Polar Bears

Proceedings of the Tenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group

Compiled and Edited by
Steven C. Amstrup and Oystein Wiig,
IUCN/SSC Polar Bear Specialist Group

Occasional Papers of the IUCN Species Survival Commission (SSC)
No.7

IUCN—The World Conservation Union

IUCN Species Survival Commisson

Role of the SSC

The Species Survival Commission (SSC) is IUCN's primary source of the scientific and technical information required for the maintenance of biological diversity through the conservation of endangered and vulnerable species of fauna and flora, whilst recommending and promoting measures for their conservation, and for the management of other species of conservation concern. Its objective is to mobilize action to prevent the extinction of species, subspecies and discrete populations of fauna and flora, thereby not only maintaining biological diversity but improving the status of endangered and vulnerable species.

Objectives of the SSC

1. To participate in the further development, promotion and implementation of the World Conservation Strategy; to support the implementation of the Programme; and to assist in the development, screening, and monitoring of projects for conservation action.

2. To maintain an international network of independent volunteer members selected for their expertise in species conservation and to provide a forum for the exchange of views and scientific information on species and populations of conservation concern.

3. To cooperate with the World Conservation Monitoring Centre (WCMC) in developing and evaluating a data base on the status of and trade in wild flora and fauna, and to provide policy guidance to WCMC.

4. To provide advice, information, and expertise to the Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and other international agreements affecting conservation of species or biological diversity.

5. To carry out specific tasks on behalf of the Union, including:

   - coordination of a programme of activities for the conservation of biological diversity within the framework of the IUCN Conservation programme.
   - promotion of the maintenance of biological diversity by monitoring the status of species and populations of conservation concern.
   - development and review of conservation action plans and priorities for species and their populations.
   - promotion of implementation of species-oriented conservation action plans and response to related issues.
   - provision of guidelines, advice and policy recommendations to governments, other agencies and organizations with respect to conservation and management of species and their populations.
   - periodic evaluation of the status of species and biological diversity conservation initiatives.

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Cover photo: Polar bear *Ursus maritimus* (Photo by Steven C. Amstrup)

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October 25-29, 1988
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Contents

Introduction

These proceedings are the written record of a truly historic event. Between October 25 and 29, 1988, 20 representatives of the 5 nations having jurisdiction over the world's polar bear habitats met in Sochi, USSR, to exchange data and ideas, and to plan the future of polar bear conservation and management (and indeed, the future of polar bears).

This was an historic event for several reasons. It was the first time during its 23 year existence, that the IUCN/SSC Polar Bear Specialist Group met in the Soviet Union. The Soviet Union was the first jurisdiction to take actions recognizing that the future of the world's polar bears could be in jeopardy (in 1956), and it was a principal force behind the international movement that ultimately resulted in the formulation of the International Agreement for the Conservation of Polar Bears which was signed by representatives of Canada, Denmark, Norway, the United States and the Soviet Union in 1976. Also, the Soviet Union controls roughly half of the polar bear habitat on the globe. So, as goes the Soviet Union so goes the fates of many polar bears. Soviet participation in the group was minimal after 1981. This was the cause of much concern among other jurisdictions and within IUCN, and made their offer to host the 1988 meeting all the more gratifying. Having made the offer, the USSR took great pains to make the meeting a success. Outstanding facilities and support for the meeting were provided in a beautiful and productive setting. Exciting extra-curricular activities, including an unbelievable helicopter supported tour of the nearby Caucuses Mountains, were also provided. The participants had occasion not only to work together, but also to begin friendships!

The meeting was marked by the introduction of a number of relatively new contributors to polar bear perspectives in all of the jurisdictions. This "new blood" made it very clear that polar bears will be in dedicated and capable hands for some time to come. It also was marked by the farewell of the last of the "original" members of the PBSG—Dr. Savva Uspensky, USSR, who formally bid the PBSG adieu, as he turned the reins over to some of his younger colleagues. Dr. Uspensky is, however, making himself available on a consulting basis. So the PBSG will be able to draw upon his expertise for some time to come.

The historical nature of these proceedings is apparent in the abundance of new information available herein. Much of this information would not otherwise be readily available at least not for some time. In fact, the 18 technical reports along with the minutes and the list of formal resolutions makes this the most technical and informative PBSG proceedings ever. This volume will be valued reading outside of, as well as within, the sphere of polar bear biologists.

The historical nature of this meeting is marked, most significantly, by the working group discussions which formulated plans for cooperative research and management efforts among the parties. Already, some of those plans have come to fruition. As these proceedings go to press, early in 1991, we have already seen Soviet researchers working in the USA, side by side with their American counterparts. Likewise, American researchers and managers have worked with their counterparts on the eastern end of the vast Soviet arctic. The details of similar cooperative research among Norwegian and Soviet scientists on the western end of the Soviet arctic are also being finalized. As of these proceedings, cooperation among polar bear jurisdictions has taken a quantum leap forward!

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Acknowledgments

Dr. Savva Uspensky overcame many administrative and logistical problems to allow this meeting to occur. Anna Minevich did a marvelous job of translating during the formal sessions. Ludmilla Bogdan and Faina Godina helped with translating and interpreting among working groups, and facilitated the drawn-out editing process. Annechen Ree typed the first drafts of many of the manuscripts included herein, and John Bevins and Bill Seitz assisted with technical editing.

Dedication

This volume is dedicated to the memory of John Bevins and George Menkens; two polar bear researchers, with the U. S. Fish and Wildlife Service, who did not return from a polar bear radiotracking mission on 11 October 1990. Their aircraft was last seen on radar approximately 240 miles northwest of Point Barrow, Alaska. This is prime polar bear habitat, but humans rarely venture this deep into the polar basin.

At the time of this ill-fated flight, John was a veteran of only 5 or 6 radiotracking missions and George was on his first radiotracking mission since joining the polar bear project. Yet, both were enthusiastic and loved their work, and they were aware of the risks it entailed. It truly can be said that they died doing research which they enjoyed and to which they were devoted. Although neither John nor George had attended a Polar Bear Specialist's Group Meeting, it is fitting that these historic proceedings be dedicated to their memory.

(Photo by Steven C. Amstrup)

Polar Bear Management in Canada 1985-87

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Since the Ninth Working Meeting of the IUCN/SSC Polar Bear Specialist Group in August 1985, there have been some changes in the management of polar bears in Canada. The regulations covering polar bear management in Canada as of 31 August 1988 are summarized in Table 1. Changes made prior to 1985 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 Quebec), continued to meet annually to discuss research results and to make management recommendations. Research arising from these meetings is outlined here (Calvert et al. 1990b).

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 1984-85, 1985-86, and 1986-87 are summarized, and recommended quotas for 1987-88, are given in Table 2.

Response to 1985 IUCN Resolutions

In 1985, the IUCN Polar Bear Specialist Group passed a series of resolutions. The Canadian PBAC discussed these resolutions individually and responded directly to the IUCN. The essence of their response to each resolution was as follows:

A: Protection of females with young and bears in dens: In this resolution,there was specific reference to the lack of legal protection, in the Province of Quebec, for females with cubs and bears in dens. While it was agreed that this situation was not acceptable, it was noted that Anguvigak (which represents the Inuit hunters and trappers in Northern Quebec) recently agreed to protect both those categories of polar bears. While this does not constitute protection by legislation, it goes a long way toward this goal.

B: Management of internationally-shared populations: There is strong support of this concept in Canada. Progress in the cooperative research and management of polar bears between Canada and Alaska was reported.

C-E: Analysis of harvest data, trend indicators, and improvements of design of mark and recapture studies: Canada supported this area of investigation.

F: Study of unhunted bears at Svalbard: This research proposal was supported in principle but no jurisdictions had funds available.

G: Participation of Norway and Denmark in polar bear research: Canada noted the significant contributions these two countries had made in polar bear research in the past and strongly supported any effort on behalf of the IUCN to increase the level of their participation again.

H: Participation by Soviet scientists in IUCN Polar Bear Specialist Group Meetings: Canada strongly supported IUCN in encouraging the participation of Soviet scientists in these meetings again.

Principles to Consider in Dividing Quotas

The PBAC discussed problems associated with setting quotas on a polar bear population shared between two or more jurisdictions. They drafted seven principles and distributed them to the PBTC for comment. These were expanded by the PBTC and further developed by the PBAC. A committee of Goulden, Simkin, and Lloyd, coordinated by Lloyd, received comments from all jurisdictions and developed a final version. These guidelines might be useful when Canada enters into such negotiations with another country (such as with the U.S. in the Beaufort Sea). A rationale for subdividing quotas from shared populations was finalized at the PBAC meeting in 1987:

Guidelines for Dividing the Quota for Shared Populations of Polar Bears

Objective: To determine the sustainable harvest of polar bears in Canada, and to allocate that harvest fairly between jurisdictions.

Basic Principles

1. The polar bear is a terminal predator, subject in its numbers to abundance of food and other environmental factors, and limited in its extent and range.

2. The polar bear is a resource shared among circumpolar nations, not only in its contiguous range as a species, but sometimes in home ranges of individuals; by international agreement, management of polar bears is to be based on sound conservation principles.

3. The polar bear is similarly shared among circumpolar jurisdictions within Canada and its management is the responsibility of those jurisdictions.

4. Sustainable harvest of a species shall be calculated with due regard for interjurisdictional effects.

5. The value of the polar bear resource to the Canadian people is both direct (hunting and viewing) and indirect (knowing that its existence in Canada is secure).

Guidelines:

1. The maximum amount of scientific information available will be used to calculate the total sustainable harvest from each subpopulation of polar bears in Canada. In particular, attention will be paid to estimation of population size, reproductive and mortality rates, seasonal movements, traditional hunting patterns, non-hunting mortality, aboriginal land claims or treaties, and estimated interjurisdictional or international effects.

2. In the event that there are no scientific data available, the jurisdictions affected, in consultation with the users, may jointly establish conservative interim harvest quotas for conservation purposes. The interim quotas shall be revised as more information becomes available.

3. The jurisdictions shall collectively determine the appropriate total sustainable harvest and the appropriate share that each will have, paying particular attention to the relative contribution that each makes to the maintenance of polar bear populations, and on the basis of mutual agreement and without unilateral action.

4. Values and enjoyment of polar bears other than hunting will be included in establishing the total allowable harvest and the geographical distribution of that harvest.

5. Jurisdictions will prepare accurate summaries containing the number of settlements, number of hunters, and number of other users so that relative need can be fairly considered in allocating the harvest among jurisdictions.

6. Each jurisdiction will divide its share of the total sustainable harvest in each management zone for use within its borders as it sees fit.

Users' Agreement for Polar Bears in the Beaufort Sea

In Alaska, the U.S. Fish and Wildlife Service (USFWS) worked with members of the North Slope Borough's (NSB) Conservation and Environmental Protection Office (EPO) and the Fish and Game Management Committee (FGMC) to promote a better understanding of polar bear biology, identification of problems with the current management system in Alaska and their solutions. This effort was stimulated by the IUCN-PBSG 1985 Resolutions A (Protection of females with young and bears in dens) and B (Management of internationally shared populations).

An August 1985 meeting of the NSB/FGMC included a delegation from the Inuvialuit Game Council (IGC) and the Government of NWT. Although the meeting was abbreviated for other reasons, polar bear management received much interest and discussion. Avenues of communication were opened and encouraged by both parties. As evidenced by a subsequent discussion of the need for local involvement in management, voluntary restraint on the taking of denning females and females with cubs, and the formation of a joint management working group with Canada, the meeting and presence of the Canadian contingent made a favorable impression on the chairman and members of the FGMC. The North Slope Borough had previously contractually agreed to assist FWS in sealing polar bear hides harvested in the Barrow area.

The PBAC strongly supported continued negotiations between the Inupiat of Alaska and the Inuvialuit of Canada toward developing a users' agreement for polar bears in the Beaufort Sea. It was also suggested that similar discussions might be held between the Inuit of NWT and northern Quebec to develop a user-based management plan for that area.

In April 1986, the NSB/FGMC passed resolution 86-01, Protection and Use of Polar Bears. The resolution called for protection of females and cubs, and denning bears, and also for the committee to work with the IGC to develop a polar bear management plan that ensures the health and productivity of the population. At a meeting on September 16, 1986, representatives

of the NSB/FGMC and IGC developed a draft Memorandum of Understanding (MOU) regarding the management of Beaufort Sea polar bear. The MOU was initialed in concept by representatives of the NSB/FGMC and IGC. The MOU specified that a joint commission of two representatives from each delegation be formed. Responsibilities of the Joint Commission are:

1. Develop a preliminary Beaufort Sea Polar Bear Management Plan.

2. Review the Management Plan annually, or more often as desirable, and address the polar bear management issues including research information, harvest limits within sustainable yield, allocation between Canada and Alaska, and other conservation measures.

3. Set up an *ad hoc* technical committee to provide information and advice to the commission.

4. Seek support of the respective management agencies to implement the Management Plan.

Principles and objectives in the Management Plan included sustained yield management based upon technical data to support harvests, promotion of the wise use of polar bears and their by-products, conservation measures such as harvest limits, protection of pregnant females and those with cubs or in dens, and a management system to regulate harvest, including hunter reporting requirements.

The NSB/FGMC unanimously ratified the MOU on November 6, 1986 in Barrow. News releases were issued locally. The USFWS transmitted copies of the MOU to the Director of the USFWS and to the Governor of Alaska which explained the chronology of events and USFWS involvement. Information on the MOU was transmitted to the U.S. Department of State at their request.

An *ad hoc* technical committee was named at the NSB/FGMC meeting in Anchorage 2-3 March 1987, the responsibilities of committee members were delineated, and drafting of the Management Plan was initiated. The USFWS has congratulated the parties involved through letter to the NSB Mayor and has offered continued assistance by providing biological expertise and technical assistance in developing and implementing particular segments of the Management Plan.

In March 1987, the IGC produced a draft of the Articles of Agreement for review. A Joint Commission and Technical Advisory Committee were named. Discussions continued in fall 1987 with an exchange of draft versions of the plan. On October 16 and November 19, respectively, the NSB/FGMC and the IGC adopted the draft plan. It was then sent to villages for review by hunters and users. The final, revised plan was ratified by both parties on January 29, 1988 in Inuvik.

It should be noted that this agreement is not based in law, but is between users taking responsibility for the conservation of a shared subpopulation of polar bears. It is a valuable precedent for the direct involvement of native people in other wildlife management problems in the north. Already, there is the possibility of a similar draft agreement for beluga (*Delphinapterus leucas*) management.

Non-consumptive Use of Polar Bears

In several jurisdictions, tourism activities based upon the non-consumptive use of polar bears have increased. These activities, which have included the construction of permanent or temporary facilities, the use of large all-terrain vehicles for ground excursions, and the use of fixed- and rotary-wing aircraft for aerial tours are resulting in an increase in human/bear interactions and the encroachment of people into what was unexploited and prime polar bear habitat. In addition to the threat to human life from increased human/bear interactions, such activities could have an adverse impact upon the bears and their habitat either directly, because bears are harassed or even killed in self-defense, or indirectly, because of displacement from primary habitat or abandonment of traditional denning sites.

The PBTC agreed that this non-consumptive use was valid and acceptable, and could be extremely important economically, as it presently is in Churchill, Manitoba. The PBTC, after reviewing the situation in 1987, also determined these activities would soon reach the level to cause concern for polar bear habitat and ecology, and that no jurisdiction had guidelines or legislation to deal with the situation. Therefore, the PBTC recognized that non-consumptive use adds other dimensions to polar bear management, and raised the following issues to the PBAC by resolution in 1987:

1. Consumptive and non-consumptive users of polar bears could adversely affect each other. In management zones where both activities occur, there are presently no guidelines for solving conflicts.

2. Demand by non-consumptive users to see bears in their natural environment rather than at artificial feeding sites such as dumps is increasing. This is resulting in more distant excursions and proposals for facilities in important polar bear habitat. Again, no guidelines to handle these new activities have been developed.

3. Inadvertent or deliberate harassment of bears is increasing. The consequences of harassment are not known but could include human fatalities, more bear fatalities, or abandonment of important habitat areas.

Manitoba, as the jurisdiction with the most rapid expansion of non-consumptive polar bear tourism have prompted Manitoba to address some of the above issues. Concerns expressed by residents, tourists, the tour operators, and polar bear managers and researchers. By September 1988, Manitoba intends to implement a permit system for all commercial tourism operations using the

Cape Churchill Wildlife Management Area (where most of the activity takes place). The permit system will: require tour operators to keep their vehicles on designated routes; restrict access to prime polar bear staging areas; prohibit tour operators from placing food for feeding or holding polar bears; allow for limited, temporary overnight facilities at designated locations for extended tours. increase information, education, and enforcement efforts to ensure compliance.

Other measures Manitoba may consider include: regulating commercial aircraft excursions into the area, limiting the numbers of vehicles that can operate in the area each day, designating sites for temporary versus permanent overnight facilities, and a more intensive information and education program.

U. S. Marine Mammal Protection Act

There has been no change of position by Canada regarding a waiver application under the MMPA. The possibility of a waiver by individual zones is not being considered. The PBAC still wants all management zones of Canada to be considered together or not at all. Since the MMPA is a U.S. act, the PBAC feels that any applications for changes to the act should be made by Americans. The PBAC also felt that the problems created by the MMPA could be rectified within the U.S. during the reauthorization hearings scheduled for 1988. For Canada to take the initiative and apply for a waiver would risk attracting negative publicity for a small gain. Present Canadian regulations do not need to be changed to ensure sound conservation of the species as is required of Canada by the Polar Bear Agreement.

The NWT suggested caution regarding a proposal that polar bear hides be transportable to the U.S. on CITES permits. It was suggested that whalebone carvings and seal-skin products be considered first and then if there are no political problems, possibly consider polar bears. The PBAC concurred because of the potential for damaging progress made in the management of polar bears in Canada.

Manitoba Management Changes by Jurisdiction

The Manitoba Department of Natural Resources continued the annual Polar Bear Control Program during the fall in 1985, 1986, and 1987. This program, started in 1969, is directed at the Churchill townsite and surrounding accessible area. Its primary objective is to ensure the safety of people and the protection of property from damage by polar bears and its secondary objective is to ensure bears are not unnecessarily harassed or killed.

Three serious human/bear incidents in 1983 and 1984, including one human fatality in the Churchill townsite, combined with a declining resident population, a rapidly expanding tourism industry, and a better understanding of bear ecology, caused the Department to undertake a major review of the program. As a result, several revisions and additions were made to policy and procedures. These were implemented in 1985, and continued in the 1986 and 1987 programs. Some of the new procedures implemented included the removal of all bears from the Churchill area, including the dump (a favoured viewing area for the public), and their placement in cages within an indoor compound specifically constructed for this purpose; the permanent removal of specific bears with lengthy histories in the Churchill area; increased communication with local government officials; an annual questionnaire to Churchill residents to assist in program evaluation; and a re-vitalized public information/education program.

The 1985-87 programs have been mostly uneventful. An unusually high number of bears was handled in 1985 and an average number in 1986 and 1987. No serious human/bear interactions occurred within the Churchill townsite in the 3 years and, based on questionnaire responses, the majority of Churchill residents support the program. There was concern that aspects of the program, particularly the removal of bears from the dump, could have a negative impact on the tourism industry, but there is no evidence to date to support this. Perhaps the most unfortunate aspect of the revised procedures was the permanent removal of four adult females for which long-term reproductive histories had been established. Although these bears never caused problems, their cubs were responsible for problems in later years. Program highlights for the 3 years are summarized in Table 3.

Newfoundland

When the village of Port Burwell closed several years ago, the quota of eight bears for that area was divided evenly between Quebec and Newfoundland. The hunting season in Labrador, Newfoundland has been closed since, but the quota of four was retained. In February 1988, the president of the Labrador Inuit Association met with the Newfoundland Minister of Culture, Recreation, and Youth to discuss reopening the polar bear hunting season along the Labrador coast. As a result, four licences were assigned for use by Inuit at Nain, Labrador between April 4 and May 31, 1988. No bears were taken. The hunt will probably become an annual event, though all the details have not been worked out. There is no intention to increase the quota and a change would not be considered in the future without the prior consultation and approval of the Technical and Administrative committees.

Northwest Territories

In 1985, administration of the last Yukon polar bear tag was given to NWT and was assigned to Inuvik. Within the COPE Land Claims settlement area, all the special red tags have now been converted to regular silver tags. This was requested by IGC as they felt they did not need artificial incentives to provide complete hunter kill information on polar bears.

Studies between 1981-1985 on northeast Baffin Island showed a declining population. In response, the communities involved agreed to take 42 fewer bears annually, although the quotas will remain the same.

Changes in zone boundaries were approved by the PBTC. The new boundaries represent the best judgements that could be made with the present data, and will be revised periodically when sufficient new information becomes available. There may still be some changes in opening dates or modifications of boundaries following further analyses of the data. Regulation changes reflecting the boundary modifications are proceeding. A general recommendation was made to the PBAC that the protection of family groups be addressed with information and education programs.

Sport hunts continued to be conducted in NWT villages in several zones. In 1984-85, 27 of 38 hunts were successful while in 1985-86, 35 of 39 were successful. In 1986-87, an outbreak of canine distemper in the sled dogs forced the cancellation of some hunts. Even so, the number of bears shot under the sport hunt program was 54 out of 74 tags assigned.

Polar Bear Management Plan - The NWT Department of Renewable Resources is in the process of developing a management plan for polar bears throughout the NWT. To the greatest degree possible, management will take place on a population basis. Because several of the populations are shared with one or more other jurisdictions, discussions will have to take place on joint management concerns and allocations of quotas.

