days) on the model plot(s); H is the total number of days the ground observations on model plot(s) were conducted and when aerial surveys were possible; B is the number of aerial survey days. Ratio S/H is the average number of open dens per day during the time period H and SB/H is the average number of open dens per B days. The number of maternity dens (N) on stratum area in Method 2 is calculated by formula (1), where the coefficient K₁ is replaced by the coefficient K₂.

Method 1 and Method 2 differ in the following manner:

- a) for Method 1, values S and H are not defined; instead, it is enough to know the value of A which is easily defined.
- b) for Method 1, the bias in the estimate of K₁ is caused by desynchronization of den openings on stratum sample areas and den openings of corresponding model plot(s). If the synchronization of den openings increase, the bias reduces to zero.
- c) for Method 2, the coefficient K₂ is defined by the average number of open dens on model plot(s) for all days of period H, but the number of open dens which may be detected by plane on the stratum area in aerial survey sample day(s) varies from day to day. Therefore, the coefficient K₂, which is calculated for the entire period H, may differ from the sample value of coefficient K for the aerial survey day(s).
- d) The number of open dens recorded on aerial survey day(s) using Method 1 is more relative to Method 2, because aerial surveys by Method 1 are conducted during period when den openings are most intensive and on days when the number of open dens is highest.

Aerial census only

This method was used for counting dens on the Chukotka mainland (Stishov 1991) because ground survey crews cannot detect a sufficient numbers of maternity dens in areas with a low density of maternity dens. Censuses on Wrangel Island in 1973 and 1976 indicate that a one-day aerial survey of a model plot would

detect 20–30% of the total number of reproducing females on the plot. It could be supposed that by conducting aerial surveys over a three–four day period that it may be possible to count the number of open dens which is approximately equal to the total number of

reproducing females. An over-estimate is possible if the number of temporary dens is large. If aerial surveys are conducted on the sample area, then spatial extrapolation for the different strata can be accomplished using the Jolly or Chelintsev method.

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Recent Studies on Heavy Metals in Polar Bears from Greenland with reference to other Marine Mammals

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Data on zinc, cadmium, mercury and selenium were developed for muscle, liver and kidney tissue from 38 polar bears caught in the Scoresby Sound area, central East Greenland. Data on cadmium and mercury were compared to a number of other marine species. Cadmium levels were lower in all analyzed tissues of the polar bear compared to the ringed seals from the same area. Ringed seal blubber, constituting an important part of the polar bear diet, had low cadmium levels being often below detection limit. This finding provides a probable explanation for the low cadmium concentration in the polar bear tissues. Mercury levels in muscle tissue were likewise lower in polar bears compared to ringed seals, whereas the opposite was the case for liver and kidney tissue. This finding shows that trophic accumulation factors are dependant on the tissue being compared. Contrary to other marine mammals, polar bears had higher mercury levels in kidney than in liver. The previous geographical trend for cadmium and mercury found in Canada could be extended to cover East Greenland as well. Hence higher cadmium levels were found in Greenland while the opposite was the

case for mercury. As previously found, mercury and selenium showed molar ratios close to unity in liver. A similar ratio was found in kidney tissue, where cadmium and selenium molar ratios were also 1:1.

Significant correlations were found between the concentration of mercury in hair and in liver and kidney. Based upon these findings, mercury levels in 135 hair samples collected from East Greenland between 1973 and 1990 were examined. Significant differences were found for sampling year and different geographical areas, but the effects of these two parameters could not be separated. Sex and season were not significant contributors to the model, and neither were any of the first order interactions. Concentration of mercury increased significantly with age, most pronounced for animals less than eight years of age (annual increase of approximately 0.6 g/g w.w.). Mercury in hair of mother and cub pairs from whole Greenland showed significant correlations ($r=0.779$; $n=23$). Significant correlations were also found between cubs of the same litter ($r=0.966$; $n=11$).