Ontario

Management policies and allowable harvest limits remained unchanged. Ontario has strongly supported the adoption of guidelines for dividing the quota for shared populations of polar bears. A study to examine the economic viability of an Indian-guided sport hunt for polar bears recommended against such a program. Partly, this was because the hides are of poor quality in the fall when the bears are accessible. Ontario is looking into the possibility of developing non-consumptive viewing opportunities.

Quebec

There have been no official changes in management policies in Quebec. The hunt is not regulated by quota, but all signatories to the James Bay Agreement can hunt; they have agreed to restrictions listed in the 1985 Report to IUCN on Research on Polar Bears in Canada. The regulations seem to be known, and there is willingness to respect them. There will be no sport hunt on Akpatok Island.

No hides can be bought and tanned unless they have been sealed. However, an estimate of the number of bears killed, based on hides sent to tanneries, may be biassed low. Also, there is presently little information on date of kill or unusual circumstances, such as self-defence kills, but this is expected to improve. A recent program of visiting the villages and talking to hunters will probably give a more accurate estimate of the size of the harvest. An increasing number of skulls are being provided by hunters for age determination. Information on tag-returns is also improving.

A program for registering all polar bears killed by Quebec Inuit was organized during 1985-86 after representatives of the Ministere du Loisir, de la Chasse et de la Peche (MLCP) completed a tour of the most important villages of northern Quebec. The representative of the Inuit organization Anguvigak in each village agreed to collaborate with MLCP and to complete a form every time a bear is killed; secretaries of village councils will help with gathering the data. Samples from the bears (teeth, muscle, organs, etc.) are collected and shipped to the office in Kuujjuaq. Presently, the program is working much better than was initially expected. Stickers and information have been sent to cooperating hunters, and rewards of $20 for information on a kill, $5 for each tissue sample, $25 for ear tags or tattoos, and $40 for the skull or jaw are paid immediately, with good results.

Recently, a management plan was prepared for discussion with Inuk hunters. It points out, among other problems, the necessity of stopping the hunting of bears on island refugia used during the ice-free period, and a need to adjust Quebec hunting regulations, including the introduction of a quota, in cooperation with adjacent jurisdictions. This plan will be discussed further during 1988.

Anguvigak is also concerned with proper management of polar bears and all species. Following the 1984 agreement on four points for protecting polar bears, they would like to continue to census bears, working with the Quebec MLCP to set quotas or whatever is required to protect the population. Eight points were emphasized by Anguvigak: 1) June to August closure 2) females and cubs are protected (except for problem bears) 3) bears in dens are protected 4) bears 2-years-old or less are protected 5) bears are not to be sold without a permit 6) tags are to be issued by the local municipal government 7) there is to be no drugging 8) the rights of other communities to harvest bears are recognised. Consultations between communities and decisions are made at a general meeting held each year.

Makivik Corporation has had an ongoing study since 1977 on land use and ecology. Information on denning in northern Quebec, movements, behaviour, and ecology of various species are presently being entered on computer. The information should be available internally in 1988.

Yukon

In 1986, it was agreed that the sixth Yukon tag should be given to Inuvik and be administered by the Inuvialuit Game Council (IGC) and the NWT Department of Renewable Resources.

The Herschel Island Territorial Park was created by an Order-in-Council of the Government of Yukon in spring 1987. Wildlife will be managed through decisions made by the North Slope Wildlife Management Advisory Committee, as specified in the settlement of the claims of COPE. Inuit Park Warden trainees have been hired. An incinerator was installed in summer 1987, and a building incorporating the Park Office, interpretation centre and living accommodations is planned for summer 1988.

The Northern Yukon National Park Reserve was established, and wildlife there are also managed by the North Slope Wildlife Management Advisory Committee. The warehouse at Stokes Point was improved in 1987 and a small building with accommodations will be built in 1988. The main Park Headquarters will be 50 km inland on Sheep Creek. No other developments are planned.

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 which 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'). NWT prepared a summary on the status of polar bear populations in Canada for CITES in case it is needed. It will be kept in draft form until all comments have been received. Before it could be considered to represent the country, it would be put before the PBTC and PBAC.

Since July 1975, 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. Data for 1975-83 were included in the management reports prepared for the previous two IUCN meetings. The 1984, 1985, and 1986 data are summarized in Table 4. In those years, most of the exported hides were again destined for Japan.

In 1985, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) requested an opinion from the PBTC of the status of present polar bear populations. The classifications used by COSEWIC are 'rare' - at the limit of natural distribution, relatively uncommon through time, or susceptible to a crash; 'threatened' - in jeopardy, because of man (similar to Appendix II of CITES); 'endangered' - in great jeopardy, and may not recover without conservation efforts; and 'Not in any Category (NIAC)' - a sufficient number that there is no problem at this time. Some species such as woodland caribou (*Rangifer tarandus caribou*), which are classified as rare, are still being taken, as are polar bears. If the polar bear is approved as 'threatened', COSEWIC will want thoughts and comments from the PBTC regarding the present active promotion of a polar bear hunt. Ian Stirling, (Can. Wildl. Service) wrote the COSEWIC draft; he did not think any of 'rare', 'threatened', or 'endangered' were appropriate, and since 'vulnerable' (the classification used by the Red Data Book) is not available, he opted for 'NIAC'. Although the categories should perhaps be redefined in terms of specific functions in the future, the PBTC thought it was best to reach a consensus and give their opinion to COSEWIC rather than let the decision be made for them. Also, there is pressure from the public to have a category for polar bears. The consensus of both the PBTC and PBAC was that NIAC is the best category at this time.

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Table 1. Summary of regulations covering polar bear management in Canada as of 31 August 1988.

Category	Jurisdiction		
	Manitoba	Newfoundland	Northwest Territories
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; 01 Oct. to 31 May for 4 tags in Lake Harbour; 01 Dec. to 31 May all others.
Who can hunt	Treaty Indians for own use, but sale of hide prohibited	Inuit only during season	Inuit residents and non- residents with Wildlife Certificate if HTA provides necessary tag
Quota	total quota of 50, 15 of which are presently 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)
Females and cubs protected	no	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
Bears in den protected	no	yes	yes
Proof of origin of untanned bear	seal proposed	documented proof (no seal implemented to date)	seal on hide and export permit
Export permit required and cost (out of province or territory of origin)	required - no cost	required - $5.00	required - $1.00
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		

Table 1. continued

Category	Jurisdiction		
	Manitoba	Newfoundland	Northwest Territories
Scientific Licences	discretion of Minister	discretion of Minister	discretion of Director of Wildlife Management, Department of Renewable Resources
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
Basis of Regulation	Wildlife Act 1970	Wildlife Act 1970 - classified as big game	Wildlife Ordinance and Regulations; 1960 Order-in-Council (Endangered Species)
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
Taxidermy	$5.00 Wildlife Act Licence	legislation in preparation; legal if obtained legally elsewhere	$25.00 Taxidermist Licence
Tanner's Authority	$10.00 licence	no legislation at present	$25.00 Tanner's Licence
Live Animals—Capture	Ministerial permit	illegal unless authorized by permit from Minister for scientific purposes	$5.00 licence to capture live wildlife
Live Animals—Export	Ministerial permit	Wildlife Export Permit	Wildlife Export Permit - $100.00 - $5000.00 licence to export live wildlife

Table 1. continued

Category	Jurisdiction		
	Ontario	Quebec	Yukon
Hunting	closed	none	01 Oct. to 31 May in GMZ1 only
Who can hunt	permissible kill by Treaty Indians	Inuit and Indians	Inuit only who are issued polar bear tags
Quota	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	no	no	yes
Bears in den protected	no	no	yes
Proof of origin of untanned bear	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 - 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 District Manager	discretion of Minister	discretion of Conservation Officer (Wildlife Research Permit)
Selling of hide by hunter	must be sealed by Ministry staff	$15.00 Royalty fee - must be sealed	permit required from Conservation Officer
Basis of Regulation	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	- $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	see Tanner's Authority	see Tanner's Authority	$25.00 Resident Licence - $30.00 Non-resident Licence
Tanner's Authority	Game and Fish Act ($28.00 licence)	$150.00 Tanner's Licence	$2.00 Resident,- $10.00 Non-resident
Live Animals—Capture	District Manager	Ministerial permit free	Wildlife Research Permit,- $5.00 fee for capture of live wildlife
Live Animals—Export	District Manager	Ministerial permit	Special permit

Table 2. Quotas[1] and known numbers of polar bears killed in Canada, 1984-85, 1985-86 and 1986-87.

	Man[2]	Nflnd	NWT[2]	Norway	Ontario	Quebec	Yukon[2]	Total
1984-85 Quota	35	4	611	5[4]	30[3]	*	0	685
Bears killed[5]	22	0	578	0	21	24	0	645
Bears captured and held in zoos	3	0	0	0	0	0	0	3
1985-86 Quota	35	4	611	5	30	*	0	685
Bears killed[5]	7	0	554	0	22	49	0	632
Bears captured and held in zoos	9	0	0	0	0	0	0	9
1986-87 Quota	35	4	611	5	30	*	0	685
Bears killed[5]	12	0	535	0	16	37	0	600
Bears captured and held in zoos	5	0	0	0	0	2	0	7
1987-88 Quota	35	4	611	5	30	*		

[1] Management year extends from 1 July to 30 June the following year. Numbers may change as more information is received from the villages.
[2] The entire quota of 6 in the Yukon and 15 of the Manitoba quota of 50 are administered by NWT; any kills under these quotas are included in the NWT total.
[3] Permissible kill.
[4] Allowed to Norway for protection of life under the Agreement on the Conservation of Polar Bears (1973).
[5] Includes quota and sport-hunt kills, problem kills, illegal kills, bears found dead, and bears that die while being handled by scientists.
* The allowable kill has not yet been set.

Table 3. Manitoba Polar Bear Control Program 1985-87.

	1985	1986	1987
Program duration	Aug.15-Nov. 28	Aug. 26-Nov. 15	Aug 16-Nov. 25
No. of occurrences	74	75	86
No. of bears captured	76	26	30
No. of bears killed			
-by Department personnel	1	5	3
-by public sector	0	0	0
No. of bears to zoos	9	5	0
Program staff man-days	760	476	510

Table 4. Number of permits issued for polar bears, polar bear hides, and polar bear parts to be legally exported from Canada, 1 January 1984 to 31 December 1986 (from McLean and Robillard 1985 and 1986 and Heppes et al.1987).

	1984	1985	1986	Total
Live polar bears[1]	5	12	7	24
Polar bear hides[2]	245	185	336	766
Skulls/jaws	2	2	1	5
Pieces of fur	6	2	2	10
Larynx	1	0	0	1
Claws	0	18	0	18
Tissue specimens	0	0	101	101

[1] for zoos
[2] includes some hides with skulls and some as whole mounts

Research on Polar Bears in Canada 1985-87

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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. 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 1985 and 1987.

Cooperative Studies

Coordination of Data Bases and Access to Information

Since the PBTC was first formed, there has been a "gentlemen's agreement" on the sharing of data. All jurisdictions have access to data for management purposes, with the permission of the jurisdiction that collected them. Data are also shared for other research and publication needs with written permission from the person or agency that collected the data.

Presently, all of the CWS, Manitoba, and Ontario records and all but the most recent kill records from the NWT and Quebec are maintained by CWS on a mainframe computer at the University of Alberta. NWT maintains an abbreviated copy in Yellowknife. Updated tape copies of the data files are supplied for use on the NWT computer system. Jurisdictions which do not have tape-reading facilities can receive a printout.

Usually, when a bear is recaptured or killed in a jurisdiction different from the original capture location, the recapture information and a tooth or one slide for aging are sent to the first jurisdiction so their collection will be complete. Jaws and kill-return forms from Quebec are sent to Yellowknife for ageing and computer entry. Mark-recapture and hunter kill data from the NWT are entered into the computer as they are collected.

Population Modelling

Research on mathematical models to simulate polar bear population dynamics has continued each year since the last meeting of the IUCN group. Efforts have continued in several areas.

The ANURSUS model continues to be developed by M. Taylor (NWT). ANURSUS is a set of programs that: 1) estimates various life history parameters based on age-specific data from the harvest and from mark-recapture studies, 2) estimates population size based on mark-recapture data, and 3) projects population trends based on estimates of life history parameters, population size, and kill data. The fundamental difference in this modelling approach is that the reproductive interval is a function of the number of females available to breed, litter production, survival of cubs, and litter size. The projection model is not fixed at a specific length as in most population projection models. Papers on ANURSUS were published in the recent IBA proceedings.

A detailed examination of the ANURSUS results from analysis of the Beaufort Sea data indicated a potential problem in the ANURSUS approach: the program calculates estimates of vital rates from actual counts of the sex, age, and maternal status of females observed during the mark-recapture programs. If the data are collected predominantly during "bad" years when survival and recruitment are relatively poor, the final estimate of survival and recruitment are lower than the mean for the years sampled. Conversely, should the sampling be mainly in "good" years, the estimates will be too high. These difficulties are being addressed by expressing the annual observations of sex, age, and maternal status as proportions rather than actual counts.

During a modelling workshop in February 1988, the working group concurred that the lack of reliable information on age-specific survival and recruitment rates made simulation of several subpopulations unreliable for setting quotas on populations of polar bears. At that point, the working group decided to discontinue discussing the population parameters on a zone-by-zone basis. An alternative approach to setting quotas for zones was proposed that is based on the sustainable take of adult (i.e., non-cub) females from a population (Taylor et al. 1987), the sex ratio of the harvest, and an estimate of population size:

Quota = (population est.)(0.015)/(prop. females in harvest)

For example, for a population of 1000 animals, and a proportion of females in the harvest of 0.33, the quota would be 4.5% of the population, or 45 animals. On average, 15 of those harvested would be female bears. This represents a harvest of 15 bears from a female population of 500, or 3%. This approach has the advantage of being easy to understand and explain, uses the reliable data on harvest and relatively reliable data on population size, and assumes that most bear populations are similar enough in their life histories so that a sustainable yield estimate of female bears is robust across populations. It is assumed, in using this approach, that the proportion of females in the harvest is relatively constant from year to year, and that as long as the quota is not reached, the number of female bears taken will be less than the estimated sustainable yield. It is clear from this approach that reliable estimates of population size must be available. Where this is not the case, the group suggested using minimum estimates of population size, so that the quota would be conservative.

DeMaster reviewed a population model, referred to as the truncated geometric model, that he wrote for use during the workshop. The model is based on a recent paper by Eberhardt (1985). Data on the average survival of adult females, average reproductive rate of adult females, recruitment (the probability of surviving from birth or the first census to the census following the age of sexual maturity), and maximum age are used to estimate the discrete rate of increase for the population. Harvest rates were non-selectively incorporated into the adult survival rate and rate of recruitment. Reproductive rates (R) were estimated as:

$$R = \frac{(\text{Litter Size} \times \text{Sex Ratio at Birth} \times \text{Adult Survival})}{(\text{Mean Reproductive Interval})}$$

It is necessary to assume in using this equation that the census interval is from spring to spring. For simulations where the census was assumed to occur in the fall, adult survival is replaced by the product of adult survival and the survival rate of cubs-of-the-year (COYs) from birth to the fall. Better data on recruitment are still needed for both the ANURSUS and the truncated geometric model.

It was noted that the truncated geometric model cannot take into account any compensatory or other density-dependent effects, which might be expected if the population was initially near maximal levels and subsequently harvested. Furthermore, this model cannot explicitly handle age-specific harvest rates or birth rates. On the other hand, the ANURSUS model can incorporate density-dependent functions and age-specific birth rates. Therefore, because birth rates and harvest rates are age- and sex-specific, differences in estimated rates of increase between the two models are to be expected. However, because of the degree to which adult survival influences the dynamics of population simulations for long-lived animals, and because of the lack of information on density-dependent effects and age-specific survival rates for the adult age classes, the models were expected to produce comparable estimates of the growth rate of a population.

Concerning the potential for compensatory mortality in polar bear populations, the working group had no information on the status of any population relative to maximum levels and no information on the functional relationship between any of the life history parameters or the growth rate and density. Therefore, it was agreed that a conservative approach of not accounting for a compensatory response was merited at this time. In addition, the comment was made that in some areas the management goal is to maximize the size of the population and not net production.

Manitoba developed a simple menu-driven model named POLARPOP for wildlife managers to forecast the population dynamics of polar bears given data on recruitment and mortality. It does not incorporate a 3-year cycle of cub production. Managers in Manitoba, NWT, Yukon, and Ontario used this model to analyse their population data.

Another model, developed for the Michigan Department of Natural Resources to simulate black bear populations was modified by NWT to simulate brown and polar bear populations with 2 or more years between cub production. It allows for projections that include any combination of harvest, density effects, and random variability. If a harvest is chosen, the model simulates a selective harvest and records changes in the distribution of the harvest as the sex ratio changes. This allows one to explore how the sex and age of the harvest will vary for sustainable and non-sustainable harvests. Although the model is designed as an expert system, it is user-friendly and the results can be viewed graphically, stored as a file, or examined as a table.

Other polar bear population modelling efforts include those of Nils Oritsland and Karl Ugland of Norway. All existing models underscore the importance of adult female survival to estimates of population status, and the sensitivity of sustainable harvest to the fraction of the harvest that is adult females. The PBTC supports continued comparisons of the different modelling approaches as a research tool.

Research on New Immobilizing Drugs

Telazol was used by CWS biologists to immobilize 347 bears in 1985-86 with no mortalities. A paper reviewing CWS data from about 500 bears drugged under winter, summer, and fall conditions is being prepared. Lars Knutsen worked with CWS in Manitoba in the summer and fall of 1985, comparing the effects of Telazol and Ketamine-Rompun for an M.Sc. thesis at the University of Oslo.

Telazol is now listed in Canada as a narcotic because it contains tiletamine, so a separate permit for import and use will be required by the Bureau of Dangerous Drugs.

Tetracycline Marking

If a sufficient quantity of tetracycline is administered to a mammal, a permanent mark deposited in a cementum annulus of each tooth will be visible under UV light. If dose can be standardized, and an inexpensive method of injection developed, then many more bears could be marked for a mark-recapture estimate of population size. In 1986, NWT Renewable Resources designed a study, using a range of dosage levels, to inject tetracycline into polar bears in the Churchill area. About 50 of these bears were recaptured and a premolar tooth extracted to determine the required dosage to achieve a reliable mark. Dr. Ulysses Seal, University of Minnesota, participated in the field work, and helped plan the project. CWS and Manitoba contributed to this work by inoculating polar bears that were immobilized as part of their deterrent and research programs. Ontario provided technical training in the reading techniques with fluorescent light, and the use of their facilities at the Ministry of Natural Resources laboratory in Maple, Ontario.

Funding was insufficient for NWT to complete testing of the tetracycline marking procedure in 1987. Preliminary investigations indicated that 15 mg/kg was sufficient to leave a permanent mark in the teeth if the tetracycline was administered into muscle. Injections which did not penetrate the fat layer appeared to remain encysted in the fat.

During fall 1987, CWS injected selected polar bears with tetracycline at 15 mg/kg and they and Manitoba collected teeth from captured bears that had been given tetracycline in 1986. NWT also received teeth from tetracycline-marked bears harvested in Ontario. These teeth will be examined in 1988 when the required microscopy equipment has been obtained.

A 50-calibre dart rifle for administering the large volumes of 200 mg/ml tetracycline hydrochloride to large males was field tested. The dart uses vinegar and bicarbonate of soda for injection rather than an explosive charge so the 15 ml volume is pushed in rather than explosively forced in. The needle has no barb and the liquid is expelled out of the side of the needle rather then the end. When tested by NWT, contents of the dart were injected in about 2 seconds and the dart fell out a few minutes later. Darts that did not penetrate through the fat layer into the muscle bounced out on impact. Additional testing with Pneu-Dart disposable darts indicated that the disposable darts were reliable and accurate, although limited to 7 ml volume. Darts with gel collars and gel barbs failed to stay in the bears when they fired. A light wire-barbed dart worked reliably, and could be removed with a slow steady pull.

Collection of Blood Samples

In 1985, in conjunction with the University of Saskatchewan, NWTWS conducted a serological screening of blood for a variety of infectious diseases, including toxoplasmosis, chlamydiosis, hepatitis A, enteroviruses, adenoviruses, brucellosis, leptospirosis and trichinosis. Blood from approximately 300 bears captured over the last several years in the NWT and Manitoba by NWTWS and CWS was used. Preliminary results show positive indications of brucellosis, trichinosis, adenovirus, chlamydiosis and toxoplasmosis.

Toxicology and Monitoring of Pollutant Levels in Polar Bear Tissue

Ross Norstrom of the Canadian Wildlife Service Research Centre, Ottawa, has recently completed a comprehensive survey of chlorinated hydrocarbon contaminants (CHCs) and heavy metals in polar bears throughout their range in the NWT. Samples of fat and liver were taken by Inuk hunters in 1982-84 and analysed to identify and quantify CHCs accumulating in the bears. A wide range of contaminants was identified, some not previously reported in the Arctic. The most significant finding was technical chlordane, a highly-toxic pesticide. The types of contaminants were the same in all areas, in spite of a wide difference in origins of the water. Levels were generally inversely correlated to latitude. CHCs are clearly being transported to the Arctic from mid-latitudes by air currents. Distribution of the more water-soluble alpha-hexachlorocyclo-hexane (HCH) was affected by runoff from land. A study on the accumulation of CHCs in the Arctic cod - ringed seal - polar bear food chain has also been completed.

Reanalysis of polar bear fat samples from the CWS specimen bank showed that 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 data base. Following the completion of this work, it was obvious that potentially toxic chemicals were more widespread than originally anticipated. In the fall of 1985 the NWT Department of Renewable Resources, in conjunction with CWS and DFO began a NWT-wide collection of ringed seal liver and blubber to begin to examine the PCB levels in native foods in the NWT. A major collection of a larger number of human wild food items and human milk and blood was started at Broughton Island in September 1985. Results of both studies are available. CWS continues to maintain a tissue bank and NWT and CWS continue to assist with the collection of specimens for these studies.

In 1989-90, Norstrom would like to examine samples from all the Canadian jurisdictions, the U.S.A., Greenland, Norway, and the U.S.S.R. in an international survey of CHCs in polar bears.

Fur Trade and Harvest Record

In the late 1970s, P. Smith (CWS) compiled a series of progress reports on the harvest of polar bears in Canada. She kept track of statistics on harvest quotas and numbers, where the hides were sold, and their value to the hunters and the fur marketing agencies. I. Stirling (CWS) felt those records were a good sum-

mary of the value of the trade in polar bear hides, of fluctuations in the market, and of the value and economic benefits to the Inuit of the polar bear hunts. In addition, having these statistics available helps polar bear researchers quantify the value of the resource and hence the importance of continuing research on population ecology to address management needs. It is very important to quantify the economic significance of polar bear hunting to native people. CWS and NWT are presently compiling the more recent records.

Polar Bear - Human Interactions

Parks Canada, Prairie Region, and the NWT Department of Renewable Resources, Yellowknife, let a contract to the University of Calgary. Assistance was also provided by CWS, Yukon Fish and Wildlife Branch, Manitoba Department of Renewable Resources, and Alaskan researchers. The following is based on the abstract of a report by Susan Fleck and Stephen Herrero.

This study asks why polar bear - human conflicts occur and how such conflicts can be reduced. The recommendations apply to anyone attempting to protect people living, travelling, or working in the Arctic from polar bears and to reduce the number of polar bears killed because of conflicts with humans. A thorough search of records covering a 20-year period in the NWT and Manitoba revealed records of only 19 persons who were injured or killed by polar bears; 353 interactions which did not result in human injury were documented. During these interactions, at least 230 polar bears were killed. A typical polar bear - human interaction in the NWT occurred between 0000 and 0600 when people were asleep or within a shelter. More conflicts without human injury occur during the ice-free months at Inuit hunting camps when bears are attracted by animal carcasses or camp odours. However, most interactions that resulted in human injury occurred at industrial exploration camps during the winter season. In Manitoba, a typical polar bear - human interaction occurred in Churchill when there was no ice on Hudson Bay. The rate of interaction increased as polar bear and human density increased. The results support the hypothesis that predaceous attacks by polar bears on humans have occurred. Overall, all attacks by male polar bears but only one by a subadult female polar bear appeared to be predatory. In contrast, productive female polar bears appeared to attack humans to protect their cubs. Such attacks were rare. The potential for polar bear - human conflicts in northern parks is compared to black and/or grizzly bear - human conflicts in Canadian and American national parks. Recommendations to avoid conflicts focus on five areas - alertness, avoidance, attractants, detection, and deterrents. Responses of humans should vary in relation to the type of behaviour displayed by a polar bear.

Population Research in Hudson Bay and Foxe Basin

Southern Hudson Bay (Ontario)

The overall goal of the polar bear program in Ontario is to provide sustained, optimal cultural, social, and economic benefits to the people of Ontario through the management and protection of polar bears. The goal of the management policy is to manage polar bears to maintain the present population level as the minimum acceptable. The province will accomplish these objectives through its own research and management strategies and in cooperation with adjacent jurisdictions.

From 1985 through 1987, Ontario continued a series of studies on polar bears that spend the summer on the Ontario coast and then return to Hudson Bay to hunt seals during the winter. That pattern of seasonal movement is followed by all bears except pregnant females who continue inland to den, reproduce, and then return to the sea ice the following spring.

Spring productivity surveys to monitor the number of females with young emerging from inland dens were conducted from 1985 to 1987. The estimated number of family groups ranged from 23 in 1985 to 68 in 1986. The estimated number of cubs produced varied from 43 in 1985 to 129 in 1986. During the 4-year period from 1984 to 1987, an estimated 100 cubs were produced annually. That was an increase of 41% over the estimated annual production recorded from 1974 to 1978. Although total cub production was higher in the 1980s than in the 1970s, average litter size declined from 2.0 to 1.6. Possible reasons for the decline may be an overall increase in the polar bear population and/or a greater number of younger or very old females reproducing. Studies have shown that those two age categories may have smaller litters than prime age females.

A. Late Summer - Early Fall Tagging

A live-capture and tagging study started in 1984 was continued in 1985 and 1986. The objectives of the study were to determine the size, discreteness, and seasonal distribution of the polar bear population inhabiting southern Hudson Bay. Techniques included eartagging, back marking, and radio telemetry.

During the 3-year field study, 457 different bears were handled 536 times. The sex ratio of total individual bears captured was 53 males : 47 females. The mean ages were 6.9 years and 5.8 years for captured males and females respectively. Differences were significant. The oldest male captured was 22 and the oldest female 21. The mean annual survival as indicated by the Chapman-Robson curve was 0.89 for males and 0.85 for females. The natality rate for females aged 5-20 was 0.860. Most females produced their first litters at age 5 or 6. In one instance, a 5-year-old was accompanied by a single yearling. Thirty-eight percent (n=53) of yearlings captured were alone. The presence of solitary yearlings suggests the occurrence of a two-year breeding cycle. A

2-year breeding cycle was documented for 40% of the females in western Hudson Bay by M. Ramsay (CWS), but is rare in polar bear populations further north. There was no evidence of reproductive senescence in our sample as four of six females 19 years or older were accompanied by young. Litter sizes ranged from one to three and averaged 1.6 for both spring and summer. Weights of solitary females considered to be pregnant according to progesterone level in blood serum were heavier than those in the non-pregnant group.

Based on three different models, the polar bear population in southern Hudson Bay in 1985 and 1986 was about 700 and appeared to be stable.

Mean late summer weights of polar bears ranged from 77 kg for female COYs to over 520 kg for adult males. Most sex and age classes of bears were lighter in 1985 than in 1984 or 1986. The heaviest male weighed 654 kg. Adult males were 65% heavier than adult females. Males aged 18 years or older were lighter than those aged 12-17.

Female polar bears attained ultimate body size earlier than males. For females, ultimate growth for front foot width and skull length occurred at age 3, and for body length, neck circumference, chest girth, weight and skull width, at age 4. For males, ultimate growth for front foot width and chest girth occurred at age 5, and for skull length, body length and neck circumference at age 6. Skull width continued to increase until age 7 and weight until age 12.

During the 3 years, 84 radio-collar transmitters were placed on adult females; 27 solar eartag transmitters were placed on adult and subadult males and one 2-year-old female in 1986. The maximum period of known transmission was 29 months for a radio collar and 7 months for a solar eartag. During October, bears were concentrated along the coastal region waiting for the ice to form. By the third week in November, tagged bears were out on the sea ice, but distances from shore (x=125 km) were only about half as great as they were later in the winter. From December to April, all bears, except pregnant females, were out on the sea ice at distances of 24-568 km. Mean monthly distances from the coast varied from 250-280 km. Over a period of two years, one adult female utilized an elliptical-shaped area 480 x 260 km and a second adult female a similar-shaped area 373 x 214 km. These would be minimum areas because of lengthy time intervals between some locations.

Between 1984 and 1987, 34 bears tagged by Ontario were killed: 68% by NWT hunters, 21% by Ontario hunters and 12% by Quebec hunters. The finding that most bears are taken by NWT hunters accentuates the need for close cooperation among jurisdictions when establishing harvest quotas.

B. Fall Aerial Surveys

Annual fall aerial surveys to monitor the numbers and distribution of polar bears along Ontario's coast continued. The 1987 survey was the 25th consecutive one. Numbers in 1985 and 1986 were similar to the long-term average of 105, whereas the number in 1987 was slightly below the long-term value. One reason for the lower value was the apparent disappearance of many family groups from the coastal area during the September survey. During a goose reconnaissance flight in late July, family groups were quite numerous along the coast, but apparently had dispersed inland by the early September flight. A similar pattern of movement appears to occur every year, but in 1987, the proportion moving inland seemed greater than usual. It is speculated that females with young vacate the coast to avoid potential conflicts with adult males that utilize the coastal strip as their summer retreat.

C. Future Research

It appears unlikely that there will be any funds for field research in the immediate future. Telemetry flights will probably end after March 1988 because of low location success. Annual fall aerial surveys and collection of skulls will continue. Spring productivity surveys are not planned for 1988 and will probably not resume until about 1991. That schedule is based on the earlier format of surveying for 2 consecutive years at 5-year intervals.

To examine the problem of changes in distribution and numbers along the coast, the Moosonee district office would like to conduct aerial surveys at 2-week intervals from mid July to mid September. The probability of that happening is contingent upon availability of funds and priority of other district projects.

Western Hudson Bay (CWS)

A. Distribution and Abundance of Polar Bears inWestern Hudson Bay

Derocher has completed his M.Sc. study. The following is adapted from the abstract of his thesis on the distribution and abundance of polar bears during the ice-free period in western Hudson Bay.

The distribution and movement patterns of polar bears during the ice-free period in western Hudson Bay were studied from a total of 2242 locations of animals of known age and sex, collected between 1966 and 1985. Annual patterns of segregation by age, sex, and reproductive status were found. Aspects of learning, intraspecific aggression, habitat selection, foraging, energetic constraints, and physiological parameters were considered to be important to observed patterns.

The high degree of reported philopatry apparently is the result of learned behaviour, winter distributions of sea ice habitat and seals, and the noncompetitive conditions during the ice-free period that make dispersal of limited benefit. An energy conservation strategy was apparent in movement patterns although many bears moved substantial distances to return to specific sites. The direction of movement of some animals indicated a significant ability to orient.

Polar bears on the study area were not uniformly distributed. Some adult males formed aggregations on coastal islands and prominent points, composed of larger individuals than were found alone; possible evidence of a dominance hierarchy based on size. Age and weight were not highly correlated with distribution or movement patterns and were only a factor during some time periods.

In autumn 1985, a Petersen mark and recapture estimate of the population between the Churchill and Nelson rivers yielded an estimate of 685 bears, with 95% confidence limits of 513 and 945. The assumptions of the Petersen method were met or approximated. A population of 773 bears, with 95% confidence limits of 535 and 933, was estimated from strip transect data using Kelker's method. An estimated 103 family groups (SE=24) were present during the fall. The number of COYs was estimated at 111 and compared well with the estimated productivity of a population of 700 bears, based on population parameters. Both the Petersen method and the strip transect technique performed well and produced lower coefficients of variation than multi-year population estimates from other areas.

Derocher is beginning a Ph.D. study of mortality patterns in polar bears. His research will be concentrated in Western Hudson Bay and the Western Arctic.

During late winter 1985, it was possible to fly a single survey over Hudson Bay to determine the winter distribution of some of the polar bears that were radioed in 1984. Using a Cessna 337, the area from the Manitoba-Ontario border north to Rankin Inlet and up to 250 km from the coast was surveyed. Nine radios were located on the sea ice. The bears were found to the northeast, east and southeast of Cape Churchill at an average distance of 117 km (SD=50 km).

In anticipation of obtaining funding to conduct a detailed study of age- and sex-specific survival of subadults, and aspects of condition and age of females in relation to production and survival of cubs, CWS conducted a brief program in 1986 in the area south of Churchill to maintain continuity in the mark—recapture studies. Field work was based at Nestor-1 and Lee Lake. Of 119 polar bears caught, 69 (58%) were recaptures. If the 16 COYs, which could not have been caught before, are excluded, then 67% were recaptures. There appeared to be a substantial proportion of pregnant females occupying dens in the southern portion of the denning area. The bears were in quite good condition. Of the 119 bears, only three had been captured or recaptured near the Manitoba-Ontario border. Preliminary training in immobilization of polar bears with Telazol was provided to the Manitoba Department of Renewable Resources Conservation Officer Rick Tease.

During 1987, field work on the ecology of polar bears in the area between the mouth of the Churchill and Nelson rivers was conducted during two field seasons: a spring session designed to sample families leaving the denning area and a fall session aimed at all segments of the population. The objectives of the study included:

1. the determination of the survival rates and factors affecting survival in the population for each age and sex class,

2. investigation of the fidelity of cubs to their natal area as reproducing adults,

3. investigation of annual productivity of the population, and

4. an analysis of the population dynamics and trend of the Churchill population.

B. Reproductive Biology

Malcolm Ramsay completed his Ph.D. thesis at the University of Alberta, "The Reproductive Biology of the Polar Bear: a Large, Solitary Carnivorous Mammal". Much of the thesis is now published or in press.

Foxe Basin (NWTWS)

The Foxe Basin polar bear program was conducted from 17 August to 10 November 1985. To distribute tagging effort, a new base camp was used for 35 hours of flying in the Wager Bay area. Of 48 bears observed in the area, only 11 could be caught and none had been previously tagged. Most bears were seen in the coastal areas on the south shore of Wager Bay. Tagging then centered on Southampton Island from mid-September to mid-November, covering most of the island in 90 hours of flying. Of the 57 bears handled, 42 were males and 15 were females. Eight females had cubs - four with COY, four with yearlings. Three of the 57 were first caught in 1984. Large concentrations of single bears were found in the Bell Peninsula and Cape Low areas, while in the northeast and west coastal areas, concentrations were lower.

Most of the major islands and coastline of Foxe Basin were surveyed by helicopter during September and October 1986. Most of the polar bears observed were seen in the southwestern part of Foxe Basin, particularly Southampton Island and Wager Bay. Twenty-nine radio collars were deployed.

In 1987, the Foxe Basin project had four objectives: (i) to determine which population of polar bears the northern and eastern Foxe basin communities are harvesting in spring; (ii) to deploy 30 radio collars in the summer concentration areas on Southampton Island and Wager Bay; (iii) to continue monitoring radio-collared bears to document distribution; (iv) to field-test the drug-delivery system for the tetracycline tagging.

Tagging operations were carried out in April and September 1987. The spring survey covered the coastal and nearshore areas of Foxe Basin except for the eastern islands and coastline. The fall survey concentrated on the coastal areas of Wager Bay and Southampton Island where polar bears concentrate. Bears were classified by sex and age.

In April, the density of polar bears was low in both Hudson Strait and northern Foxe Basin. Nine radio transmitters were placed on adult females in April 1987. In total, 34 bears were seen or handled in these areas. In the Gulf of Boothia, polar bear density appeared extremely high; this area is believed to be outside Foxe Basin, so polar bears were not captured there.

September field work was restricted to the coastal areas of Roes Welcome Sound, Wager Bay, Coats Island, and Southampton Island. Thirty-one radio collars were deployed in these areas. Bear densities in Wager Bay were high: males were found on islands in coastal areas whereas females with cubs were in high-relief areas on the south shore. The density of family groups on the northeast coast of Southampton Island was high relative to that of males and subadults. A survey of the coastline between Wager Bay and Repulse Bay, Vansittart Island and White Island revealed low bear densities. In total, 144 bears were seen or handled in September.

The 57 radios deployed in both 1986 and 1987 (at least 35 still transmitting) will be followed throughout 1988. Telemetry surveys should identify the primary winter and spring habitat of the Foxe basin polar bears. In 1987, three radio-tracking surveys were conducted throughout the Foxe Basin in January, May, and December.

There are two preliminary conclusions:

1. Spring surveys have indicated a boundary in spring for the Foxe Basin population at the northern and eastern extremities of Foxe Basin. All of the Cape Dorset harvest may come from the Foxe Basin population; all of the Hall Beach and Igloolik harvest taken east of Fury and Hecla Strait may come from the Foxe Basin population. The Igloolik and Hall Beach harvest taken west of Fury and Hecla Strait may be considered to be from the Gulf of Boothia population.

2. Wager Bay and Southampton Island form the core denning and summer retreat areas for the Foxe Basin population. Helicopter surveys and radio-tracking results indicate that in winter and spring, Foxe Basin polar bears occupy the southeastern and south-central portion of Foxe Basin, the southern coast of Hudson Strait, and Hudson Bay.

The primary objectives for the remainder of the Foxe Basin project are (i) to continue to document winter and spring distribution by radio-tracking collared bears during four surveys in 1988; and (ii) to derive a population estimate for Foxe Basin polar bears using mark-recapture methods. This second objective will require another year of testing the tetracycline methodology. In 1989, field work will attempt to mark a large sample of polar bears with tetracycline. The first population estimate can be expected in 1990.

Northern Quebec

In 1985, the Quebec polar bear project concentrated on recording all tag returns from kills, and collecting jaw specimens for ageing as a first priority. An extensive public relations effort, partly aided by NWT Renewable Resources personnel, was concentrated mainly in the villages. Quebec hopes to get a precise estimate of the harvest, the ages of the killed bears, and the extent of tag returns. Estimated costs of this program in 1985 were $20,000 CDN, mostly for travel to the communities.

The data collection program in each community is coordinated with Anguvigak out of Kuujjuaq. The objectives of the program are: 1) set up a registry to record age, sex, and location of all kills in each community, 2) cooperate with other jurisdictions to study populations, especially movements, 3) estimate populations with mark-recapture or genetic studies.

Aerial census and harvest statistics are used to monitor the population, as there are no funds for mark-recapture work. A survey in September 1986 using three observers in a DC-3 counted 52 bears on six islands from Hudson Strait to Twin Islands. With corrections for missed bears, the total count was estimated at 58 bears. Few bears were on the beaches; most were inland in pits. The only COYs seen were 9 that were observed on Twin Islands.

The aerial survey of six summer island retreats was repeated in 1987. Significantly more bears were seen in 1987 than in 1986. The difference was mainly attributed to increased sightings on Mansel and Akpatok Islands. Only one COY was observed on Twin Islands in comparison with nine the year before. An internal report is available (Crete and Vandal 1988).

NOGAP-funded Studies in the Western Arctic

From 1985 through 1987, the population of polar bears in the eastern Beaufort Sea was studied by CWS with assistance from NWT and Yukon. This project was funded by the Northern Oil and Gas Action Program.

The study area for this project is the Beaufort Sea east of 141° W and south of 75° N, and Amundsen Gulf. The objectives were to determine the present population size of polar bears in the study area, and their vital statistics, and then compare these results with data collected in the 1970s and evaluate the effects of offshore hydrocarbon exploration and production on polar bears. From 1985 through 1987, 608 polar bears were captured. No deaths were caused by the drugging and handling procedures. Preliminary examination of movement data continues to indicate a separation of the polar bear population along the mainland coast from that on the west coast of Banks Island and Amundsen Gulf.

The average ages of males and females 1 year of age or greater were 7.36 ± 0.33 (SE) and 7.57 ± 0.38 (SE). Of the 290 males and 318 females handled, 73 (25.2%) and 86 (27.0%) were

≥10 years of age. The mean litter size of COYs caught between 1985 and 1987 was 1.84 ± 0.16 (SE). Natality rates of adult females (6-31 years old) fluctuated between 0.296 in 1986 and 0.519 in 1985. Differences in productivity appeared to be related to changes in ice conditions. These variations were similar to those recorded in the mid 1970s. Estimates of sex-specific annual survivorship, calculated from the combined 1985-1987 age structure, ranged from 87.5% to 88.5% when calculated by the Chapman and Robson method. Survival rates calculated from the age structure of a capture sample already include harvest mortality. Thus, the natural survival of some age and sex classes may be as much as 5% higher. Population estimates for the whole of the study area ranged between 1300 and 2100 polar bears, depending on the method used. These values are similar to estimates made in the mid 1970s. A large portion of Amundsen Gulf, and part of the northern coast of Banks Island were not completely surveyed in some years. Overall, size and reproductive parameters of the population from 1985 through 1987 were similar to what they were in the mid 1970s. The present harvest is probably at maximum sustained yield.

The possible ways in which offshore development might affect polar bears are discussed. No negative effects of development or increased hunting pressure were detected. Maternity denning appears to be increasing along the mainland coast.

CWS and NWT also assisted U. S. Fish and Wildlife Service to put extra radio collars on adult females and to track them in the Beaufort Sea. Data analysis and report writing for these studies will be done by USFWS.

Single Agency Research

Canadian Wildlife Service

The long-term goal of the CWS with respect to polar bears is to ensure the conservation and management of viable populations throughout the Canadian range of this species, consistent with the public interest as well as the interests of those who rely on harvesting this resource on a sustained yield basis. This is done by conducting management-oriented research on the population dynamics, movements and size of polar bear populations; baseline and monitoring studies of polar bear populations and their ecological requirements; and process-oriented research on polar bear populations, their habitat and the consequences of different management options. CWS coordinates the storage and retrieval of polar bear research data, and the planning of interjurisdictional studies among the Federal Government, the Provincial and Territorial agencies, and other national agencies.

CWS has also taken a role in education and the development of field competence whenever possible. Besides a program of graduate student research, CWS has provided training in the techniques for handling and studying bears and other marine mammals to biologists from Norway, Denmark, and Alaska, as well as several other Canadian jurisdictions. Similar assistance has been provided in laboratory methods.

Ecological Interrelationships

The ecological relationships among polar bears, seals, sea ice conditions, and polynyas are being studied. Since 1985, the major efforts have concentrated on field observation studies of the activities of polar bears and pinnipeds around the Dundas polynya in the early spring, evaluating the correlation between vocalizations and behaviour of walruses at the Dundas Island polynya and the interspecific relationships between polar bears and walruses.

The biological importance of polynyas to overwintering populations will be evaluated by studying winter and early spring distribution and abundance in and out of polynya areas. Some analyses of the environmental impact of offshore developments on polar bears have been undertaken.