On ICC's Environmental Strategy and some local Polar Bear Problems

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The Inuit Circumpolar Conference (ICC) is a non-governmental organisation that takes care of the general interests of the Inuit from Chuchotka, Alaska, Canada and Greenland. The organisation was founded in 1980.

When people from a widespread area meet to express their concerns, there will always be a wide range of ideas, needs and expectations expressed. Within a short time such issues can be innumerable, contradictory and confusing.

So, already at the second General Assembly, held in 1983, the ICC recognised the necessity of working out an overview of its policy—what we now for short call our "ARCTIC POLICY". I consider it to have been a farsighted and wise initiative to develop the Arctic Policy paper, which was approved at the last General Assembly in 1992. It is now published as "PRINCIPLES AND ELEMENTS FOR A COMPREHENSIVE ARCTIC POLICY".

With the Arctic Policy document we now have a reference book for our work in the ICC. In addition it can also be used by other NGOs as a catalogue of ideas.

We do not perceive the document as a final one. It will have to be revised and kept alive through the coming years.

The Arctic Policy document has six chapters:

1. Inuit Rights, Peace, and Security Issues
2. Environmental Issues
3. Social Issues
4. Cultural Issues
5. Economic Issues
6. Educational and Scientific Issues.

The Environmental Issues chapter takes up nearly 30% of the publication.

Our people have always known that we lived in a delicate and fragile environment. As we grew up we were taught to protect our streams, our waters, our lands and our game. And until only a few years ago we lived under an illusion that our homelands were so isolated that we in a relaxed way could look upon the industrial pollution in North America and Eurasia—as long as we lived in balance with our own environment.

The last year's knowledge about the global warming, the ozone layer depletion, the Arctic haze, ocean dumping of all kinds of litter, the transboundary pollution by PCB and other persistent chemicals, the Exxon Valdez oil spill and many other examples have taught us that we have to take part in international policy-making concerning the environment.

From the introduction to the mentioned Arctic Policy publication I can quote:

"From an Inuit viewpoint, Arctic policies must provide more than a prescribed course of action. They must reflect a vision of the Arctic that promotes fairness and social justice for northern peoples. Arctic policies must support the aspirations of indigenous peoples and nurture their cultural development. Equally important, Arctic policies must fully recognise and respect fundamental indigenous rights."

The chapter on Environmental Issues deals with environmental protection and the relationship between conservation and development.

It stresses that the Arctic constitutes a delicate environment on which Inuit depend. It talks about the interdependency between Inuit and the surrounding world, about aboriginal subsistence, the need for national and international laws to develop sustainable use of the resources: it also mentions international anti-harvesting pressure groups as part of our environmental problems.

Aside from these general informative remarks, I shall mention some more specific concerns about polar bears that have been brought to ICC's attention.

Chuchotka

Luidmilla Ainana, who is one of the two Chuchotkan executive council members of the ICC, said last summer:

"I would (also) like to speak on the problems which we are trying to resolve in co-operation with ... the Association of Indigenous Peoples of the North. All these problems can be associated with the gravest political and economic crisis, which swept the former USSR. This deformation of the society has affected the Indigenous Peoples of Russia's North through:

- 1) the decline of traditional economy, including the sea-mammal hunting, which is the basis of Inuit's subsistence,
- 2) to a considerable extent we have lost our traditions, our culture and language. These losses will lead to the extinction of our spiritual values and ethnic consciousness,
- 3) Unemployment among the indigenous peoples,
- 4) It has had an impact on the demography—the Yupiit are only about 1500 individuals. The life-span is 8.8 years shorter for men, while it is about 10 years shorter for women, compared with the rest of Russia,
- 5) Environmental deterioration as a result of the barbarian industrial expansion, irrational construction and natural resource utilisation. The present state of the air, the water, the flora and the wild life has an economic, ethnic and social meaning to the aboriginal peoples.

In the last decades the sea mammal hunt has resulted in alarming conditions in our society."

To return to our main subject here, the polar bears, Ainana continues: "I must raise still another issue: It is prohibited to harvest polar bear in Chuchotka. You see, native people fed on polar bears meat since time immemorial. Some rites and family celebrations are based on polar bear harvesting. It was a component of our culture. The population of polar bears increase now from year to year. Polar bears become a nuisance in the remote coastal villages. That is why my people must be allowed to harvest polar bear."

Luidmilla Ainana ends this part of her "Overview of Current Issues in Chuchotka" saying: "As I understand, the above mentioned problems represent a component of a great phenomenon, which has the name Infringement of the National Interests of Native Peoples; some non-natives are arrogant to us and unwilling even today to see in the aboriginal populations of Russia's North and Far East as a colourful diversity of ethnosis. We are persistent on preserving our distinctive ethnical and cultural values."

Thule or Avanersuaq

Even the importance of the polar bear hunt in Avanersuaq will be known to the participants of this meeting, I want to include some facts in this overview:

Polar bear pants are not only the preferred kind of clothing for the hunter in this area, they are also a necessity if you want to be able to cope with the severe climate in a decent way in the traditional hunting.

Maybe more important is the cultural aspect of the polar bear hunt. For centuries the polar bear hunt has been the proof of the individual hunter's ability and skills. Any able man can normally hunt seals, walrus, belugas and other sea mammals to feed his family and his dog team. But it takes a skilled person to have collected enough food for the family, and to have brought his equipment and dogs up to a state, that he can leave his family for the four to six weeks period a polar bear hunt in the Melville Bay or to Kane Basin lasts. A polar bear hunt like this is also looked upon as a very prestigious event in one's life, and as one of the peak experiences a hunter must have through his life—a proof of manhood.

It is worth mentioning that the Avanersuarmit for centuries up to about 40 years ago have been the only people who have been using the area of Ellesmere Island for subsistence hunting.

During the same 40 years three factors have limited the livelihood of the Avanersuarmit:

- 1) the building up of the international boundary or border between Canada and Greenland,
- 2) the placement of the Thule Air Base, and
- 3) the resulting move from Uummanaq to Qaanaaq.

The mentioned issues are dealt with in following ICC resolutions:

- 89–33 – Thule People's Right to Hunt Polar Bear on Ellesmere Island
- 92–19 – The IUCN Specialist Group on Sustainable Use of Wild Species
- 92–20 – Support of the Restoration of Traditional Inuit Hunting Rights

Seen from a ICC perspective the work in your group is very important. Trustworthy estimates of the polar bear populations in our areas are crucial to us. Which areas do the populations cover? What is the reproduction rate for polar bears? What is the impact of the global pollution on the individual polar bear and to the species in general? Are quotas the way to secure a sustainable yield? Or do we find the answer in a sex-

selective hunt? Many other questions must be answered in the future, as they are crucial to our politicians in their efforts to make sustainable use of the polar bears.

We know that just some decades ago, the subsistence hunt of the polar bear would never threaten the bears as a species. But now with the growing populations in the Arctic, the modern means of transportation, modern guns and scopes, the lack of money income for the hunters in our areas, and the rapid cultural changes among our peoples we realise that we unintentionally, ourselves can become a threat to this precious game.

I want to thank you for your invitation to the representatives of the hunters from Alaska, Canada and Greenland through ICC. We have learned a lot from you, and I hope, that we have been able to give an input to your meeting that is beyond your traditional methods for data hunting.



Polar Bears killed in Svalbard 1987–92

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All polar bear hunting in Norwegian territory has been banned since 1973. Since 1973 polar bears have only been shot in acts of self-defense, as precautionary measures or have been killed as acts of mercy. All such cases are considered a police matter and are either investigated by, or authorized by Sysselmannen. Data on bears killed has been obtained from Sysselmannens files. A total of 26 polar bears have been killed in Svalbard since January 1987. Twelve of these kills (46%) occurred in July and August. These same months constituted the period with most killings in self-defense (53%). June and November were the only months with out bears being killed. Fifteen of these 26 cases were

self-defense, four precautionary measures, six acts of mercy and one unknown. Twelve of the 15 self-defense cases (80%) occurred at remote cabins or tents. No cases occurred in populated areas. Of all self-defense cases, seven involved tourists and six scientists, hence 87% of all self-defense cases involved non-residents of Svalbard. Fourteen of the 23 bears killed and aged were adults. Of the 21 bears killed for which sex is known, 18 were males (86%). Eight of the 15 bears shot in self-defense were males, three were females and four unknown. Of these 15 bears, six were adults, seven subadults and two unknown.