Studies of the influence on polar bears of ice conditions, of seal distribution and abundance, and of polynyas are of particular interest. Behavioural observations on polar bears have yielded data on habitat utilization, hunting efficiency of different age and sex classes, effect of harassment, man/bear conflicts, bear interactions, movements, and time budgets to facilitate a deeper understanding of the management and impact assessment studies. A greater amount of CWS time and effort will be spent in this general area in future years.

Polynyas and Walruses

In April and May 1986 and February to May 1987 and 1988, studies were conducted on the behaviour of walruses at the Dundas Polynya, north of Resolute. The work includes a long-term component of looking at the biological importance of polynyas to marine mammals including polar bears.

In all 3 years, good series of under-ice walrus vocalizations were recorded and data collected on walrus and bear behaviour. Analyses of these data are continuing and preliminary results have been published. This work is now the body of a Ph.D. study by Becky Sjare.

Condition in Polar and Black Bears

Marc Cattet has finished his M.Sc. studies. The following is from his thesis:

Thirty-eight black bears and 43 polar bears were dissected to determine the most statistically-reliable equations for predicting total body weight (TBW) and non-fat body weight (NFBW). Physical condition was evaluated by calculating a fat-to-non-fat ratio, equalling (TBW-NFBW)/NFBW. This ratio was independent of body size, and thus comparable between sex and age classes.

Measurements of marrow and intramuscular lipid, and morphometric measurements that can be obtained in the field, were evaluated as indicators of physical condition. TBW and NFBW were predicted by multiple regression equations using various combinations of measured variables. The neutral lipid content of marrow or muscle was not a reliable indicator of physical condition.

The fat-to-non-fat ratio is best applied in intraspecific comparisons of groups of black or polar bears. Comparisons among individual bears require the development of more accurate techniques.

Anatomical and chemical investigations on five black bears and six polar bears were conducted to determine (1) distribution of neutral lipid by tissue; (2) relationships between physical condition indices and whole-body lipid content; and (3) relationships between lipid and energy content on a tissue and whole body basis.

Adipose tissue was the major lipid storage tissue for both species. However, the lipid content of most tissues was significantly related to whole body lipid content. Polar bears accumulated adipose tissue lipid in a positive allometric pattern while black bears did so isometrically. This may reflect greater emphasis on long-term lipid storage in polar bears relative to black bears.

Among physical condition indices, the fat-to-non-fat ratio was the best indicator of whole body lipid content; percentage lipid in marrow or muscle did not show significant relationships with whole body lipid content.

Lipid and energy content were significantly related in all tissues and the whole body of both species, although the relationship was strongest in adipose tissue. Approximately 60% of the whole body gross energy of black and polar bears could be accounted for by the energy content of all neutral lipids in the body; lipid in adipose tissue contained most of this energy.

Ringed Seal Distribution in Open Water

From August to October 1986, studies were conducted on offshore concentrations of ringed seals in the Beaufort Sea. The study has two aspects: patterns of aggregation in four species of marine mammals in the Beaufort Sea during the open water period; and comparison of ringed seal distribution with oceanographic features. Aerial surveys of seal distribution in the open water were conducted and the location of concentrations of bowhead whales and ringed seals identified. These were tied to ship-board oceanographic measurements that were taken at the same time.

Patterns of aggregation in ringed seals, bearded seals, bowhead whales, and white whales during August-September 1982, 1984, 1985, and 1986 at four different scales were examined and compared. The following summary is the M.Sc. thesis of Lois Harwood.

In 3 of 4 years, dense aggregations of ringed seals were observed in both nearshore and offshore (50-80 km) waters, but the number of aggregations and their locations varied. Observed seal behaviour, and the presence and behaviour of sea birds, feeding bowhead whales, and bearded seals within or near the ringed seal aggregations suggest feeding is a major activity therein. In 1986, three areas of seal aggregation were found, and mean cell densities were 1.67-1.75 ringed seals/km^2 surveyed. Together these areas accounted for 9.5% of the surveyed area and 54% of the on-transect sightings. Ringed seal density in remaining areas considered overall was 0.14/km^2 surveyed. The results may be useful in determining areas of overwintering concentrations of ringed seals and hence, important feeding areas for polar bears. Additional data on offshore concentrations from past years of bowhead whale surveys are being extracted from old data bases.

Age determination

Wendy Calvert and Malcolm Ramsay have been working on a detailed evaluation of the accuracy of our present techniques of age determination. The results indicate the technique is quite accurate if the sectioning and reading are done carefully.

Manitoba

Manitoba assisted CWS research efforts in western Hudson Bay through the provision of staff, facilities, and support. Assistance was also provided to NWT for specific research programs.

Newfoundland

There has been no active research in Newfoundland.

Northwest Territories

Northeast Baffin Island, Clyde River - Broughton Island

In 1981, a population study began in the northeast Baffin Island area. By 1984, indications were that the population could not sustain the current harvest.

Discussions with the Broughton Island and Clyde River Hunters' and Trappers' Associations (HTAs) on quota reduction and management options took place during 1984 and 1985. These discussions resulted in a Letter of Understanding being signed between the HTAs and the Department of Renewable Resources in which the HTAs agreed to reduce their polar bear harvest effective July 1985 from 45 to 15 in Clyde River and 22 to 10 in Broughton Island. They also agreed to totally protect family groups of all ages and to take most problem bears off the quota. The Department of Renewable Resources agreed to provide extra assistance to the HTAs to offset hunters' loss of revenue, and to conduct a "complete review of the polar bear status" after 6.5 years from the date of signing the agreement. This represents the first time in the NWT that a reduction of polar bear harvest has taken place in a cooperative manner for management purposes.

Marking Dyes

Although the need to mark polar bears as a part of deterrent and research programs is recognized, marked animals are sometimes harvested by NWT hunters. When the hides are marked with a permanent dye the value of the pelt is reduced. Until recently, NWT compensated the hunter for the loss of value no matter who marked the bear. NWT has now ceased marking bears with permanent dyes and will no longer pay for the marks put on by other programs. In 1984, a resolution was adopted that specified each jurisdiction would be responsible for compensating hunters who suffered financial loss due to spoiled pelts resulting from research activities. This was reaffirmed at the 1987 PBTC meeting, with the exception that hunters killing bears marked during the Manitoba Polar Bear Control Program will still be compensated by the NWT.

Research is continuing into dyes that will not fade during the field season, but can be removed if required. Dye testing was conducted by NWT in Rankin Inlet during the summer of 1985. Squares of raw polar bear hides were used in the testing. Nineteen dyes from seven different products were used (Loving Care, Nice'N Easy, Wella Colour Charm, H. Kohnstamm and Co. Ko-Print Ink, H. Kohnstamm and Co. Fine Colors, Raidex and Nyanzol). Of the seven products tested, four (Loving Care, Raidex, H. Kohnstamm and Co. Ko-Print Ink, and H. Kohnstamm and Co. Fine Colors) either washed out completely or faded after the initial salt water rinse on all three treatments (dry, damp, wet). The other three products (Nice'N Easy, Nyanzol, and Wella Color Charm) did not run or fade throughout any phase of the testing.

The company that had originally agreed to tan the hides and strip the mark was not willing to do so once the samples were ready to be shipped. Other tanners in Ottawa, Winnipeg, Calgary and Edmonton were contacted, but none were willing to take on this project.

Most recently, a paint used for paint ball combat games has been tested for durability and permanence by Dr. Ulysses Seal at University of Minnesota. Tests on hide swatches indicated that the oil-based paint could be removed from the fur with solvents that would not damage the pelt. The projected longevity of the mark on the fur was 6 months. NWT hopes to field test the paint in 1988.

Detection and Deterrent Research

In 1985, workshops sponsored by the NWT bear deterrent program were held to train people to more effectively prevent and handle bear problems. The program covered several aspects of detection, deterrence, and education. Workshops held in Yellowknife for 1-, 2-, and 4-day sessions were designed for groups ranging from occasional visitors through to instructors. Thebacha College in Fort Smith now gives 2-day workshops to students in their Renewable Resources program, while Renewable Resource Officers throughout the territories give workshops in their jurisdictions. A short workshop was also given to sport-hunting guides at a guide training course at Courageous Lake. A course for class "B" outfitters was given in spring 1988. Instructors' workshops have been held in Whitehorse and Winnipeg.

The "Safety in Bear Country" Reference Manual was available for distribution in August 1985. More than 1000 manuals have now been sent throughout North America, and some to Europe. The manual, along with an instructor's guide is being used for the instructors' workshop. Everyone receiving a manual is placed on a computerized distribution list and as the manual is updated, revisions will be sent out. The manual has been distributed at no charge; however, in the future, people or agencies not involved in past support of the program may be charged $10.00 per manual. Reviews and comments on the manual have been very favourable.

Two booklets to inform the the general public about safety precautions around bears, "Safety in Polar Bear Country" and "Safety in Black and Grizzly Bear Country" were produced by the Conservation Education Section, NWT Department of Renewable Resources, and became available for distribution during the summer of 1986.

A Problem Bear Site Operations Plan was developed to be included in the "Safety in Bear Country" manual. Each plan addresses bear problems at a specific site and outlines who is responsible and how problems can be prevented and effectively handled. Renewable Resource Officers are trained to complete and implement site-specific plans with community or industry representatives for sites throughout the Northwest Territories.

Tests of deterrents for bears were conducted at Norman Wells, NWT in August 1985 and at Cape Churchill, Manitoba in October and November 1985 and 1986. Tests were done using the Bear Thumper developed by Butler (a large 25 mm slug), 12-ga. Ferret slugs and Cart-a-balls, two electric fence designs, and various sound frequencies. The Bear Thumper and Ferret slug were successful in deterring polar bears from the study site. The 12 ga. plastic slugs were successful in deterring 12 of 12 bears from the bait site in 1986. Three different cracker shells (Banger, Screamer, and Whistler) fired from an adapted starter pistol were successful in deterring only 15 of 19 bears. The Screamer was the most successful, since the noise it makes is more intimidating. The electric fence was successful in deterring two of six bears. The Cart-a-ball was not accurate enough to be considered effective. However, when hit with the Cart-a-ball bears were deterred. The sound frequencies were not effective in deterring bears. The flashlight siren was also ineffective.

A Symposium on Bear - People Conflicts held 6-10 April 1987 in Yellowknife was well attended. Proceedings of the symposium will be published.

Bear deterrence continues to be a matter of serious concern in NWT. There is no longer a full-time deterrent biologist. Plans are underway to evaluate the previous program, continue implementation at the operational level, and increase awareness.

Infra-red Camera Testing in the Beaufort Sea

In May 1985, CompuHeat Services was contracted to test an infra-red camera for censusing polar and grizzly bears. The work was conducted out of Tuktoyaktuk. During the testing, several problems became evident. The major problem with the infra-red camera is the narrow survey swath. Even when using two cameras the survey swath would be too narrow for any practical use. Another problem during testing was hot spots that appeared on the screen but were not bears. It is doubtful that the bears on which the camera was tested could have been located without being seen first. Polar bears appeared quite faint on the screen in comparison to seals or grizzly bears. When grizzly bears were located in areas of complete snow coverage the camera clearly detected the bears, however, visual observers can easily locate the same bears under similar conditions.

If further testing of the infra-red camera is considered, the problems of narrow survey swath and hot spots should be addressed. This camera may prove helpful in locating polar bears along narrow areas such as lead edges, for darting and tagging, but it is doubtful that it can be an effective survey tool yet.

A forward-looking infra-red (FLIR) scanner unit is being tested by DFO Winnipeg for locating ringed seal birth lairs, but it does not seem very useful for surveying polar bears.

Analysis of Age Distribution

Dr. Scott Carley, UBC, has been contracted by NWT to determine what information can be extracted from capture and harvest sex and age distributions. He will examine traditional analysis methods and explore new approaches developed for theoretical demography.

Quebec

Studies of Genetic Variation

A study of genetic variability was begun in 1985-86 in an attempt to distinguish polar bear populations frequenting the Quebec coast and hunted by the Quebec Inuit. Using 20-25 kidney, liver, and muscle samples from bears killed by Inuk hunters in Ungava or Hudson Bay, plus some from the Western Arctic and western Hudson Bay, Chesser at the University of Texas analysed the samples for polymorphic loci, distribution of enzymes, etc. After examining around 20 loci, no polymorphic sites were detected and it was concluded that the technique was inappropriate for polar bears. Trace elements present in bear bones may now be used in an effort to discriminate populations.

Yukon

Education and Awareness Program Development

The booklet catalogue "Polar Bear Awareness Aids Available in North America" has been compiled by Barney Smith. It will be updated annually to reduce duplication of effort among agencies. This information is available to teachers, librarians, or anyone interested in sources of material on polar bears. Generally, there are sufficient high-quality aids and the public profile of the species is very high. Two aids, however, are required, and progress on them has been limited. One involves effective curriculum materials at the high school level, such as a simple simulation model that would be suitable for small classroom computers. This would allow students to learn of population impacts resulting from harvest composition patterns, oil spills, localized overharvest and maternity den disturbance. The development of an interactive polar bear management model for use in high schools has been delayed pending a review of Project Wild and similar curriculum materials available for fostering greater conservation awareness in school children.

A second awareness aid is required to address the impacts of oil spills and management strategies. A public brochure on polar bear management concerns in the event of an oil spill has been cancelled.

The PBTC agreed that continued high priority should be placed on communication of population status to the public at large, taking advantage of the high degree of interest by television companies. A continuation of the present cooperative, open approach to groups with conservation concerns was recommended. Willingness of PBTC members to accommodate photojournalists continues to result in high-quality television documentaries that help keep the species in high profile.

From a management orientation, the diversity of uses of polar bears should be emphasized to a greater extent to the public as well as to Hunters' and Trappers' Associations (HTAs). HTAs specifically should be provided with information on pelt marketing, pelt care, viewing opportunities and sport harvest. Progressive management efforts at the community level should receive a higher profile, to serve as examples to other communities. At the individual hunter level, sex and size selective hunting methods and their relationship to sustained yield management need to be continually emphasized. NWT's efforts here in their 'comic book' format will be a valuable asset.

Researchers continue to recognize the need to standardize their work. The use of video cameras in the field was suggested to aid in discussions of drug responses, and to standardize quantitative and qualitative measures.

Institute of Arctic Ecophysiology, Churchill

No experiments have been conducted in the last 3 years, but the work is starting again and there have been some new publications. A computer has been purchased to aid in the modelling of starvation studies. The IAEP also has cooperative studies with Laurentian University and the University of Manitoba; two credit and three non-credit courses are offered and there are presently two graduate students working on whales at the Institute. The facilities include nine cages, a treadmill, metabolic equipment, and simulated denning. Paul Watts presented the results of a study

on tour operations at the Yellowknife symposium. Watts may start working in Churchill on only a seasonal basis within the next few years, but the administrative framework of IAEP will remain intact.

Department of Fisheries and Oceans

While employed with DFO in Winnipeg, Ramsay collected samples of fat, muscle, and bone of polar bears and ringed seals for a study of C-isotopes that may indicate terrestrial versus marine origins of polar bear food. First analyses were done in April 1987.

University of Saskatchewan

M. Ramsay is now an Assistant Professor of biology with the University of Saskatchewan. He has several projects planned, mainly on physiological aspects of polar bear ecology, but they are dependent on adequate funding and students. Funding has been approved by the U.S. National Science Foundation (Washington) for M. Ramsay, R. Nelson, and I. Stirling to study the dynamics of feeding, fat deposition, and fat utilization. Field work will begin in Churchill fall 1988. Ramsay will have a Ph.D. student involved in this project as well.

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(Photo by Ray Schweinsburg)

Polar Bear Research and Management in Greenland 1985-1988.

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Research Activities in Greenland

Study Area and Methods

Tissue samples (liver, kidney and muscle) of 37 polar bears collected from the Greenland harvest in the period 1983-1987 were analyzed for contents of various heavy metals (Zn, Cd, Se and Hg). Analyses were done as a part of Greenland Environment Research Institute's research on heavy metal contamination in the marine environment.

Variation in non-metrical traits in polar bear skulls sampled in Greenland and adjacent areas were recorded by Poul Henrichsen (Zoological Museum Copenhagen). The purpose of this work was to explore whether there is geographical variation in non-metrical traits of polar bear and whether such variation might be helpful in determining stock discreteness.

Diaphragm muscle tissue was collected from 21 polar bears harvested by Inuit at Ittoqqortoormiit (Scoresbysund, E. Greenland). These samples were analyzed, using digestion techniques, for *Trichinella spiralis* at the State Veterinary Serum Laboratory (Copenhagen) and at the Greenland Fisheries Research Institute.

A summary of current knowledge of the occurrence of polar bears in eastern Greenland and adjacent seas was prepared for the Greenland Environment Research Institute. This document, based on a literature survey including published and unpublished sources, was prepared by Danbiu ApS. (Biological Consultants, Hellerup).

In January 1988 the Department for Wildlife Management, Greenland Home Rule, initiated a 3-year research program with the purpose of providing details of the polar bear harvest in Greenland. The studies, coordinated by E.W. Born (Greenland Home Rule Denmark Office), consist of two elements:

a) Over 3000 questionnaires were distributed to informants in Greenland. The questionnaires request that hunters and fishermen in Greenland provide detailed information on hunting methods, locations, and numbers and sex and age categories of bears killed in order to provide detailed information on the Greenland polar bear harvest. This work is being done in cooperation with the Greenland Fishermen's and Hunter's Organization (KNAPK) in Nuuk (Godthaab). In the questionnaires the above information is requested together with miscellaneous other information such as observations of denning sites. Completed forms should be returned by the end of 1988. The study continues until 1990. During this period personnel of the Greenland Home Rule Government also will visit various areas of Greenland to gather additional information on the polar bear harvest.

b) Biological samples from the subsistence harvest of polar bears in Greenland are also being collected. In Avanersuaq (Thule), Upernavik, Tasiilaq (Ammassalik) and Ittoqqortoormiit (Scoresbysund) (See Fig. 1 for locations of places named in this report), hunters are payed to collect the lower first premolar, blubber and muscle samples, kidneys, liver, diaphragm and reproductive organs from killed polar bears. They are also requested to fill in data sheets with details of the kill and to take measurements of body length and girth. The purpose of this study is to obtain detailed information on the age and sex composition of the catch as well as information on biological parameters such as body growth and sexual maturity. Samples may be analyzed for variation in mitochondrial DNA to elucidate the occurrence in Greenland of different subpopulations.

Samples of trachea, lung tissue and bladder from eight polar bears killed in the spring of 1988 in Avanersuaq (Thule) were examined to determine whether polar bears had served as vector for the propagation of canine distemper across northern Baffin Bay from Canada to northwestern Greenland. These studies were conducted by M. Blixencrone-Møller and E. Lund (Inst. for Virology and Immunology, State Agricultural University, Copenhagen) and J. Bohm (Hospital of Thule, Greenland)

Results

Analyses of contents of heavy metals in polar bear tissues were completed this spring and findings are being prepared for publication. Preliminary results were presented in Danish and Greenlandic in Dietz (1987). Mean cadmium (Cd) concentrations (mg per kg fresh tissue) were: kidney, 14.6 (n = 21); liver, 0.628 (n = 15); muscle, 0.152 (n = 13). Mercury (Hg) concentrations (mg per kg fresh tissue) were: kidney, 13.2 (n = 19); liver, 6.01 (n = 19); muscle, 0.112 (n = 13). Ages of the individuals were not stated in this article.

A summary of the preliminary results of the studies of non-metrical traits in polar bear skulls was presented at the last PBSG meeting (Henrichsen and Sjovold 1986). Henrichsen (unpubl. data) has continued non-metrical analyses. Based upon examinations of 25 skulls from bears killed recently, Henrichsen (unpubl. data) concluded that the non-metrical traits he has examined are not temporally variable, and are thus valuable for spatial comparisons even when specimens available were collected at different times. Henrichsen has developed a computer program with which to examine similarities and differences in non-metrical traits. Details regarding this program, which is compiled in Turbo Pascal can be obtained directly from Henrichsen, at the Zoological Museum in Copenhagen.

Eight (38%) of 21 polar bears (ages 1-21 years) collected at Ittoqqortoormiit in 1983-1984 were infested with an average of 6.6 *Trichinella* larvae per g of diaphragm tissue (range: 1-15 larvae/g tissue). All infested bears were above 8 years of life (Henriksen and Born, upubl. data). More samples are currently being analyzed for contents of *Trichinella*.

Published and unpublished information on the occurrence of polar bears in the East Greenland area is summarized in Dietz et al. (1985). Polar bears occur year-round along the entire East Greenland coast where they are observed most frequently during spring and autumn. Information available from various sources indicates that in eastern Greenland, polar bear dens may be found in most areas north of Kangerlussuaq (approx. 68° N) but the Blosseville coast between Kangerlussuaq and the entrance to Scoresby Sound appears to be a particularly important denning area.

Results are not yet available from studies conducted by the Greenland Home Rule. Completed questionnaires were to be returned by the end of 1988; biological samples are currently being collected.

Canine distemper virus antigen was demonstrated in dogs and Arctic foxes (*Alopex lagopus*) sampled in Avanersuaq during the spring of 1988. In Arctic foxes found dead, hemorrhagic faecal matter was observed but otherwise, no clinical disease apparently related to the outbreak of distemper has been observed in wildlife in the area. Reports received from the Inuit, however, indicated that during the period the abundance of Arctic foxes decreased markedly in the area. Infection of bears (Ursidae) with distemper virus has not been reported. Unfortunately, the failure to find evidence of distemper infection in the few bears sampled late in the epizootic in northwestern Greenland cannot be considered conclusive (Blixencrone-Møller, Bohm and Lund. In prep).

Future Research Needs in Northwest Greenland

The current research program described briefly in section 1.5 aims at providing up-dated and detailed information on the harvest of polar bears in Greenland. However, studies to determine the status and size of the populations harvested in northwestern Greenland and in the Tasiilaq area (southeastern Greenland), respectively, are also greatly needed. The rationale behind this statement and research needs are briefly outlined below.

Background

In the Avanersuaq and Upernavik areas hunting for polar bears is still a very important element of the traditional Inuit culture. Here most bear skins are used for traditional clothing and only very few are sold. The meat is used for human consumption. Official catch statistics indicate that since 1980 the annual take of polar bears has been approximately 30 animals in Avanersuaq and 10 in Upernavik. However, these figures are estimates that may not be accurate (Table 1). Neither the magnitude of the annual polar bear harvest in these areas nor the status of the exploited population(s) are accurately known.

The size of the polar bear population in northwestern Greenland is not known. Based on the supposition that the catch in these areas is sustained, Anonymous (1985:40) gave a subjective estimate of at least 300 animals for a presumed resident population ranging the Ellesmere Island, Jones Sound and the Avanersuaq (Thule) areas. A mark-recapture estimate of 2008 bears also was presented for the Canadian Zone F in 1980 (Anon. 1981:41). Using a similar technique Schweinsburg et al. (1982) derived an estimate of about 1000 polar bears for a more or less sedentary population in the Lancaster Sound region. Aerial surveys conducted in early May 1979 over the pack ice in northwestern Baffin Bay indicated the presence in these areas of about 1680 polar bears (Koski 1980). The offshore areas in northeastern Baffin Bay and Melville Bay have never been surveyed.

Bears tagged in the eastern Canadian High Arctic have been captured in both areas. Bears from the Canadian Management zone F which includes Ellesmere Island and Lancaster Sound do move into northwestern Greenland as suggested by Schweinsburg et al. (1982), and Stirling et al. (1984). Bears from the Canadian Management Zones D and G may also occur in northwestern Greenland. But, the magnitude of any influx from Canada is undetermined. A movement of bears in the opposite direction - from Greenland to Canada - has not been demonstrated although it most likely occurs. Of six polar bears which were tagged in northeastern Baffin Bay at the edge of the "Northwater" in the spring of 1978, only one has been recovered. It was killed in the general area of the release in 1981 (Vibe 1982).

The Inuit report that central Melville Bay, protected as the Melville Bay Nature Reserve after 1980, is a maternity denning area. This was a major reason for giving the area status as a reserve. However, the quantitative importance of this region as a denning area has not been determined.

In conclusion, the extent and nature of the exchange of polar bears between eastern High Arctic Canada and northwestern Greenland are undetermined, the size of the annual harvest of bears by the Inuit of Avanersuaq and Upernavik areas is not accurately known, the quantitative importance of the denning area

along the coasts of Melville Bay is unknown, and the spatial distribution and the abundance of bears in the pack ice in northeastern Baffin Bay at the edge of the Northwater are unknown. In order to provide information for sound management advice for the exploitation of bears in northwestern Greenland and adjacent areas studies need to be conducted in order to determine:

a) Range of population, population discreteness and level of interchange between Greenland and Canada—This would be accomplished mainly by tagging bears with VHF and satellite transmitters in the Melville Bay and the Humbolt Glacier areas and in eastern Ellesmere Island and subsequently monitoring their movements. Variation in mitochondrial DNA in samples taken from bears in Canada and in Greenland may also help assess population discreteness and movements.

b) Population size (sizes?) and distribution in northeastern Baffin Bay, Smith Sound, southern Kane Basin, and adjacent coastal areas—Springtime aerial surveys centered in Jones Sound (Grise Fjord) and Thule Air Base (NW Greenland) would be used to supplement population size estimates derived from mark-recapture estimates.

c) Extension and quantitative importance of the denning areas in Melville Bay, off Humboldt Glacier, and in eastern Ellesmere Island—Aerial surveys of denning areas at the time of emergence from the den would be conducted.

The suggested studies requiring several seasons of work in areas which are remote and very difficult to access will require international cooperative efforts. As the population(s) also ranges in Canada and is harvested there, a Greenlandic/Danish/Canadian joint study program is suggested. The possibility of participation in these studies by scientists from other nations is also suggested.

Future Research Needs in Southeast Greenland

The status of the polar bears occurring along the approximately 1000 km stretch of coast south of 69° N in southeastern Greenland is virtually unknown. For this and other reasons, detailed studies of polar bear populations in Southeast Greenland are just as necessary as they are in northwest Greenland.

Background

Traditionally polar bear hunting is an important element of the Inuit subsistence harvest in the municipality of Tasiilaq (Ammassalik) in southeastern Greenland. The hides are sold and/or used for clothing and the meat is used for human consumption. The greatest portion of the Greenland polar bear catch normally comes from this area. According to the Hunter's Lists of Game an average of 43 bears were harvested annually in these areas in the period 1980-1985. As stated earlier it is suspected that this figure represents a minimum estimate. The relatively high harvest which can be explained partly by the number of people living in the municipality (2524 in 1985) presumably also reflects the abundance of bears in the area. Polar bears are reported to occur in the district all year round with the peak hunting season in February-April when the majority of bears are reported to migrate northward along the shores and in the flaw zone between landfast ice and the pack ice in the Denmark Strait. An influx of bears coming from a very large region to the Tasiilaq (Ammassalik) area has been demonstrated. Bears which have been tagged off northeastern Greenland, at Svalbard, and northwest of Franz Josef Land have later been caught in Southeast and Southwest Greenland (Larsen 1986).

Vibe (1982) proposed that bears arriving in southeastern and southwestern Greenland inevitably will meet their "destiny" in these areas in what might be called an "ecological cul de sac". Being unable (according to the theory) to work their way against the southwards drifting ice current the bears are "trapped" in SE and SW Greenland and therefore ultimately are either shot or destined to die from starvation. According to his theory bears killed in SE and SW Greenland represent a surplus from the population ranging in the Svalbard-Franz Josef Land areas, while some bears might have begun their fatal journey further east. Bears can, however, move against strong ice drifts (Larsen 1986). Telemetry studies have demonstrated a connection between bears occurring off NE Greenland and in the Svalbard area and Larsen considered that bears in eastern Greenland and in the Svalbard-Franz Josef land region belong to one common population numbering between 3000 and 6700 bears (Larsen 1986). Conversely, recent studies of non-metrical cranial traits indicated that bears collected in SE and SW Greenland were different from those of NE Greenland and at Svalbard. Information obtained from hunters of Tasiilaq and Ittoqqortoormiit indicates that the majority of bears encountered in spring are moving north and that bears travel between the coast and the moving pack depending on the ice conditions. Some information obtained from the same sources indicates that the Blosseville coast is a denning area and that some bears can also den further south (Dietz et al. 1985).

Although there are clearly many hypotheses, some conclusions regarding the status of southeast Greenland polar bears are obvious: the size and composition of the polar bear harvest in eastern Greenland are very scarcely known; the spatial and seasonal occurrence and distribution of polar bears in Southeastern Greenland and in the Denmark Strait area are uncertain; the migration pattern(s) and range of polar bears occurring in southeastern Greenland are undetermined and the relationships between these bears and those occurring further north in Greenland and at Svalbard-Franz Josef Land remain undetermined; a better evaluation of the status of the polar bear population at Svalbard-Franz Josef Land, and how that population relates to bears in Greenland is necessary; the quantitative importance of the Greenland coast south of approximately 69° N for denning is undetermined.

In order to be able to evaluate the status of a polar bear population(s) occurring in southeastern Greenland and to provide advice for sound management of a population occurring here and in adjacent areas, the following studies should be initiated:

a) Determine the range of population, migration patterns and population discreteness in southeastern Greenland and Denmark Strait and level of interchange between eastern Greenland and Svalbard. Tagging of polar bears near shore and offshore (with ear tags as well as VHF and satellite telemetry). Helicopters should be based at Kulusuk in southeast Greenland and Hurry Inlet (east-central Greenland) (and northwest Iceland ?) in spring. Telemetry and tagging studies will be augmented with assessments of the variation in DNA in bears sampled at southeast and northeast Greenland and at Svalbard.

b) Aerial surveys and mark-recapture efforts will help determine spatial distribution and abundance of polar bears in the coastal areas of southeast Greenland and offshore, and the significance of coastal denning in the region south of 69° latitude.

These studies like those proposed for Northwest Greenland imply several seasons of field work in remote areas. Because the studies aim at elucidating the connection between the population component occurring in eastern Greenland and those of the Svalbard-Franz Josef Land region joint studies are suggested involving Greenland/Denmark, Norway, and other interested nations are recommended.

Management Information From Greenland

Methods

The main source of information about the take of polar bears in Greenland has been the Hunter's Lists of Game (HLG) where every hunter voluntarily reports his annual catch of various wildlife species. A summary of these reports was published each year between 1955 and 1985 by the Ministry for Greenland.

Results

The harvest of polar bears in Greenland, according to received HLGs for the period 1970-1985 is presented in Table 1. Harvest data for 1986-1988 are not available. Data are presented by region and area based on the current knowledge of distribution of polar bears in Greenland. Several amendments to the regulations governing harvest of polar bears in Greenland were enacted in 1988 and went into effect on 5 May (see Appendix). Regulations in effect prior to these amendments were presented by Vibe (1981).

In western Greenland, the catch near Avanersuaq (Thule) and Upernavik originates from the area of Melville Bay north to the Humboldt Glacier region. The harvest is presumably from a common population also ranging in the Ellesmere Island region although its range and identity is undetermined. In the central portions of western Greenland from the Uummannaq area south to Nuuk (Godthaab), the catch primarily consists of bears occurring at the eastern edge of the Baffin Bay - Davis Strait pack ice. Depending on the ice situation these animals presumably are stragglers from the above mentioned areas and/or from the eastern Baffin Island region. Between Nuuk and Paamiut (Frederikshaab) there is a hiatus in the ice distribution. Polar bears which are taken in southwestern Greenland arrive from eastern Greenland with the East Greenland pack ice often extending south of Kap Farvel in winter and spring. Therefore, although listed as takes from "West Greenland", this catch actually represents an East Greenland component.

In East Greenland, polar bears are taken by Inuit in the areas from Ittoqqortoormiit (Scoresbysund) south. Some of the bears reported from Ittoqqortoormiit (Scoresbysund) are apparently taken from a more or less sedentary population occurring north of the area while the majority is taken at the entrance to the Scoresby Sound and along the northernmost parts of Blosseville coast. Bears are reported by the Inuit to immigrate to these areas from offshore and from the south. There is little information available on the polar bear harvest in the Tasiilaq area (southeastern Greenland). Most bears are taken, in this region, during February-April when they are migrating northward along land and in the shear zone.

Discussion

Since 1984 the responsibility for the compilation and publication of the harvest data has been with the Greenland Home Rule in Nuuk. As a response to the decline since about 1974 in numbers of HLGs received from Greenland (Fig. 2), personnel from the Ministry for Greenland and later from the Greenland Home Rule administration has added to the reported catch a certain number to compensate for this underreporting. For 10 years, between 1974 and 1985 where estimated catches have been added, the estimates have averaged 24% of the total harvest officially reported for Greenland (Table 1).

The harvest between 1955 and 1985 as reported by the compilation of the HLG (estimates included) indicates a slight decline in the annual take of polar bears in Greenland over this 31-year period (Fig. 3). This trend is significant only if the "uncorrected" harvest data alone (estimates excluded) are considered (Fig. 4; $Y = -1.86x + 3762.81$; $r = 0.45$; $t = 2.677$; $P < 0.02$; $df = 29$). If decline in the number of HLGs returned is considered, however, a different trend is evident. A crude "index" of this trend can be established by dividing the numbers of catches reported annually in the HLG (Fig. 4) by the total number of HLGs received (Fig. 2)). If this index is graphed, a slight though non-significant increase in the polar bear harvest in Greenland over the period 1955-1983 is suggested (Fig. 5; $Y = 3.369E\text{-}4x - 0.626$; $r = 0.22$; $t = 1.196$; $P > 0.10$; $df = 28$).

According to the available sources (estimates included), the annual catch of polar bears in Greenland has fluctuated around a mean of 109 bears between 1955 and 1985 (28-182 bears/year). A peak in the years 1981-1983 (Figs. 3,4,5) was primarily caused by increased kills in eastern Greenland. A possible explanation for this peak was, harsh winters and heavy ice during those years. This possibly also explains why relatively many bears were taken in southwestern Greenland in 1982 and 1983.

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Appendix: Recent Amendments to Hunting Regulations in Greenland

An unofficial translation of the hunting regulations including the most recent amendments is presented below. The following provisions of the amended regulations are of special interest to the IUCN polar bear specialist group:

§ 2, sec. 1: According to this section, cubs up to 2 years of age and female bears with such cubs are now protected all year long in Greenland with the exception of the municipalities of Avanersuaq (Thule), Upernavik and Ittoqqortoormiit (Scoresbysund where it is permitted to kill cubs older than 12 months of age and female bears with such cubs. In these areas cubs younger than 12 months and females with such cubs are still protected all year round.

§ 2, sec. 3: This section allows for hunting single adult male bears all year around.

§ 3: This new regulation aims at reducing disturbance to denning bears.

§ 4, sec. 1: According to this amendment it is now no longer permitted to hunt polar bears from ships above 40 Gross Register Tons (GRT).

The intention of the amendments in § 2 ,sec.1 and in § 3 is to give increased protection to the reproductive elements of the population such as females with cubs and denning bears. It is now allowed to hunt single adult males all year round. The rationale behind this new regulation is that it has been claimed by hunters in Greenland that such bears have a detrimental influence on the entire population through predation on cubs and young polar bears. It no longer permitted to hunt polar bears from ships above 40 GRT. The purpose of this new amendment is to terminate the take of polar bears from large fishing vessels operating during spring close to or within the edge of the Baffin Bay - Davis Strait pack ice off the western coast of Greenland.

Polar Bear Hunting Regulations in Greenland (unofficial translation by E.W. Born)

Order No. 7 of 5 May 1988 concerning preservation of polar bears in Greenland. Greenland Home Rule.

§ 1. Hunting of polar bears (*Ursus maritimus*) must only be undertaken by persons permanently residing in Greenland with close connection to the Greenland society and who possess a valid licence issued by their home municipal council stating hunting as their primary occupation.

Sec. 2. Polar bear hunting must, however, not be undertaken by any person who is transported by, or is acting as paid attendant of, persons not fulfilling the conditions mentioned in section 1, above.

Sec. 3. A person fulfilling the condition stated in section 1 is allowed, however, to hunt polar bears if the one for whom he serves as a paid attendant is a government employee travelling in official business.

§ 2. Polar bear cubs up to two years of age and accompanying female bears are protected year round. In the municipalities of Avanersuaq (Thule), Upernavik and Ittoqqortoormiit (Scoresbysund) it is, however, allowed to hunt polar bear cubs older than 12 months of age and accompanying females apart from the periods of complete protection stated in section 2.

Sec. 2. Polar bears which are not included in section 1 are protected from 1 July through 31 August in all of Greenland; though from 1 August through 30 September in the municipality of Tasiilaq (Ammassalik).

Sec. 3. Adult, single polar bear males can be hunted all year round.

§ 3. It is illegal to disturb, including digging out, polar bears in dens.

§ 4. Airplanes, helicopters and motor-driven vehicles for transportation on ground, including snowmobiles, and ships exceeding 40 GRT must not be used for hunting polar bears or for transportation to and from the hunting ground.

Sec. 2. It is illegal to use poison, foothold traps, snares, or set guns.

Sec. 3. It is prohibited to use saloon (gallery) rifles, shot guns, and semi or fully automatic rifles for hunting polar bears.

§ 5. Immobilization and tagging of polar bears can only be done with a permission from the Greenland Home Rule.

§ 6. It is illegal to keep polar bears, including cubs, in captivity or to export polar bears from Greenland without permission from the Greenland Home Rule.

§ 7. It is prohibited to buy or accept meat, skin, and other parts of polar bears illegally killed.

§ 8. Any person violating the above mentioned provisions will be liable to a fine and, further the meat, skin, and other parts of any polar bear illegally killed or bought will be confiscated. Decision about the use of the confiscated parts is to be made by the Greenland Home Rule authorities. In case of any violation of the provisions contained in § 4, the means of transportation and the implements used may be confiscated.

Sec. 2. In case of violations of the provisions contained in §§ 1-2 and § 4, not only the individual hunter shall be held responsible but also the owner of the boat, sledge, or other equipment that has been used for hunting provided that he has taken part in the hunting trip or has been aware of the intention to use the equipment in question for illegal hunting.

§ 9. For scientific or other purposes, the Greenland Home Rule may grant exemption from the provisions contained in this Order.

§ 10. This Order is effective by 5 May 1988. As of the same date Order No. 10 of 19 March 1985 concerning preservation of polar bears in Greenland is rescinded.

Greenland Home Rule, 5 May 1988.
Aqqaluk Lynge / Dorthe Johannsen

(Photo by Steven C. Amstrup)

Table 1. Harvest of bears in Greenland, partitioned by region and by year. Numbers in parentheses indicate estimates of unreported harvests (see text for discussion).

	1970	1971	1972	1973	1974	1975	1976	1977
NW Greenland								
Avanersuaq (Thule)	15	2	.	.	2	2	7	.
Upernavik	4	1	1	3	2	4	12	5
C.W. Greenland								
(Uummannaq-Nuuk)	3	3	0	1	0	0	2	0
S. Greenland								
(Paamiut and south)	14	11	13	1	11	1	2	1
Total W. Greenland	36	17	14	5	15	7	23	6
Eastern Greenland								
Ittoqqortoormiit								
(Scoresby Sound)	45	39	24	40(10)	36(9)	26	64	40
Tasiilaq (Ammassalik)	55	40	47	37	53(21)	30	34	38
Total E. Greenland	100	79	71	77(10)	89(30)	56	98	78
Total Greenland	136	96	85	82(10)	104(30)	63	121	84

	1978	1979	1980	1981	1982	1983	1984	1985
NW Greenland								
Avanersuaq (Thule)	16(15)	21(20)	20(20)	32(10)	25	35	22(5)	25(25)
Upernavik	6	10		2	10	4	9	20(15)
C.W. Greenland								
(Uummannaq-Nuuk)	11	0	9	4	3	2	2	0
S. Greenland								
(Paamiut and south)	2	1	1	1	13	7	1	2(2)
Total W. Greenland	35(15)	32(20)	30(20)	39(10)	51	48	34(5)	47(42)
Ittoqqortoormiit								
(Scoresby Sound)	22	22(10)	41(10)	60(20)	52(20)	39(10)	33(15)	23(5)
Tasiilaq (Ammassalik)	28	16(10)	20	51	77(10)	50	47(5)	10(5)
Total E. Greenland	50	38(20)	61(10)	111(20)	129(30)	89	80(20)	33(10)
Total Greenland	85(15)	70(40)	91(30)	150(30)	180(30)	137(10)	114(25)	80(52)

Figure 1. Map of Greenland illustrating locations discussed in text and tables.

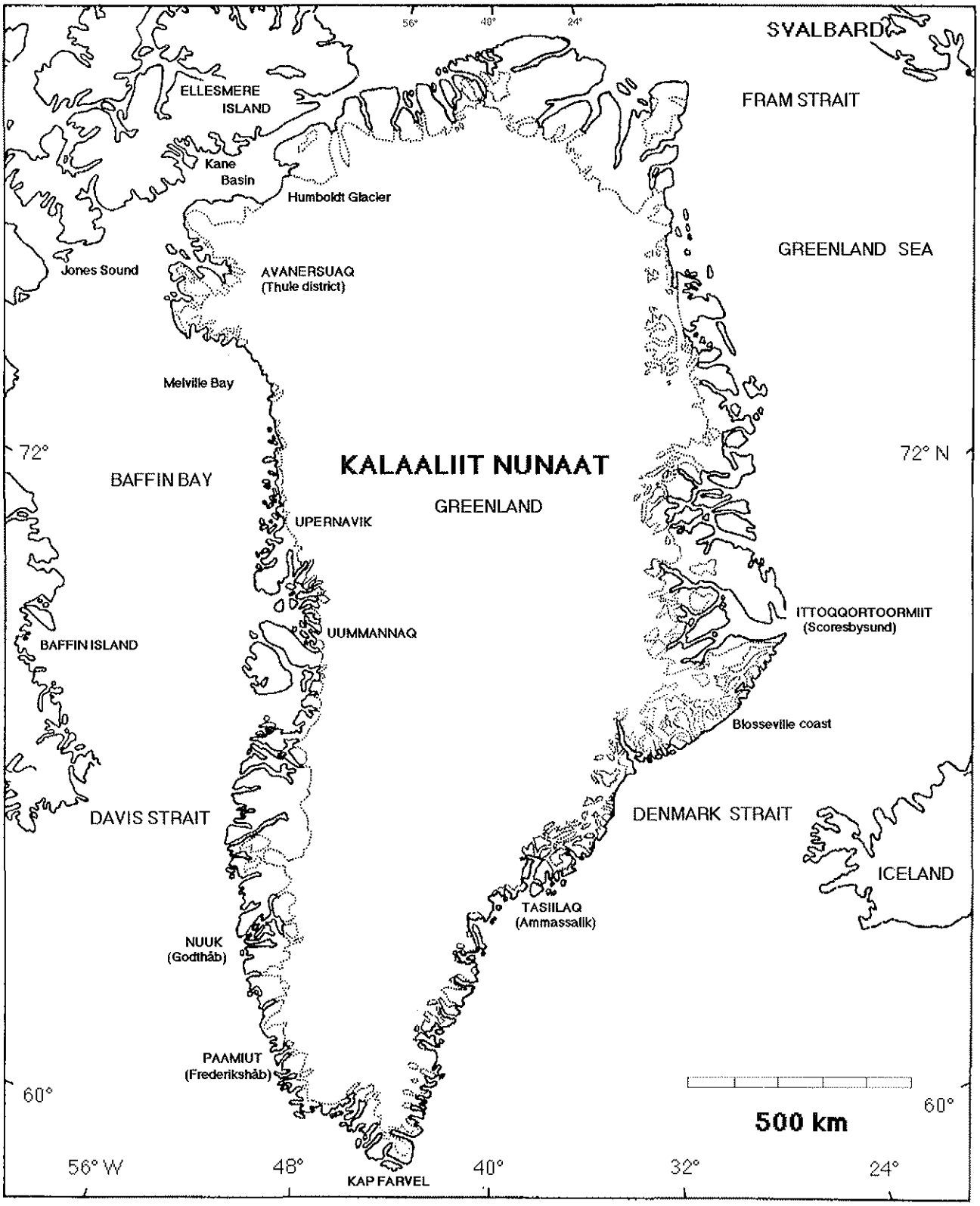


Figure 2. Number of lists of game received in Greenland, 1955-1983.