Chlorinated Hydrocarbons in Polar Bears from North America, Greenland and Svalbard

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It has been suggested that the Arctic Ocean may become one of the principal global sinks of organochlorine compounds such as PCBs, DDT, chlordane and dieldrin because of the tendency for net atmospheric transport from warmer to colder areas. This may have some basis in fact, since recent estimates indicate the net flux of PCBs from the atmosphere to the ocean surface is greater at higher latitudes (Iwata *et al.* 1993). Organochlorines have been detected in arctic air, snow, ice, water and biota (Barrie *et al.* 1992; Muir *et al.* 1992). Knowledge of the circumpolar distribution and temporal trends in concentrations of organochlorines is therefore important in determining the sources and potential significance of these contaminants to arctic marine and maritime wildlife and the humans that consume them. It has already been demonstrated that levels of PCBs are about three times higher in breast milk of Inuit from northern Québec than in the southern Caucasian population (Dewailly *et al.* 1989).

The polar bear (*Ursus maritimus*) is an excellent candidate biomonitor for organochlorines. Polar bears are the principal mammalian predators at the top of the arctic marine foodchain, and are distributed widely throughout the Arctic and Subarctic circumpolar regions. Several studies have been published identifying organochlorines and their metabolites in polar bear tissues, studying their bioaccumulation in the food web and determining geographical distribution of levels in fat and liver. Most of the studies have been in the Canadian Arctic, but there is some information for Alaska, Greenland and Svalbard bears (Clausen *et al.* 1974; Bowes and Jonkel 1975; Lentfer 1976; Edelstam *et al.* 1981; Norstrom *et al.* 1988; Muir *et al.* 1988; Norstrom *et al.* 1990; Letcher *et al.* 1992; Jarman *et al.* 1992; Norheim *et al.* 1992; Bergman *et al.* 1993).

A proposal for a circumpolar survey of contamination in polar bear fat was presented by the Canadian Wildlife Service at the IUCN Polar Bear Specialist Group in Sochi, USSR in October 1988. The Department of Renewable Resources of the NWT (M. Taylor,

Yellowknife), the University of Saskatchewan (M. Ramsay, Saskatoon), the University of Alberta (I. Stirling, Edmonton), the Kuujuaq Research Centre (S. Olpinski, Kuujuaq, Québec), the Norsk Polarinstitut (Ø. Wiig, Oslo), the Greenland Fisheries Research Institute (E. Born, Copenhagen) and the United States Fish and Wildlife Service (S. Schliebe, Anchorage) agreed to collaborate in the survey. Although the former USSR agreed to participate, no samples were actually obtained. Unfortunately, the survey is therefore only hemispheric. Approximately 700 samples of fat from hunted bears and subcutaneous biopsies from research programs were collected from across Canada, Alaska, Greenland and Svalbard in 1989–91. These have been analysed by the Canadian Wildlife Service for over 20 different PCB congeners and organochlorines. The summary statistical analysis and brief discussion of the data are presented in this report. A manuscript for publication in the scientific literature, based on these findings, with all of the participants as co-authors, is in preparation.

Samples were placed into 17 geographical groups based on the likelihood of similar exposure to contaminants through a common food supply and common range. In the case of Canadian bears, these groups were modified from the Polar Bear Management Zones used by the Department of Renewable Resources of the NWT.

For purposes of statistical analysis, bears were put into three sex categories, male (M), solitary females (F) and females with cubs (FC). Levels of PCBs and chlordane in fat biopsy samples from western Hudson Bay showed a tendency to decrease from cubs to approximately five years of age. Trends in levels with age were much less pronounced in mature adults. Therefore, all statistical comparisons among areas were made with results from bears older than five years. In the case of multiple-compound classes, the data were summed to give the total for the class: S-DDT (DDT+DDE), S-Chlordane (mainly the metabolite oxychlordane and

nonachlor-III), and S-PCB (sum of 20 congeners) prior to statistical analysis. Details on the identity of the various individual organochlorine compounds and most of the chemical methodology has been reported previously (Norstrom *et al.* 1988; Muir *et al.* 1988).

The dataset was cleaned up by removing records for which some critical data (either biological or chemical) were missing. There were 300 bears in the final adult dataset. Statistical analyses were done using the SAS GLM procedure. To obtain normality, the data were log transformed (square root for dieldrin). Where it was significant, sex (PCB and S-Chlordane) and sex by age interactions (PCBs) were eliminated by standardizing the data to solitary females for purposes of comparing geographical distribution free of these effects. Overall, females have 42% higher levels of S-Chlordane than males (P). Females with cubs also have 32% higher levels of S-DDT than males. There is no significant difference between the two groups of females for any organochlorine. The pattern is quite different for S-PCBs than for S-Chlordane and S-DDT. Males have 50% higher levels than females (P<0.05).

Ranges in concentrations were: S-Chlordane, 1.5–6.2mg/kg; dieldrin, 0.08–0.49mg/kg; S-DDT, 0.09–0.68mg/kg; S-PCB, 1.7–15.7mg/kg. With few exceptions, the geographical variation for each chemical group was within a factor of two or three throughout the North American Arctic, and was not statistically significant among areas. The most pronounced geographical variation was the significantly higher level of S-PCB (11–16mg/kg) in eastern Greenland, Svalbard and M'Clure Strait bears than in the other 14 areas, which averaged 3.7 ± 1.6 mg/kg. There were also higher levels of S-DDT in the M'Clure Strait area. Apart from these anomalies, geometric mean levels tended to increase gradually from west to east and south (Alaska–Svalbard–Hudson Bay), as was found in the Northwest Territories of Canada in a previous study (Norstrom *et al.*, 1988). This trend was most obvious for S-DDT and dieldrin, and is consistent with long-range atmospheric transport of contaminants from the North American continental land mass, which is expected to contribute more to the "background" levels in the eastern and

southern Arctic west of Greenland. East of Greenland, Europe and Eurasia were probably responsible for the higher PCB levels. The relatively uniform levels of most organochlorine compounds, especially S-Chlordane, indicates that they are well distributed in the Arctic marine ecosystem of the western hemisphere, perhaps even close to equilibrium with global atmospheric cycling (Iwata *et al.* 1993).

The significance of these results to polar bear ecotoxicology is difficult to determine. Mean PCB levels in fat are generally four to ten times below those which are associated with reproductive effects in most wild mammals such as mink and grey seal (Olsson 1987). However, some individual bears have PCB levels (20–30mg/kg in lipid) which are approaching the level of concern if polar bears are sensitive species. It is suspected effects may be most evident during fasting, especially on denning females, fetuses and newborn cubs (Norstrom 1990). We have recently identified methylsulphone metabolites of PCBs and DDE in Polar bear tissues (Bergman *et al.* 1993; Letcher *et al.* 1992). DDE methylsulphones have been implicated in an endocrine disease syndrome (hyperadrenocorticism) in Baltic grey seal which led to osteoporosis, possible immune deficiencies and reproductive failure (Bergman *et al.* 1986; Brandt *et al.* 1992).