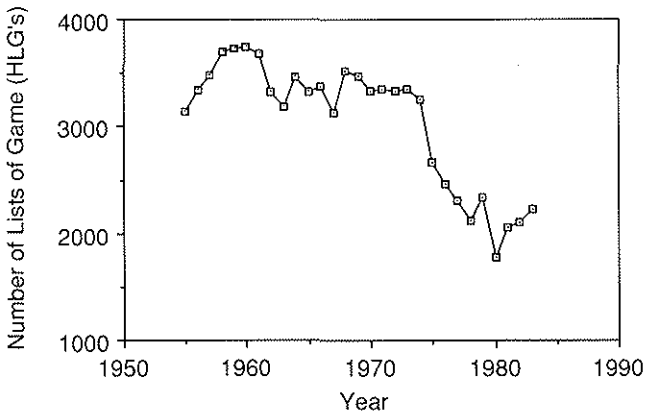


Figure 3. Catch of Polar Bears in Greenland, 1955-1985.

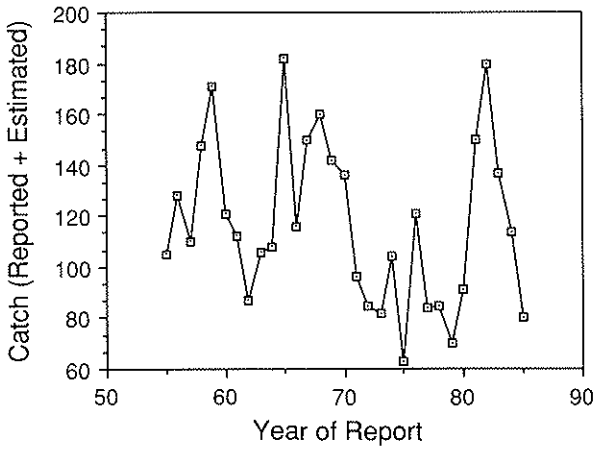


Figure 4. Catch of Polar Bears reported in Hunters Lists of Game in Greenland, 1955-1985.

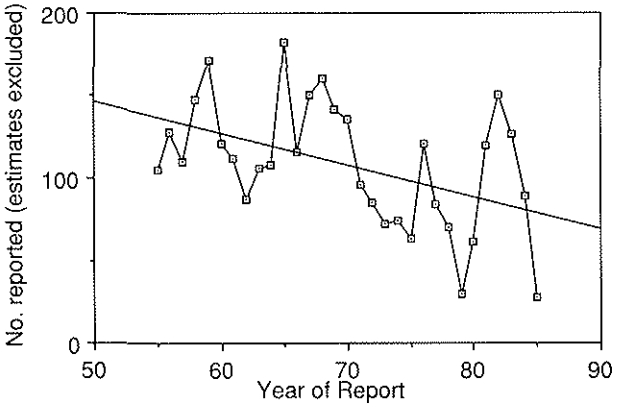
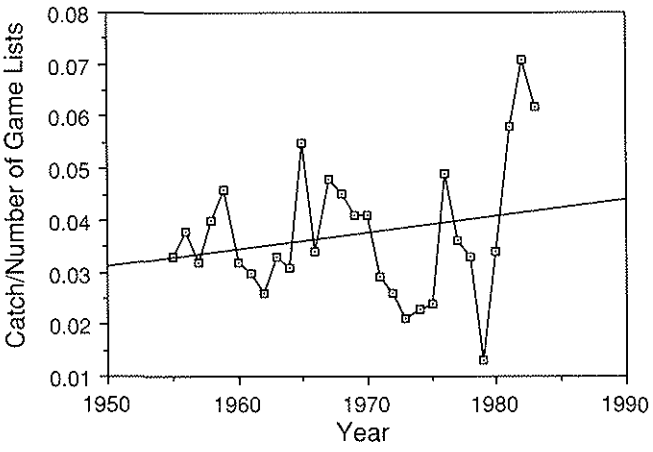


Figure 5. Polar Bear catch index for Greenland, 1955-1983.



Summary of Polar Bear Migration Studies in Southern Svalbard 1987

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Hornsund is a fjord 30 km long and 5-10 km wide, surrounded by glaciers and steep mountains up to 1400m a.s.l. From the head of the fjord there are 10-15 km of glacier extending to the coast of Storfjorden (See Fig. 1, Wiig, et al. Satellite telemetry at Svalbard 1988, this volume). The inner part of Hornsund and Storfjorden north of Hornsund are normally covered by stable, shore-fast ice during the winter. Polar bears, and their principal prey, ringed and bearded seals, are abundant in both fjords in late winter and spring; and a bear migration route through Hornsund to Storfjorden has been suspected (Larsen 1986, Gjertz and Lydersen 1986).

Beginning in 1986, oil and gas exploratory drilling and seismic testing have occurred in Hornsund and Storfjorden, South Spitsbergen. The activity has involved ships, helicopters, snow machines and a drilling camp. If oil or gas is found, a shipping terminal may be constructed in or close to Hornsund. As a result of this activity, the oil companies involved were instructed to fund a study of polar bear movements and distribution in the area.

In March, April and May 1987, 13 adult polar bears were captured in Hornsund and 5 in Storfjorden. Twelve of them were males. Nine bears were captured from snow machine, 5 from helicopter, 3 from the field camp and 1 in a foot snare. Ten bears were fitted with ear tag VHF transmitters and 8 with glue-on VHF transmitters. Instrumented bears were relocated from the ground in Hornsund in March and April, from helicopter in Storfjorden in May, and from fixed-wing aircraft in Storfjorden and eastern Svalbard in July and October.

Instrumented bears stayed in Hornsund 1-29 days after capture ($x=8.3\pm7.8$ days, $n=13$). Bears relocated in Storfjorden in July had been there 67-119 days ($x=87.4\pm16.7$ days, $n=9$). No instrumented bears were relocated west of mid-Hornsund. Fifty-three percent of all first-time observations of bears (including those not instrumented) were moving eastward, 4% westward, 2% northward and 41% were not moving ($n=51$). Of the 12 bears that left Hornsund with functional transmitters, 9 (possibly 10) were relocated in Storfjorden in May. At least 8 bears instrumented in Hornsund and 1 instrumented in Storfjorden were still in Storfjorden in July. The shore-fast ice disappeared after July and no bears were relocated in the area during the last survey in October.

In May, 1987, 1064 km of transect lines were flown in Storfjorden. In July, 1987, an additional 910 km of transects were flown. Obviously, not all bears on the transect lines were seen, thus the calculated number represents a minimum estimate. The small sample size and the methodological problems preclude more accurate estimations of local population size. Helicopter transect surveys (1064 km) were flown in Storfjorden in May (Fig. 1). Safety considerations precluded flying over less than 6/8 ice cover. Airspeed was 130 km/h, altitude was 100 m. The location of the first transect line was drawn at random. Predetermined transect intervals were 8.3 km. Perpendicular distance to each sighted bear was measured. Only 15 primary sightings were made. As the detection function was unknown and the number of primary sightings was low, mean density of bears was calculated using a strip transect sampling approach (Kingsley and Smith 1981). Assuming that all bears within the transect line were seen, a mean density of $0.99(\pm0.29)$ bears/100 km^2 was estimated. This represents an estimated population of 106 (±31) bears in the surveyed area.

Several male-female couples were observed in Hornsund in April. We observed one instrumented female associated with 3 different, instrumented males. She stayed together with the first male for at least 7 days. A larger male then entered the area and was instrumented. He was later observed with the female, and probably stayed with her for 5-7 days. During this period the first male was observed alone with wounds from a fight. After the second male had left a third instrumented male paired up with the female for between 3 and 7 days. This seems to support the suggestions by Ramsay and Stirling (1986) that polar bears are polyandrus.

These observations corroborate suggestions of a late winter and spring migration of polar bears eastward through Hornsund, across the glaciers to Storfjorden. The fraction of the Svalbard polar bear population that takes part in the migration remains unknown. Although the glaciers are quite dangerous for humans to cross, this route appears to be favorable to polar bears moving eastward in late winter and spring. The route is shorter than following the coast. The extended periods for which the instrumented bears stayed in Storfjorden, indicate that this is an important spring hunting area for at least parts of the Svalbard population. As indicated by the sexual behavior observed, the high concentration of bears in this area in the spring also suggests it is an important "mating area". Consequently hydrocarbon exploration and production in Hornsund and Storfjorden may affect a resource of particular value to the Svalbard polar bears. For a more detailed report see Hansson et al. 1988.

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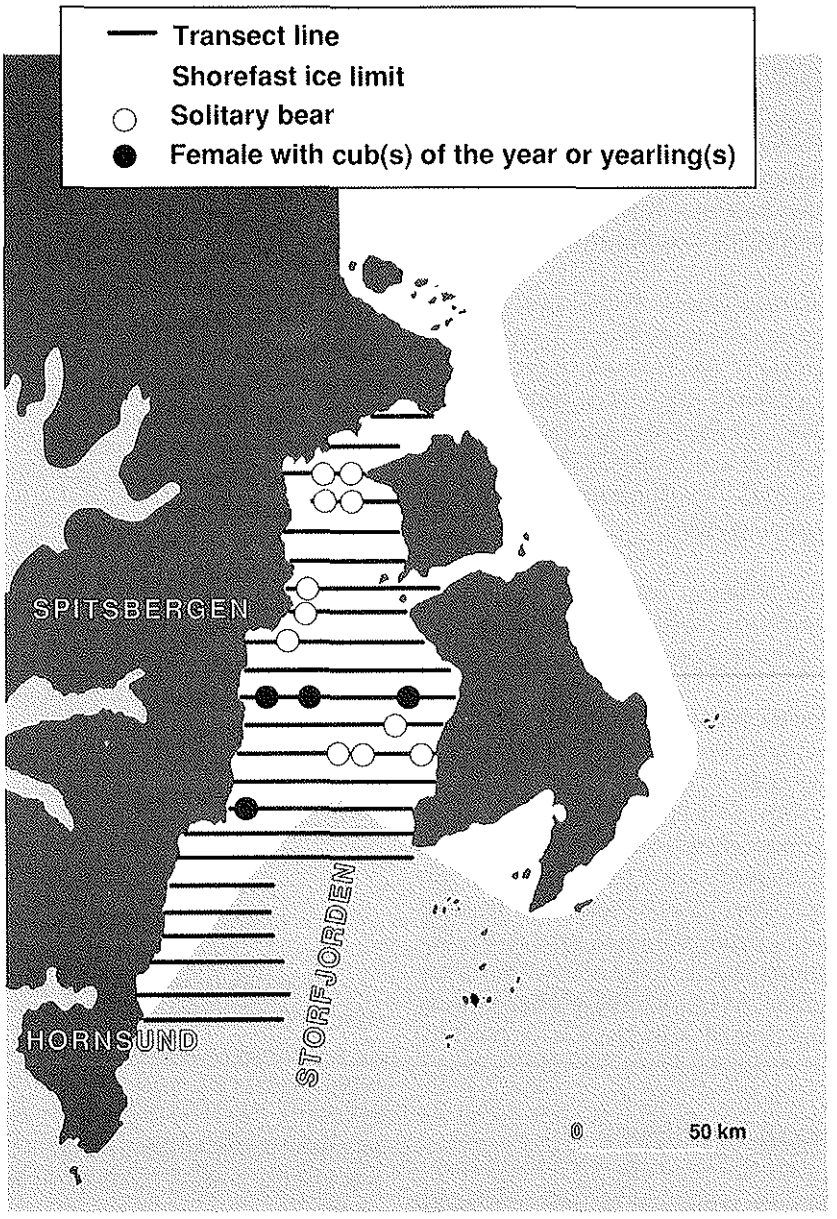
Figure. 1. Helicopter transects flown during May 1987 in region of Storfjorden. Also illustrated are the locations where polar bears were observed and the approximate limit of the shorefast ice in Eastern Svalbard.



Management of the Polar Bear in the Svalbard Area

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Introduction

Until 1969, hunting polar bears in the Svalbard area was not subject to any regulations or restrictions. The population was severely exploited, declining to 2000-2500 individuals in 1973 when it was totally protected (Larsen 1986). This is probably less than a quarter of the previous population in the area. Today, protection of the polar bear in Svalbard is regulated by the Royal Decree of 1978 "Regulations concerning the management of game and freshwater fishes in Svalbard and Jan Mayen".

A review of confrontations between humans and polar bears in Svalbard since 1973 is given by Gjertz and Persen (1987). Less than 5 bears have been shot each year. It is rumored that some bears are shot by fishermen, but this has never been confirmed.

More than 40% of the land areas in Svalbard are protected as national parks and nature reserves by the Royal Decree of 1973 "Establishment of bird sanctuaries and large nature conservation areas in Svalbard". The protected areas incorporate the most important polar bear habitat in Svalbard. Several areas within the South Spitsbergen National Park and Southeast Svalbard Nature Reserve are, however, excepted from the protective regulations on account of established mining rights.

Due to conservation measures introduced in 1973, all trapping activity was closed down. Public opposition was initially strong but soon diminished to nearly nothing.

In this decade, some trappers (actually people wishing to briefly live and hunt in a pristine environment without expecting to earn a living of it) have again established in the archipelago. Some of them plead the right to hunt polar bears referring to Article III, 1e, in the International Agreement for the Conservation of Polar Bears which states "...any Contracting party may allow taking of polar bears wherever polar bears have or might have been subject to taking by traditional means by its nationals". The Ministry of Environment has, however, refused this interpretation of the treaty, and does not consider the problem a serious threat against the full protection of polar bears in the Svalbard area.

Future Management Problems

Challenges regarding management of the polar bear in the Svalbard area for future years mainly are connected to 1) development of industry and tourism in Svalbard, and 2) petroleum activity and exploitation of the biological resources in the Barents Sea.

Norwegian Svalbard-legislation requires that large-scale industrial development projects have to be reported to the authorities at least one year prior to development. An Environmental Impact Assessment (EIA) will be conducted this year. The purpose is to get a basis for setting rules and giving advice on how the planned development shall be carried out in order to minimize damages to nature. To increase our knowledge, and thereby get a better chance to avoid damages, relevant environmental research will be conducted. Companies planning development in Svalbard are instructed to finance such research.

The Norwegian Polar Research Institute was appointed by the Ministry of Environment in 1985 to coordinate and direct the environmental impact studies in Svalbard. In order to fulfil this task the program "Miljoundersokelser pa Svalbard" (Environmental studies in Svalbard or "MUPS") was established.

Due to restrictions in economy and time, relatively few environmental projects can be conducted during the EIA process. Consequently, the selection of projects is a very critical step in the process. Priority must be given both to the problems to be assessed and to the projects to be conducted. The basis question is: What problems are most serious and what kind of research is most relevant to the EIA?

To cope with this problem we have developed what is called "A system for analysis of environment and industrial development in Svalbard". The pattern for the system is copied from the Canadian "Beaufort Environmental Monitoring System" (BEMP 1985) and is based on the AEAM-method "Adaptive Environmental Assessment and Management" (Holling 1978). A group of about 40 persons, consisting of scientists, managers, representatives from the petroleum companies and others have developed the system.

Systematic priorities are given at three levels:

First, 14 so called "Valued Ecosystem Components" (VEC) were selected (Table 1). The VEC need not necessarily be essential to the ecosystem. The VEC are essential to people. Other components of the ecosystem will be important if they appear to affect the VEC. In this way arguments can be given in an informative way to show politicians, the industry etc. why it is important to conduct research on unknown components in the system.

Second, so called "impact hypotheses" were stated to each VEC. Information flow diagrams, showing all possible connections between the human impact and the VEC, were developed to help making the impact hypotheses (Table 2). The different impact hypotheses were given a mutual priority. Table 2 lists the valid hypotheses for the polar bear.

Finally, several projects were proposed, and the projects thought to be most relevant to test the hypotheses, were given priority.

In this way we have built a management system that works. With the present extent of industrial activity in Svalbard the polar bear is probably not endangered locally or at the population level. If the companies find hydrocarbons, local and widespread effects on polar bears are possible. In addition to the industrial activity, the Norwegian authorities are planning to concentrate on tourism as a new enterprise in Svalbard. A decision will be made next year. Comprehensive tourism with hotels, cabins, marked trails, etc. will of course be an additional burden to a pristine ecosystem and to the polar bear population.

The most serious present threats to polar bears appear to be petroleum activity and the ecological situation in the Barents Sea. The Norwegian Ministry for Oil and Energy has just finished an EIA for the southern part of the Barents Sea (north to 74°30'N). They have not conducted any projects on the polar bear, despite the fact that concentrations of polar bears are recorded at the ice-edge. An oil spill in the northern part of the Barents Sea will most probably contact with the ice-edge between October and June.

Little is known on how the oil will behave in the ice. Next spring, the Norwegian Parliament will decide whether to open this area for petroleum activity. The decision appears predetermined. In fact exploratory drilling has already begun on so called "key-blocks" because the oil industry and the government want a view of the hydrocarbon potential as soon as possible as a basis to plan the future development of the area. The Soviets already have drilled for some years close to the coast of the Kola Peninsula. We have no information on environmental studies or other environmental measures in the USSR.

In 1985/86 the capelin (*Mallotus villosus*) population in the Barents Sea crashed. From an estimated size of about 5 million tons in 1980 the population was nearly exterminated in 1987. It seems that the fishing industry has the main responsibility for the crash, but natural fluctuations may also have contributed. In 1968 the herring (*Clupea harengus*) population declined from 20 million tons to less than 1/2 ton due to overexploitation. The population has not increased since then. This means that the big populations of zooplankton feeders in the Barents Sea are nearly exterminated. There has been a gap in the food web. The immediate impacts have been what is called "the invasion" of the harp seal to the Norwegian coast, crisis in the coastal fisheries, declining populations of cod and other important economic fish species, and serious declines in seabird species as for instance the thick billed murre (*Uria lomvia*). If this situation continues the impact on the whole ecosystem in the Barents Sea, including the polar bear could be dramatic.

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Table 1. Valued ecosystem components at Svalbard.

Svalbard reindeer (*Rangifer tarandus plathyruncus*)
Arctic fox (*Alopex lagopus*)
Polar bear (*Ursus maritimus*)
Walrus (*Odobenus rosmarus*)
Ringed seal (*Phoca hispida*)
Eider and geese
Seabirds
Ptarmigan (*Lagopus mutus*)
Arctic char (*Salvelinus alpinus*)
Marine biological resources
Vegetation and soil
Beach
Protected areas
Outdoor recreation

Table 2. Impact hypotheses for the polar bear.

Impact Hypothesis Number	Hypothesized Concern
Hypothesis #1.	Human installations in the ice or along the coast will attract polar bears and increase mortality because animals will be killed after confrontrations with people.
Hypothesis #2.	Oil pollution in areas with polar bears will bring suffering and death for polar bears that are affected.
Hypothesis #3.	Installations and traffic in or near denning areas will bring about decreased production in the polar bear population.
Hypothesis #4.	Disturbance and obstructions caused by installations and traffic in migration routes for polar bears will bring alterations in the populations migration routes and hence increased mortality in the population.

Management of Polar Bears in Norway

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Introduction

Human activity on Svalbard has increased during the last decade and increases are expected to continue in the future. Most of the activity is related to 1) the search for hydrocarbons and 2) tourism. Regulations which are most important in relation to the management of polar bears on Svalbard are described here and conflicts between human activity and polar bears are discussed.

Regulations

The Royal Decree "Regulations concerning conservation of the natural environment on Svalbard" was laid down in 1983 in order to conserve the natural environment of Svalbard and surrounding territorial waters. Three national parks, two nature reserves and fifteen bird sanctuaries were established according to the Royal Decree "Establishment of bird sanctuaries and large nature conservation areas on Svalbard" in 1973. 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. For further details of the regulations, see Ministry of Environment (1984).

Regulation of Economic Activity

According to the regulations controlling interference with nature on Svalbard, plans for economic activity require the approval of the Ministry of Environment before they are realized. Such plans shall as a rule be submitted to the Ministry no later than 1 year before the contemplated date for their realization. Wherever the planned activities will affect areas that are of value to the natural sciences, the Ministry may require the planned activities to be postponed, pending scientific investigations, and order the applicant to pay the cost thereof.