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The Catch of Polar Bears in Northwestern Greenland

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Polar bears (*Ursus maritimus*) are an important component of the subsistence catch for those Inuit living in the municipalities of Avanersuaq (Thule) and Upernavik in northwestern Greenland. Information on the catch of polar bears in Avanersuaq and Upernavik is limited, as in other areas of Greenland. In order to determine the age and sex composition of the catch of polar bears in these areas, samples from the Inuit's catch have been collected since early 1988. To obtain detailed information on the spatial and seasonal distribution and the size of the catch, 70 hunters from Avanersuaq were interviewed in 1989. Of these 58 had taken polar bears. They represented close to 100% of the regular hunters. In 1990, 21 hunters were interviewed in the Upernavik area. They represented less than 10% of the hunters in the area, and therefore, the information about the number of bears caught in the municipality of Upernavik may be less representative. During spring (peak activity in April) and in October, hunters from Avanersuaq travel north by dogsleds to hunt polar bears in the Kane Basin area between 78° 30' and 80°N where an estimated five to 10 bears are caught annually. The occurrence of bears in the central part of the Avanersuaq area is more sporadic; an estimated five bears are taken annually in these areas. Hunters from both Avanersuaq and Upernavik hunt polar bears in the Melville Bugt area. In this area an important site for the spring polar bear hunt is found about 100km offshore at a shallow

bank with stranded icebergs. Inuit from Avanersuaq take an estimated 20 polar bears per year in the Melville Bugt area where some bears are also taken by hunters from the municipality of Upernavik. The peak hunting activity in this area is in March. During 1988 and 1989, the only two years in which the information on numbers of polar bears taken in Avanersuaq is sufficiently representative, 24 and 48 polar bears were documented, respectively. We estimate that during the past 10 years or so, the total catch of polar bears in Avanersuaq has averaged 30–35 per year. According to the hunters, the occurrence of polar bears in the Upernavik area has increased during the 1980s, and their range has extended southward. The hunters suggested that these changes reflect a change in the distribution and duration of the ice cover in northern Baffin Bay. Based on little information, we estimate that the annual take of polar bears averages about 20 polar bears in the municipality of Upernavik. In northwestern Greenland, the majority of polar bears are taken during sled trips in February–April. Of 61 catches (1988–92) in Avanersuaq for which the method of hunting was stated, only 1.6% of the bears were taken using skiffs powered with 40hp outboard engines. Independent female polar bears (i.e. older than two years of age) comprised about 37% of the catch in Avanersuaq and Upernavik. In northwestern Greenland, the majority of the hides are used for clothing and the meat is a highly priced food.

Genetic Heterogeneity in Polar Bears: the Canadian Data

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We initiated this work because we wished to develop a method that would allow us to delineate subpopulations of polar bears in a rigorous manner. Our initial approach was to use RFLP (Restriction Fragment Length Polymorphism) analysis of mtDNA. Fifty polar bears were sampled from each of the western Hudson Bay and Beaufort Sea/M'Clure Strait regions of Canada. These sites were chosen to be as far apart as possible as we could sample within Canadian jurisdiction. We carried out analyses using 31 different restriction enzymes. No polymorphisms were detected except for one female from Hudson Bay who was polymorphic for two enzymes. To verify the RFLP results, we applied standard nuclear DNA fingerprinting methods using

Jefferies and PB-47 probes. The results with both were similar and consistent with the mtDNA data. The probability of any two bears having identical fingerprints was 5×10^{-5} ; about seven orders of magnitude higher than for people. Our data are in striking contrast to the RFLP data of Shields and Kocher (1991) who found individual differences of 0.37% among eight polar bears using 13 enzymes. Using PCR (polymerase chain reaction) techniques we are now sequencing portions of the mtDNA genome coding for cytochrome-B and the hypervariable D-loop to allow more detailed comparisons with the Alaskan data. Our results suggest that polar bears consist of at least two genetically discrete populations.

Global Environmental Change: an Involuntary Ecological Experiment with Polar Bears as a Subject

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Human activities over the past century have more than doubled atmospheric concentrations of naturally occurring greenhouse gases such as CO₂ and CH₄ as well as adding significant quantities of synthetic greenhouse gases such as CFC-11 and CFC-12. As a direct result of these atmospheric perturbations, rapid and significant (i.e., >5°C) global warming is predicted to occur over the next 50–100 years. Significantly for polar bears, most climate models predict that the greatest warming will occur in the polar regions, especially the Arctic. To put this magnitude of warming into perspective, the increase in global warming from the last glacial period to full interglacial was about 5° C. The consequences for polar bears of global warming are both direct and indirect. Mathematical models indicate that a moderate rise in Arctic temperature would reduce the sea-ice cover to <50% of that at present. Testing of the models is ongoing. Over the past 10 years the maximum extent of Arctic sea-ice has declined about 2%, in

agreement with the model. A 50% decline in coverage of sea ice would almost certainly eliminate polar bears from the southern parts of their range and reduce nutrient intake of bears in other regions. In the early stages of ice reduction, bears in the more southern parts of their range would experience reduced feeding opportunities and lengthened ice-free periods in summer. Indirect effects include: 1) an increased possibility of an epizootic (e.g., seal Morbillivirus) affecting arctic seals; 2) reduced marine primary productivity because of loss of ice algae populations, a significant change in phytoplankton populations, and phytoplankton reductions as a result of increased UV exposure due to polar ozone thinning. Directly and indirectly, the results of global warming will prove catastrophic for existing polar bear populations. Our role as researchers and managers is to design data collection programmes that can, as early as possible, confirm or falsify predictions based upon global warming models.

Grizzly Bear Sightings in Viscount Melville Sound

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Background

On 4 May 1991 a grizzly bear was sighted about 40 miles south of Dundas Peninsula, Melville Island (73° 47' N, 112° 17' W), on the sea-ice of Viscount Melville Sound. From tracks it was apparent that the grizzly bear had been hunting seal pups in birth lairs. The remains of two kills (presumably seal pups) were observed in the vicinity of where the bear was seen. The bear was immobilized, ear tagged, lip tattooed, weighed, measured, and examined. The bear was an adult male weighing approximately 700lbs. The bear was in good condition, had no broken teeth, and no visible scars or wounds. The testes were small and not descended, indicating the bear was not mating. The bear was lightly drugged, and was able to lift its head and move its paws before we left it.

On 7 May 1991 Joseph Haluksit from Holman Island encountered a grizzly bear about 40km NW of Barnard Point. The grizzly bear was seen near a seven-foot, un-sexed two-year-old polar bear cub that had been killed and partially eaten. The grizzly bear had eaten part of the hindquarters and partially buried the carcass. The grizzly bear appeared to be a large male and was presumed to be the same bear that had been captured earlier. From wounds on the polar bear, blood spread around the area, and tracks, the hunters concluded that the grizzly bear had killed the polar bear, then eaten the hindquarters.

Mr. Pat Ekpatok of Holman Island was reported to have observed two polar bear cubs that had been killed and partly eaten by a grizzly bear. Mr. Ekpatok was contacted on 17 May for details, and explained that he had not seen any cubs or any bears killed by a grizzly bear or by any bear in spring 1991. The false report may have come from a misunderstood radio message when Pat was discussing one of the other sightings.

Grizzly bears are known to venture onto the sea-ice to scavenge from polar bear kills and hunt adult and newborn seals. Two grizzly bears have been observed in Wager Bay, one of which was on a seal kill. Both researchers and local people have observed grizzly bears and grizzly bear tracks on sea-ice in the Amundson Gulf area. Kurten suggested that polar bears evolved from barren land grizzly bears that were forced onto the sea-ice when glaciers advanced north (as well as south) during the Pleistocene.

Zookeepers, particularly in the Soviet Union and Eastern Europe, have experimentally crossed polar bears with grizzly bears. Polar bears and grizzly bears readily mate, and produce fertile offspring. These offspring can mate with either polar or grizzly bears and also produce fertile offspring. The offspring have variable colour and morphological characteristics from both species. The coat colour may be all white, all brown, or patchy brown and white. A naturally occurring brown-patch polar bear cub was observed by Christian Vibe on NE Greenland which has no grizzly bears. Presumably the brown patch was a genetic reversion to the founding type (grizzly bears).