The Norwegian Polar Research Institute was appointed by the Ministry of Environment (9 December 1985) to coordinate and direct the environmental impact studies on Svalbard. In order to fulfil this task, the program "Miljoundersokelser pa Svalbard" (Environmental studies on Svalbard) was established (Prestrud and Oritsland 1987). As a tool for future investigations, a system based on Beaufort Environmental Monitoring System (BEMP 1985) has been developed (Hansson et al. 1987). The polar bear as a "Valued Ecosystem Component" was described by Hansson (1987).

Mining Claims Within Protected Areas

Several areas within the South Spitsbergen National Park and Southeast Svalbard Nature Reserve are excepted from the protective regulations because of established mining rights. Some of these are situated in areas with a relatively high abundance of polar bears during parts of the year, and include maternity denning areas. Industrial activity here will probably affect polar bears.

Confrontations Between Humans and Polar Bears at Svalbard

Regardless of protection, polar bears may be killed when necessary to remove acute danger of injury to persons, to prevent substantial material damage, or in the case of other emergencies. Such killings shall be notified as soon as possible to the Governor. In addition, the Governor may put to death or give permission to put to death polar bears which entail danger of injury to persons or of other substantial damage. All killings of polar bears on Svalbard are treated as a police matter. If the killing is found to be unnecessary, the person will be prosecuted.

A review of confrontations between humans and polar bears on Svalbard since the autumn of 1973, when the polar bear was protected, was given by Gjertz and Persen (1987). Fifty serious confrontations had been reported to the Governor, in which one man was killed and two men were injured. Of these 50 cases 46 resulted in the killing of bears whereas one bear was wounded, but escaped. During the winter season 1987/88 two men were injured by a polar bear and eight polar bears were killed.

Hunting of Polar Bears

During the last years there has been a public discussion on the legalization of polar bear hunting in Norwegian waters. In particular, the few trappers on Svalbard are interested in taking up the hunt. There are, however, no indications that the Government wishes to change its present management strategies.

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Research on Polar Bears in Norway 1986-1988

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Introduction

Most of the research on polar bears in Norway during recent years has been financed through MUPS (Environmental impact studies on Svalbard. See report on management in Norway by Wiig et al. 1990a—this volume) by companies searching for hydrocarbons on Svalbard. Research has also been financed by the Norwegian Polar Research Institute and the Ministry of Oil and Energy. This report summarizes studies already conducted and gives a brief description of planned future research.

Studies Completed

1. Polar bear predation on ringed seals in the fast ice of Hornsund, Svalbard (Gjertz and Lydersen 1986).

   Polar bear hunting success on ringed seals in subnivean lairs and basking on fast ice was studied in Hornsund, Svalbard. A few bears were observed while actually hunting, but in most cases bear tracks were followed by snowmobile to determine the outcome of hunts. Seal carcasses were classified from size and tooth annuli as pups, juveniles or adults. A total of 62 subnivean structures were entered by bears, with six seals killed. One of 10 charges on basking seals resulted in a kill. Success rates of hunting bears in Hornsund were compared with results of studies in Canada and Svalbard.

2. Polar bear surveys on the southeast coast of Spitsbergen, spring 1986 (Hansson 1987).

   During spring many polar bears are found in the area of south Spitsbergen and along the coasts of Storfjorden. In order to get more information on the polar bear activity in parts of this area, a survey was performed on the east coast of Spitsbergen during March and April 1986. Based on this survey, it was concluded that about 10 maternity dens may have been present along the east coast of Spitsbergen in spring 1986. This is about 6% of the total number of maternity dens at Svalbard. Thus, the area seems to have some importance as a maternity denning area for the Svalbard population of polar bears.

3. Noise and vibration in polar bear dens from activities related to the search for hydrocarbons (Blix 1987).

   The field work was performed at Prudhoe Bay, Alaska, in cooperation with J. W. Lentfer and with financial support from Alaska Department of Fish and Game. Professor Blix received financial support from MUPS in order to process and publish the results. The investigations were conducted in artificial polar bear dens in different representative areas. The dens were instrumented and exposed to activity. It was concluded that dry snow is very efficient as damper for sound and vibrations, and that it is unlikely that a denning polar bear will be affected by any form of activity related to search for hydrocarbons, as long as it is performed more than 100 m from the den.

4. Marine mammals and petroleum activities in Norwegian waters (Griffiths et al. 1987).

   The work, a literature review, was commissioned by the Ministry of Oil and Energy as an element of a program to review and analyse consequences of opening new petroleum leases in the sea off the counties of Troms and Finnmark, northern Norway. The polar bear is an inhabitant of land-fast ice and drifting pack ice. Its widespread distribution around Svalbard and use of fast ice and water for hunting, makes it highly vulnerable to contact with oil should a spill occur in this area. Ice occurs in that part of the Barents Sea covered by the Barentshavet Syd lease from February to April. It was therefore important to consider the known effects of oil on polar bears. Most of the polar bears oiled after a blowout in the Barents Sea would probably die if not treated. In addition, the logistics of capture and transport of these large animals would preclude treatment.

It therefore appears that the only method of improving our immediate awareness of the possible interaction between oil and polar bears, is through surveys of polar bears in the southern Barents Sea during winter when there is ice in the lease area.

5. Migration of polar bears in Hornsund and South-east Svalbard 1987.

   See Hansson, R. 1990. Summary of polar bear migration studies in southern Svalbard 1987, this volume.

6. Migrations of polar bears from Hornsund 1988.

   See Wiig et al. 1990c. Satellite telemetry at Svalbard 1988, this volume.

Future Research

The Norwegian Polar Research Institute has appointed Oystein Wiig as the new research scientist in charge of polar bear studies. The study of polar bear migration from Hornsund will continue for some years by use of VHF as well as satellite transmitters. Steps also have been taken towards conducting cooperative research on polar bears between USSR and Norway. Additional, environmental impact studies will be performed in connection with industrial activity through MUPS.

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Satellite Telemetry at Svalbard 1988

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Polar bears are distributed in many relatively discrete subpopulations (DeMaster and Stirling 1981). Larsen (1986) suggested the population of polar bears in the Svalbard area is distributed between East-Greenland and Franz Josefs Land. Svalbard polar bears are thought to migrate from west through Hornsund to Storfjorden in late winter and spring (Hansson et al. 1988). The bears may stay for a few days or up to several weeks on the landfast ice areas in the eastern part of Hornsund before they move on further. One of the highest concentrations of polar bears at Svalbard is found here during spring time (Hansson et al. 1988). The bounds of polar bear populations and the movement of individuals comprising them are, however, still uncertain.

This report summarizes our first attempt at using satellite telemetry to record the migration pattern of female polar bears throughout the year. This is not possible using other methods in the Svalbard area.

During March and April 1988 four female polar bears were captured and fitted with satellite radio transmitters (PTTs) in Hornsund (Table 1). The bears were hunted from snow machines and immobilized with Zoletil (Virbac Laboratories, Nice, France) delivered with a Cap-Chur gun (see Hansson et al. 1988). Three of the females were in estrus, whereas the fourth had two yearlings. All four females weighed about 200 kg.

The four PTTs were activated on 18 March, and attached at dates and locations listed in Table 1. Approximate movements of the bears are shown in Fig. 1.

Transmitter No 9680 fixed position for 57 days. During this period the bear went to Storfjorden through Freemansundet and then NE towards Novaya Semlya. Transmitter No 9681 fixed position only once, two days after it was attached to the bear. Transmitter No 9682 fixed position for 43 days. The bear went to Storfjorden and then towards Bjornoya. This transmitter provided sensor data (temperature and activity) until 5 May 1989.

The female with cubs (transmitter No 9684) went eastward to Storfjorden, up to Kong Karls Land and Kvitoya. She then turned NW and north of Svalbard in mid-July. She stayed up there for a month and then went SE. At the end of September she was back at Kvitoya. This unit (No 9684) fixed position until 29 April 1989.

In spite of the restricted success with satellite transmitters this year, we will try to instrument six more female polar bears in spring 1989.

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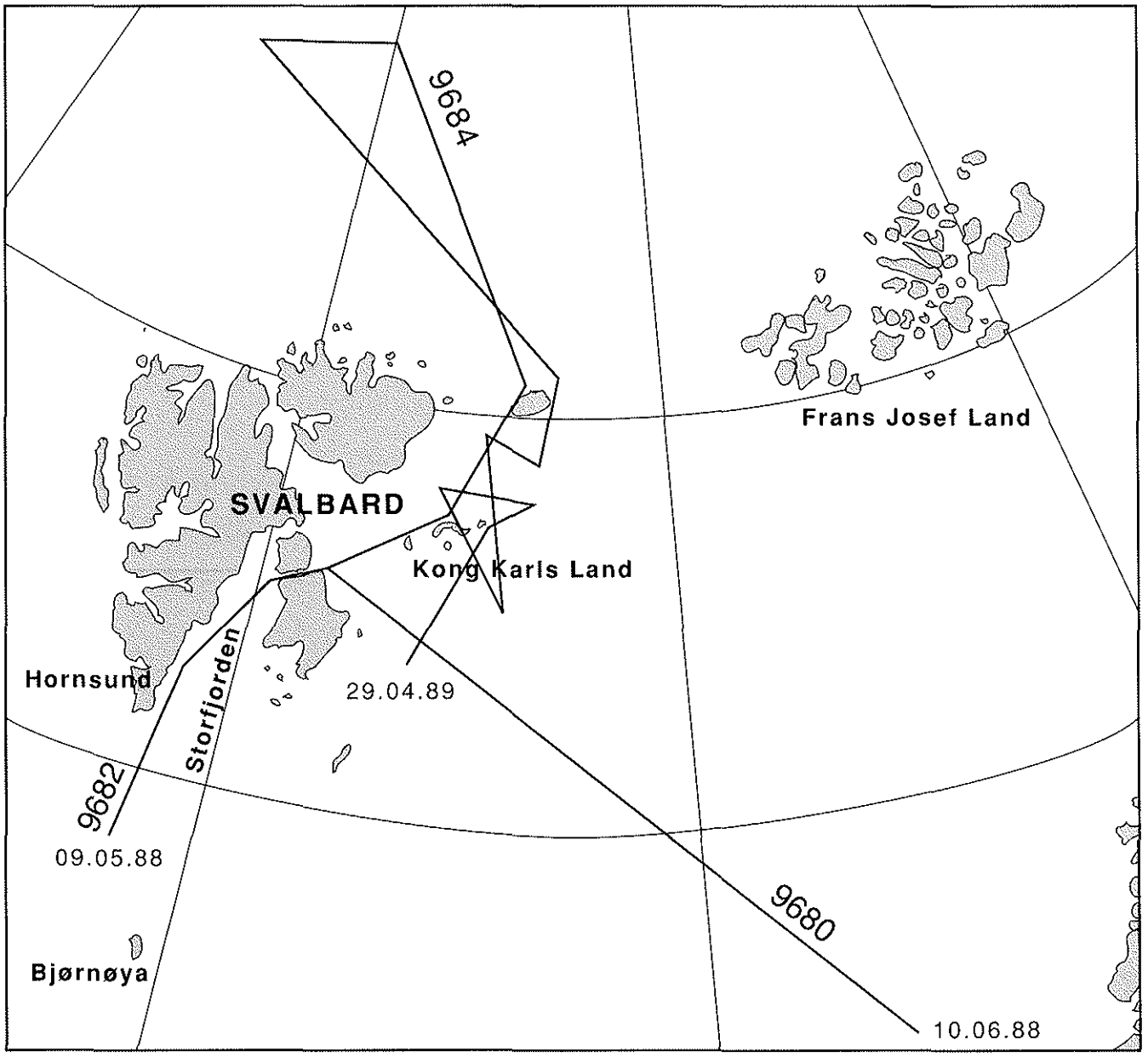
Table 1. Satellite transmitters attached to female polar bears in Hornsund, Svalbard (77.00 N 17.15 E). All transmitters were activated 15 March 1988.

Id. no.	Release date	Last position received date	pos.
9680	14.04.88	10.06.88	73.92 N 46.93 E
9681	12.04.88	14.04.88	76.86 N 17.06 E
9682	27.03.88	09.05.88	75.39 N 17.14 E
9684	05.04.88	29.04.89	77.58 N 26.71 E

Figure 1. Approximate movements of three polar bears in the Svalbard area tracked by help of satellite transmitters.



Relevance of Harbour Seal Mass Mortality to Polar Bears

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In mid April 1988 several dead harbour seals (*Phoca vitulina*) were found on the beach of the island of Anholt in the Kattegat Sea in Denmark. All age classes including fetuses were found. During the following months dead harbour seals were reported from the west coast of Sweden, the southern coasts of Norway, and from the North Sea coasts of Denmark, West Germany, the Netherlands, and the coasts of UK.

According to the figures given by Heide-Jorgensen et al. (1988) about 11,500 harbour seals have died in Denmark, Sweden, West Germany and the Netherlands. Adding about 500 from the Norwegian coast (Markussen, pers. comm.) the total number is about 12,000 seals in these areas (excluding UK). This is about 75% of the total minimum population estimate for this area.

Also some grey seals (*Halichoerus grypus*) have been found dead with the same symptoms as the harbour seals. The disease seems, however, mostly to affect harbour seals.

Autopsies of dead seals showed that most of them died from acute and severe bacterial pneumonia dominated by the bacteria *Bordetella bronchiseptica* (Phil-Andersen 1988). However, this bacteria is known to cause secondary infections. Viral infections are thought to be the primary cause of death (Heide-Jorgensen et al. 1988). According to Osterhaus (1988) viri like *Herpes* and *Picorna* seem to be involved. In addition clinical and postmortem findings have shown similarity to canine distemper virus (CDV) (Heide-Jorgensen et al. 1988). The most recent studies indicate, however, that seal deaths may be caused by a new morbillivirus (Mahy et al. 1988, Cosby et al. 1988).

In February 1988 an outbreak of canine distemper among the sled dogs in the Thule area (northwestern Greenland) exterminated the majority of the about 3000 dogs in the area. Canine distemper virus antigen was also demonstrated in arctic fox (*Alopex lagopus*) in the area.

Analysis of six polar bears sampled in the Thule area late in the epizootic, however, were not conclusive. Seals which might have died from canine distemper have not been reported from the area and there is no evidence that other wildlife was affected. The transmission of canine distemper virus is believed to be airborne over short distances and it has been hypothesized that the outbreak in Thule was caused by immigration from Canada of infected arctic foxes across Baffin Bay (Blixencrone-Moller, pers.comm.).

The timing of the two epidemics precludes the possibility of a propagation of the disease from harbour seals in northern Europe to wildlife and dogs in the Thule area. Current knowledge of the distribution and migration of marine mammals in the Baffin Bay area and European harbour seals also makes it highly unlikely that canine distemper has spread from northwestern Greenland to Europe. It has not been determined if polar bears can contract canine distemper.

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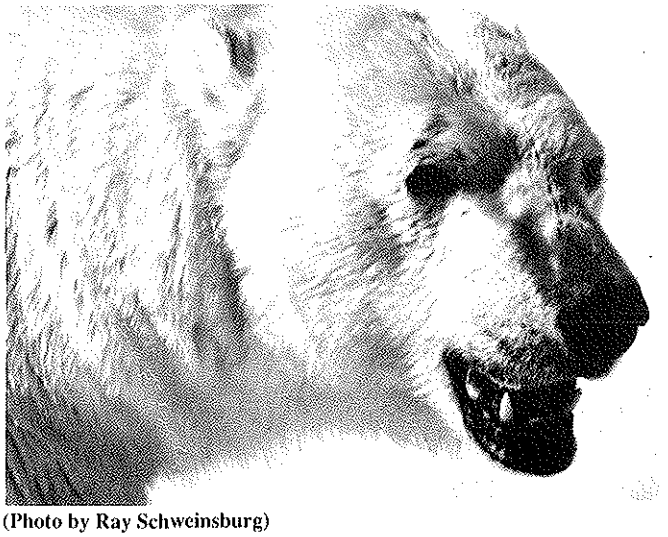

(Photo by Ray Schweinsburg)

Research on Polar Bears in Northern Alaska 1985-1988

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Introduction

Recent and future events in arctic regions may disrupt the natural history of polar bears (*Ursus maritimus*). For example, the discovery of the world's 10th-largest oil field at Prudhoe Bay, Alaska, has resulted in dramatic increases in human populations in Alaska's arctic. The influx of cash, as a result of oil and gas development, into previously cash-poor areas has improved efficiency of harvest of polar bears, and altered human distributions. Habitat alterations and changes in human distributions that may result from future development of the Arctic National Wildlife Refuge (ANWR) and offshore oil reserves are added cause to improve knowledge of the status of polar bears in the Beaufort Sea.

The Marine Mammal Protection Act (MMPA) of 1972 prohibited restrictions on the take of polar bears by native peoples. Therefore, possible increases in harvest and other human perturbations must be viewed with concern. Pipelines and roadways may prevent female polar bears from moving to and from inland denning areas. Hence, they may den in less desirable locations. Also, human activities may cause bears to abandon established dens before cubs are ready to leave (Amstrup 1986, Belikov 1976). Industrial activities such as seismic testing on the ice also may directly affect the seals upon which polar bears depend for food. Harassment will increase as will direct altercations between humans and bears. Contamination of ice, water, food species, and bears by oil and other toxic chemicals may increase. The effects of low levels of contamination may not be obvious, but high levels of contamination are fatal (Oritsland et al. 1981, Amstrup et al. 1989).

Movements of ice-breaking vessels and positioning of gravel islands and drill ships in active ice areas can keep otherwise frozen areas free of ice for extended periods, even in winter. Natural open water areas attract ringed (*Phoca hispida*) and bearded seals (*Erignathus barbatus*) and polar bears which feed upon them (Stirling and Cleator 1981). Thus, areas kept open by vessel traffic also may attract bears and their prey. There is some evidence that bears may be attracted to offshore drilling platforms, and may remain in those areas because of habitat alteration (Stirling 1988). Bears attracted to areas of human activity may pose a safety threat. Such threats may be alleviated by deaths of bears. Bilge oil and other contaminants could soil attracted animals, and cessation of vessel activities could entrap seals as ice reforms and necessitate long movements by bears that might not have occurred there under natural circumstances.

Conversely, some activities associated with hydrocarbon exploration and development might benefit polar bears. Areas kept open by vessel traffic could increase primary productivity (and thereby forage availability) benefiting seals and polar bears. Gravel islands and drill ships also create open water when built where currents keep the ice moving, and like vessel traffic could shorten the winter period of predominantly solid ice. These effects could be important, because areas characterized by open or refreezing water are the most productive in the arctic (Stirling and Cleator 1981). The elevational relief of gravel islands also might create previously unavailable habitat for maternity denning in areas adjacent to productive forage.

Recent research by the U.S. Fish and Wildlife Service suggests that Alaskan polar bears spend most of their time in the shear zone and the active ice immediately beyond. This appears to be the most important polar bear feeding habitat along the Alaska north coast. Current offshore exploration and development has reached the southern fringe of this prime habitat. As development progresses seaward, the activities will have increasing potential to affect foraging, survival, breeding habits, and other aspects of the life-cycles of polar bears.

Research has revealed that bears using the Beaufort Sea area move seasonally between Canada and Alaska. Thus, a catastrophic event associated with one site could negatively affect the entire population of the Beaufort Sea. Moreover, although approximately 75% of the maternity dens of polar bears in the Beaufort Sea are on the drifting pack ice, most dens not found on pack ice have been on or adjacent to ANWR. Thus, as hydrocarbon related activities expand into ANWR and seaward, denning areas may be less secure.

Current research is designed to determine the status of the polar bear population in the Beaufort Sea and adjacent areas relative to its resource base. Such information will be necessary to determine how to mitigate possible effects of new or more intensive human activities. It is also designed to determine how polar bear populations are distributed, what regulates them, and how regulatory factors are relevant to present and future management decisions. This report summarizes progress toward some of those objectives that has been made since the PBSG last met in 1985.

Study Area

The designated study area is the Alaskan Beaufort Sea, between the Canadian Border at 141° W Longitude and Point Barrow at 157° W. It is now obvious, however, that Alaska shares its polar bears with Canada, and that Beaufort Sea bears spend an as yet undetermined amount of time in waters of the eastern Chukchi Sea. Thus, the true area of concern is the entire region from the mouth of Amundsen Gulf in the Northwest Territories to perhaps Cape Lisburne on Alaska's northwest Coast.

Objectives

A. Population Status and Definition:

1. Determine the movements of individuals comprising the polar bear population that uses the Beaufort Sea. Evaluate, from a genetic as well as a managerial standpoint, the separation of this population from other stocks. 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.

   a. Establish age specific cub production rates for female polar bears in the Beaufort Sea.

   b. Determine the frequency and timing of loss of cubs subsequent to den emergence.

B. Polar Bear Feeding Ecology Relative to Population Status:

1. Determine ice types (habitat types) preferred by polar bears.

   a. Describe seasonal seal hunting techniques and their relative effectiveness in the available ice types.

   b. Determine what constitutes availability of seals to bears.

2. Determine the predation and feeding rates of free ranging polar bears in the Beaufort Sea and the effects sex, age, and species of prey have on those rates.

3. Establish the temporal significance of particular geographic regions to polar bear foraging.

4. Establish mitigation measures for identified impacts of petroleum related activities upon polar bears of the Beaufort Sea.

C. Polar Bear Maternity Denning:

1. Determine the distribution of polar bear dens in Northern Alaska.

2. Determine the timing of den entrance and emergence.

3. Determine the relative success rates (thus the reproductive significance) of dens in various locations.

4. Determine locations of denning areas relative to petroleum activities and determine the sensitivity of denned bears to associated disturbances.