The explanation usually given for why hybrid polar-grizzly bears do not occur in nature is temporal segregation during the mating season (April–May for polar bears) and (May–June) for grizzly bears. This explanation may be inadequate for the Wager Bay, Amundson Gulf, and perhaps Viscount Melville area where the two species do overlap during the mating season. Perhaps grizzly bears return to shore before they become reproductively active, or perhaps there is mate selection in the wild that is not operative in zoos. It is even possible that occasional hybrids are produced, but are eliminated by natural selection and are not observed.

No previous observations of grizzly bears killing and eating polar bears has been reported. Polar bears could not be considered easy prey, even for an adult male

Polar Bears

grizzly bear. The reported grizzly kills are of cubs or juvenile polar bears. The grizzly bear handled by researchers on 4 May in Viscount Melville Sound was in prime condition. From the helicopter chase for darting, it was apparent that the bear was able to run faster than the typical polar bear of that size. The grizzly bear was not afraid of the helicopter as most polar bears are, rather it ran toward the helicopter as we approached. The observation of a grizzly bear in Viscount Melville Sound is the most northern sighting of any grizzly bear ever reported.

I suggest that this grizzly bear has somehow learned to exploit the sea-ice habitat in spring. Perhaps it ventured onto Banks Island or Victoria Island to exploit Muskox calves, perhaps it dispersed as a sub-adult, perhaps it is only a curious bear that has learned to exploit marine and terrestrial habitat. In the course of hunting seal pups it probably encountered polar bears, and was able to kill one for food. Large male polar bears are not as fast as female or sub-adult polar bears. My impression was that the grizzly bear we observed on 4 May could catch a sub-adult or adult female polar bear.

Another factor is that the Viscount Melville polar bear population has been subjected to selective sport harvesting for males, particularly large males. Only 20% of all adult bears seen in the Viscount Melville Sound area were males, and only three were prime adults. The largest male bear seen was the grizzly bear. Perhaps the harvest has left the population more vulnerable to grizzly predation than populations with more large males in breeding condition.

The grizzly bear will probably continue to exploit both seals and polar bears. Once a food reward has been obtained by a certain behaviour, most bears will persist in that behaviour. It is also not proven that there is only

one grizzly bear at work. Perhaps there are several grizzly bears, and what is occurring is only a natural extension of range.

On 4 May 1991, before encountering the grizzly bear, we came across a two-year-old cub that had been killed and partly eaten. We had been following the tracks of a female and two-year-old cub that were being pursued by a larger (male?) bear. Polar bears do attack and sometimes kill cubs during mating season. In many instances two-year-old cubs are probably weaned (forced from the mother) by males during the time they accompany females in breeding condition. Males may also kill cubs of any age. One theory is that by ending lactation and by repeated copulations, ovulation can be induced in female polar bears. This results in a mating opportunity for the male. We did not study the tracks at the site of the two-year-old kill, and presumed the kill was made as part of mating behaviour by a male polar bear.

Action taken

These events are being prepared for publication as a scientific note.

Current status/recommendation

Any additional mortality, especially of female bears, is a management concern for polar bears. However, the evidence that grizzly bear predation on polar bears is frequent or even significant from a population perspective is inconclusive. The Viscount Melville population will be visited in spring of 1992, and any polar bears found killed will be carefully examined for indications of grizzly bear predation. No control action appears to be warranted at the present time.

IUCN Species Survival Commission

The Species Survival Commission (SSC) is one of six volunteer Commissions of IUCN—The World Conservation Union, a union of sovereign states, government agencies and non-governmental organizations. IUCN has three basic conservation objectives; to secure the conservation of nature, and especially of biological diversity, as an essential foundation for the future, to ensure that where the earth's natural resources are used this is done in a wise, equitable and sustainable way; and to guide the development of human communities towards ways of life that are both of good quality and in enduring harmony with other components of the biosphere.

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