5. Establish measures for mitigation of any identified impacts.

Methods

Individual polar bears were live-captured in coastal regions of the Beaufort Sea using standard helicopter and remote injection techniques (Schweinsburg et al. 1982, Larsen 1971, Lentfer 1968). Captured animals were weighed, measured, ear-tagged, and tattooed for permanent identification. Physical and reproductive condition at the time of capture and past capture history were noted and considered in determining which bears received radio collars. Captured animals were released unharmed at the location of capture. Captures occurred during October-November and March-May when ice conditions near the coast allowed safe flying, and when there was sufficient daylight to maximize efficiency of the capture operation.

Population Definition and Discreteness

Selected adult females were fitted with collars transmitting UHF and VHF signals that could be received by overflying satellites and aircraft. Satellite transmitters operated every 3 days, whereas VHF transmitters operated continually, and were tracked by aircraft 5 or 6 times per year. Blood samples were collected from each bear captured. Comparisons of mitochondrial DNA sequences recorded from blood samples of Beaufort Sea and Chukchi Sea polar bears will be used to evaluate population discreteness (Shields and Wilson 1987). Shavings were collected at four locations along claws of captured polar bears to quantify differences in concentrations of stable isotopes of carbon and nitrogen between polar bears sampled in each area. Analyses of samples collected were conducted at the University of Alaska, Institute of Northern Engineering (Schell et al. 1988). Hair samples taken from captured polar bears were examined for commensal algae with electron microscopy (Lewin and Robinson 1979).

Maternity Denning Studies

In order to determine the distribution of maternity dens of polar bears in the Beaufort Sea, instrumented bears were followed to their maternity dens by conventional VHF or satellite telemetry. To estimate denning success, instrumented bears were visually observed shortly after emergence from the den. To augment radiotelemetry data, an aerial survey of potential denning habitats along Alaska's northeastern coast was flown during April 1988. Time and coverage of this survey were determined by studying den entry and emergence data developed with the aid of radiotelemetry data collected in previous years. Dens on land were classified according to elevation, slope, aspect, depth of snow, description of landform, and adjacent vegetation.

Habitat Utilization

During the spring season of 1987, searches for instrumented polar bears were performed in a Piper Super Cub aircraft. Once located, the bear's tracks were followed to determine distance traveled in various habitat types, number of predation attempts, and number of seals captured. The kinds of predation or attempted predation were quantified (Stirling 1974; Stirling and Archibald 1977). Tracks of each instrumented bear were followed between daily relocations. Each seal structure where predation or attempted predation was observed was examined. Distances over which tracks were followed were measured with navigation aids onboard the aircraft, and estimated by recording time in flight and known airspeeds.

Trained labrador retrievers were used to locate ringed seal breathing holes and lairs in areas hunted by polar bears in April 1987. The dogs were directed to run along a known polar bear trail ahead of a slow moving snow machine. When the scent of a seal was detected, the dogs ran to the source of the odor and indicated a breathing hole or lair by digging in the snow directly above the structure. The dog handler then probed the structure with an aluminum rod to determine the exact location of the hole through the ice and, in the case of lair, the extent of the cavity. In some instances, small openings were made in the snow roofs of lairs to permit visual examination. Probe holes and examination holes were closed with snow after examination. Numbers of kills and attempted kills were calculated for structures within each category. The sex and age of seals killed by bears was recorded where adequate carcass materials remained.

Results

Between summer 1985 and spring 1988, 189 polar bears were captured, marked and released in the Alaskan Beaufort Sea. This included 81 animals that had been captured and released during previous seasons. Numbers of animals recaptured fluctuated greatly between seasons of capture attempts. Also, many animals were recaptured with the aid of radiotelemetry, making assessments of the proportion of the population marked less than straightforward. However, when collared animals captured with the aid of telemetry information were deleted, it was still apparent from the ratio of marked to unmarked bears that at least 30% of the population in the Beaufort Sea was marked during this period.

After 1985, conventional VHF telemetry was replaced, as the principal tool of our studies, with telemetry relying upon ARGOS Satellites. Since the spring of 1985, we have deployed 59 satellite platform transmitter terminals (PTTS), and 14 conventional VHF transmitters. Through June 1988, 10,547 remote relocations and 128,038 measures of activity and temperature not associated with location information were acquired from platform transmitter terminal (PTTs).

Information relayed from PTTs has allowed new insights into some aspects of polar bear ecology. It is important, however, to keep in mind that both VHF and satellite telemetry have limitations. Finding polar bears from airplanes is expensive and sizes of existing budgets limited survey flights in recent years to 5 or 6 per year. Thus, conventional telemetry may reveal seasonal (extensive) movements of large samples of bears, but not short term (intensive) movement patterns. Satellite telemetry, on the other hand, can provide details of both short term and long term movement and activity (Fig. 2). The costs of PTTs and data processing limit the numbers of bears that can be monitored in this fashion, but considerable intensive information is potentially available from instrumented individuals. The understanding of short term movements and distribution patterns may make study of the relationship between movements of the sea ice and movements of polar bears achievable assuming adequate longevity of the transmitters. Unfortunately, longevity of satellite transmitters has yet to match that of VHF units. Thus, observation periods for many animals instrumented with PTTs have been shorter than observation periods during which we relied upon VHF transmitters.

Movements and Population Assessment

Much of our existing knowledge of the seasonal and annual movements and distribution of Beaufort Sea bears was gathered by conventional telemetry over the past several years. Satellite telemetry has verified findings of conventional telemetry regarding the extent of movements of Beaufort Sea polar bears and has improved knowledge in many areas (Figs. 1 and 2). Conventional telemetry had shown that although polar bears are seasonally faithful to general regions or activity areas, those areas can exceed 250,000 km^2 in size. Satellite telemetry has corroborated and expanded upon those earlier findings and provided some details necessary to assess the purpose of some of the longest movements observed.

Recent satellite telemetry data have also confirmed that long-term studies are necessary to understand movements, population discreteness, and other aspects of polar bear ecology. Figure 3 illustrates the movement patterns of a polar bear followed

by conventional telemetry during the period 1982-1985, and subsequently followed by satellite telemetry. Areas used by this and other bears during the past couple of years were often quite different than the areas used between 1982 and 1985. Preliminary analyses suggest that ice condition and drift patterns were markedly different in the winters of 1986 and 1987, and apparently the bears responded to those differences.

Although we cannot fully explain events that led to alterations in the movements of radiocollared polar bears, it is important to note that observers might have gained a much different impression about the use of the Beaufort Sea and adjacent Chukchi Sea by polar bears if their movements were studied for only 1, 2 or even 3 years rather than 5 or 6. Even greater changes in movement patterns might have been detected if several bears that occupied more eastern reaches of the Beaufort Sea in the early 1980's had been reinstrumented recently. The need for detailed long-term studies of large mammals is not a new topic. However, our movements data may be one of the most graphic representations of how study duration can influence conclusions drawn.

Noting that characteristics of the Chukchi and Bering seas west of Alaska (e.g., warm and shallow) are quite different than those to the north (e.g., cold and deep); we reasoned that if algae occupy the hairs of polar bears in the wild, as they do in captivity, the kinds of algae occupying hair of the bears in each region might differ. Our studies have thus far failed to turn up evidence of algal colonization of the hair of wild polar bears. Lewin and Robinson (1979) speculated that algal cells invaded the hair of bears through lateral ducts on the strands of hair. Not only have electron micrographs of the hairs of wild polar bears not revealed any colonization by algae, neither have they revealed the existence of lateral ducts. This approach to examining spacial segregation of polar bears, therefore, is being abandoned.

Unlike the search for commensal algae, studies of stable isotopes of carbon in keratinous tissues may be very valuable in evaluating population definition and discreteness (we have not yet examined stable isotope ratios for nitrogen). When measures of the ratios of ^{12}C to ^{13}C in all samples taken from the claws of 31 polar bears captured in the Beaufort Sea were compared to levels in all samples taken from 23 bears captured in the Chukchi and Bering Seas, they were found to be different at the 0.0001 level of probablility (Table 1). Claw samples from bears of western Alaska waters were consistently heavier isotopically, than samples from northern Alaska. Further, it appears that like the baleen of bowhead whales (*Balaena mysticetus*) the isotope ratios in the claws of polar bears present a chronological record of where the bear fed in the past (Schell et al. 1988). That is, claw tissue (which once laid down is not metabolically active) deposited at any point in time reflects the signature of Carbon isotopes present in the environment in which the bear was foraging at that time. Moving along a bear's claw from skin line to tip, then, represents a look back in time to previous feeding sites. Observations of the rate of movement from base toward the tip, of notches filed into the claws of captured polar bears suggest that it takes approximately 1 year for a bear to grow a full length claw. Therefore, a series of samples taken from various locations along the long axis of a bear's claw might indicate where the bear had been at various times during the preceeding year (Fig. 4).

Figure 4 shows the relationship between the mean longitude recorded each month of polar bears (known by satellite telemetry) and the proportion of ^{12}C and ^{13}C in the claw tissues and zooplankton at various longitudes. The ratio of ^{12}C to ^{13}C is usually reported in what is called "delta" notation, where the ratio in the sample is compared to that of a carbonate standard (Schell et al. 1988), and is usually expressed in units of parts per thousand. The following formula is used to calculate $d^{13}C$:

$$d^{13}C_{PDB}(o/oo) = \frac{Rsample\text{-}Rstandard}{Rstandard} ¥ 1000$$

Samples from polar bear claws were taken at four locations along the lengths of the claws: 1) near the skin line, 2) inside the mid-length mark, 3) distal to the mid-length mark, and 4) at the tip by removing minute (total wt at each point=0.24 mg) shavings with a sharp knife. Although precision of such sampling is low, there appears to be a remarkable correlation between ^{13}C in the environment and in the portion of the claw that would have grown had the claw taken approximately 1 year to grow. Much work needs to be done to establish the repeatability of claw samples and to calibrate the growth of claws under different physiological and physical conditions. Nevertheless, this method of evaluating distribution of bears already shows considerable promise.

Some progress has been made in cooperative studies examining mitochondrial DNA sequences. See the section on progress in western Alaska polar bear studies for a discussion of this technique.

Maternity Denning Studies

The annual distribution of polar bears is closely tied to the distribution of ice in the Arctic Ocean and surrounding seas. A notable exception is the seasonal movement to favored maternity denning areas by pregnant female bears. Maternity denning areas have been found on large islands and on mainlands around the world. Most well known are those located on various islands of the Svalbard Archipelago north of Norway; Franz Josef Land, Novaya Zemlya, and Wrangel Island, in the Soviet Union, and on the coast of Hudson Bay in Canada. Despite a healthy population of polar bears, reports of maternity dens in Alaska have been rare. Recent research suggests that at least 150 female Alaskan polar bears should seek maternity dens each year. Yet, scientists, early explorers, and local residents had reported fewer than 50 Alaskan dens prior to 1981. Because polar bears in dens are more sensitive to human disturbances than at any other stage in their life cycle, the absence of knowledge of where bears den has been a significant management concern.

Since 1981, when we began to use radiotelemetry to determine where polar bears in the Beaufort Sea entered maternity dens, we have located 88 dens. Only 16 of those dens were on land,

4 others were on shore-fast ice, and the remaining 54 were on the active ice of the polar pack. Marine dens were found throughout the Beaufort Sea from just beyond the flaw zone - only a few kilometers from land, to as far as 550 km north of the Alaskan coast. Ten of the land dens were on the Arctic National Wildlife Refuge (ANWR) in northeastern Alaska. Two dens also were found immediately adjacent to ANWR on land fast ice. In short, most dens of Beaufort Sea polar bears were found on sea ice rather than on land, and most of those found on land in Alaska were found within the bounds of ANWR suggesting if there is an important land denning are in Alaska, ANWR is probably it.

Signs of seven land dens not found by telemetry were located while investigators engaged in mark and recapture, aerial survey, and other research activities in Spring 1988. In total researchers located 4 dens and evidence of 2 others within the bounds of ANWR, and 3 dens plus evidence of one other west of ANWR. Clearly, the 1987-88 data, supplemented by survey and other methods, corroborated the past observations that most dens of collared bears are on the pack ice. They also corroborated the observation that ANWR may be an important land denning area (Fig. 5). ANWR also holds the greatest potential for economically recoverable petroleum reserves of any land area in the United States so its significance to polar bear reproduction in the Beaufort Sea is of utmost importance.

Some recent data suggest differential success of land and sea dens. Success of females using land dens (1.1 cubs/den) was higher than that for females using offshore dens (0.69 cubs/den) for 55 dens from which productivity was known (Table 2). Success of land dens is more easily verified than is the success of dens far offshore in the drifting pack ice, however. Consequently, a greater proportion of females using land dens were checked for cub production close to the time of departure from the den. Productivity of offshore dens was often ascertained only after periods of several months or even a year or more. Obviously, causes of post-denning mortality had greater opportunity to affect cubs of females denning offshore. This bias in sampling success rates must be eliminated in order to test whether success rates of bears denning on different substrates really do differ.

Although more bear dens have still been located by conventional telemetry than by satellite telemetry, satellite telemetry has provided previously unavailable information on some aspects of denning ecology. Because they are insulated from outside weather, polar bears in a den maintain a consistently warmer temperature than those that are not in dens. Also, denning bears are essentially sleeping most of the time and move very little. Thus, activity and temperature sensors within PTTs can provide sufficient cues to accurately detect entrance and emergence times. Twenty-two polar bears wearing PTTs have entered maternity dens, providing us with more accurate den entrance dates than would otherwise be possible. Unfortunately, most PTTs deployed on denning bears have not been operational by the end of the denning season, and emergence times could not be determined for 15 of those bears.

Satellite telemetry has allowed insights into other previously undocumented denning phenomena. For example, in previous years, some bears wearing VHF transmitters were followed by radio telemetry in northwesterly directions until they were beyond the range of survey aircraft or until they entered restricted Soviet airspace. Because productivity is low far offshore and foraging therefore is difficult, we suspected that those bears were moving to offshore denning areas on the stable ice of the polar basin. Location along with activity and temperature sensor data received from satellite collars have recently confirmed the hypothesis that many of those bears travelling far offshore were seeking and entering maternity dens. Similarly, in winter of 1986, numerous collared bears moved to locations southwest of Point Barrow (Fig. 3). Activity and temperature data transmitted from PTTs on some of those bears suggested that they were in maternity dens. Thus, unusual currents prevalent in the southern Beaufort Sea that year appeared to have passively carried denned bears into areas where we had not seen them before. That hypothesis was substantiated by subsequent aerial telemetry reconnaissance.

A realized shortcoming of using satellite telemetry in studies of denning is that PTTs often do not fix position when a bear occupies a den. Thus, from sensor data, we may know that a bear is denned, but not the location of the den. Fortunately, the den entrance and emergence location can often be surmised from the last location of the fall season and the first location of the spring season after emergence from the den.

Habitat Use Studies

During 3 separate surveys between March and June 1987, instrumented polar bears were followed by Piper Super Cub aircraft to ascertain habitat use and hunting patterns. Analyses are not yet complete, but preliminary assessments suggest that polar bears make dramatic seasonal shifts in hunting patterns and corresponding habitat use. In late winter and early spring, most hunting is done along refreezing leads that occur in very active ice. During April, however, there was a marked shift in behavior and habitat use. At that time, bears hunted almost exclusively for seals in lairs, and concentrated their activities in more stable ice types that had greater deformation and greater accumulation of drifting snow. Concomitant with the shift in emphasis to hunting for lairs, male bears showed less interest in feeding, and more interest in breeding activities. Males hunted only 0.39 structures per kilometer while females hunted 0.97 structures per kilometer. Forty nine hunted structures were observed from the air, and subsequently examined on the ground. This included 27 breathing holes (mostly located in early spring), 17 haulout lairs, and 5 birth lairs. Four of the birth lairs showed evidence of a kill (80%), whereas only 15% and 6% of the breathing holes and haulout lairs were hunted successfully. Because hunting of birth lairs occurred largely in April and May, and because bears hunting lairs were so successful, the lower hunting rate by males may be significant from the standpoint of nutritional balance.

During April 1987, we augmented aerial tracking of instrumented polar bears with ground searches using trained labrador retrievers. Information gathered with the aid of dogs corroborated data gathered from the aerial work. A paper summarizing that study was presented at the 7th Biennial conference on the Biology of Marine Mammals in December 1987. The abstract of that paper appears in Appendix 1.

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Table 1. Comparison of ^{13}C values calculated for 23 polar bears (3 samples per claw) captured in the Chukchi and Bering Seas and 31 polar bears (4 samples per claw) captured in the Beaufort Sea.

Group	Count	Mean:	Std. Dev.	Std. Error
Beaufort Sea	146	16.461	0.578	0.048
Chukchi Sea	69	15.16	0.56	0.067

DF	Unpaired t Value	Prob. (2-tail)
213	15.563	0.0001

Table 2. Comparison of known production of cubs for 39 radio-collared females that denned on drifting pack ice and 16 radio-collared females that denned on land between 1981 and 1987.

Group	Count	Mean	Std. Dev.	Std. Error
SEA	39	0.692	0.832	0.133
LAND	16	1.062	0.998	0.249

Degrees of Freedom	Unpaired t Value	Probability (1-tail):
213	15.6	0.0001

Appendix 1: Predation of Ringed Seals in the Western Beaufort Sea

Kelly, B. P., S. C. Amstrup, C. Gardner, and L. T. Quakenbush. Institute of Marine Science, Univ. of Alaska, Fairbanks, AK 99775 and U.S. Fish and Wildlife Service, Anchorage, AK 99503

Polar bears (*Ursus maritimus*) and arctic foxes (*Alopex lagopus*) are the principal predators of ringed seals (*Phoca hispida*) and may exert considerable influence on seal populations. Arctic foxes prey only on ringed seal pups in subnivean birth lairs,

whereas the bears also prey on older seals in and out of lairs. Rates of predation by foxes can be measured by random surveys of seal lairs, using trained dogs, but predation rates by bears appear to be poorly estimated by this method.

We used trained dogs to locate 203 lairs, including 20 pupping lairs, in the western Beaufort Sea in 1982 to 1987. Foxes entered 14.4% of the lairs and killed pups in 4 (20%) of the birth lairs. Those rates agree well with data from other parts of the Arctic and, we believe, are accurate estimates of the actual rates in the Alaskan Beaufort Sea.

Polar bears entered only 3 (1.5%) of 196 lairs located during random searches in 1982 to 1987. No kill was made at that site. While tracking bears from low-flying aircraft near the areas surveyed with the dogs, we observed indications of much higher rates of kills at lairs.

We have begun to quantify the take of ringed seals by radio-collared bears in relation to the densities of seal lairs and breathing holes, using trained dogs to locate those structures within 2 km of tracks paralleling the paths of the bears. In April 1987, along 51.5 km of polar bear tracks in the western Beaufort Sea, polar bears attempted without success to capture seals at 8/20 (40%) breathing holes, 3/9 (33%) resting lairs, and 2/2 (100%) pupping lairs located by the dogs. Three adult females averaged one attempt every 2.7 km, and three adult males averaged one attempt every 6.8 km.

We located an additional 145 seal structures during random surveys with the dogs and while tracking bears from low-flying aircraft in April and May 1987. In all, we examined 29 breathing holes, 16 resting lairs, and 12 birth lairs in which bears attempted to capture seals. Seals were killed at 10.3% of those breathing holes, 6.2% of the resting lairs, and 75.0% of the birth lairs.

Appendix 2: Published and in press manuscripts stemming from Alaskan polar bear research that occurred between the 9th and 10th IUCN Polar Bear Specialist Group Meetings

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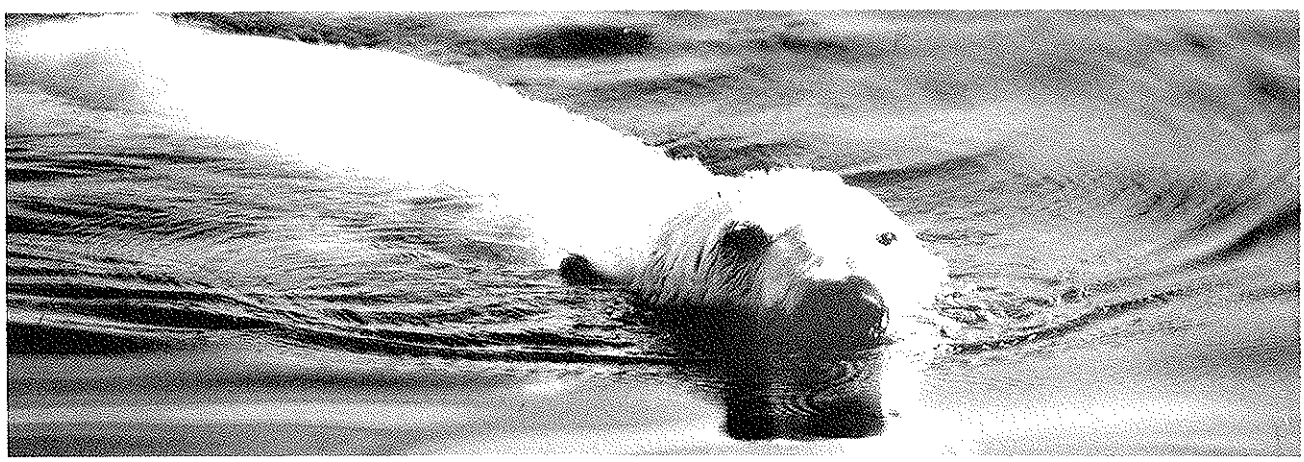


(Photo by Ray Schweinsburg)

Figure 2. Movements of all polar bears followed with satellite radiotelemetry during 1985 to 1988.

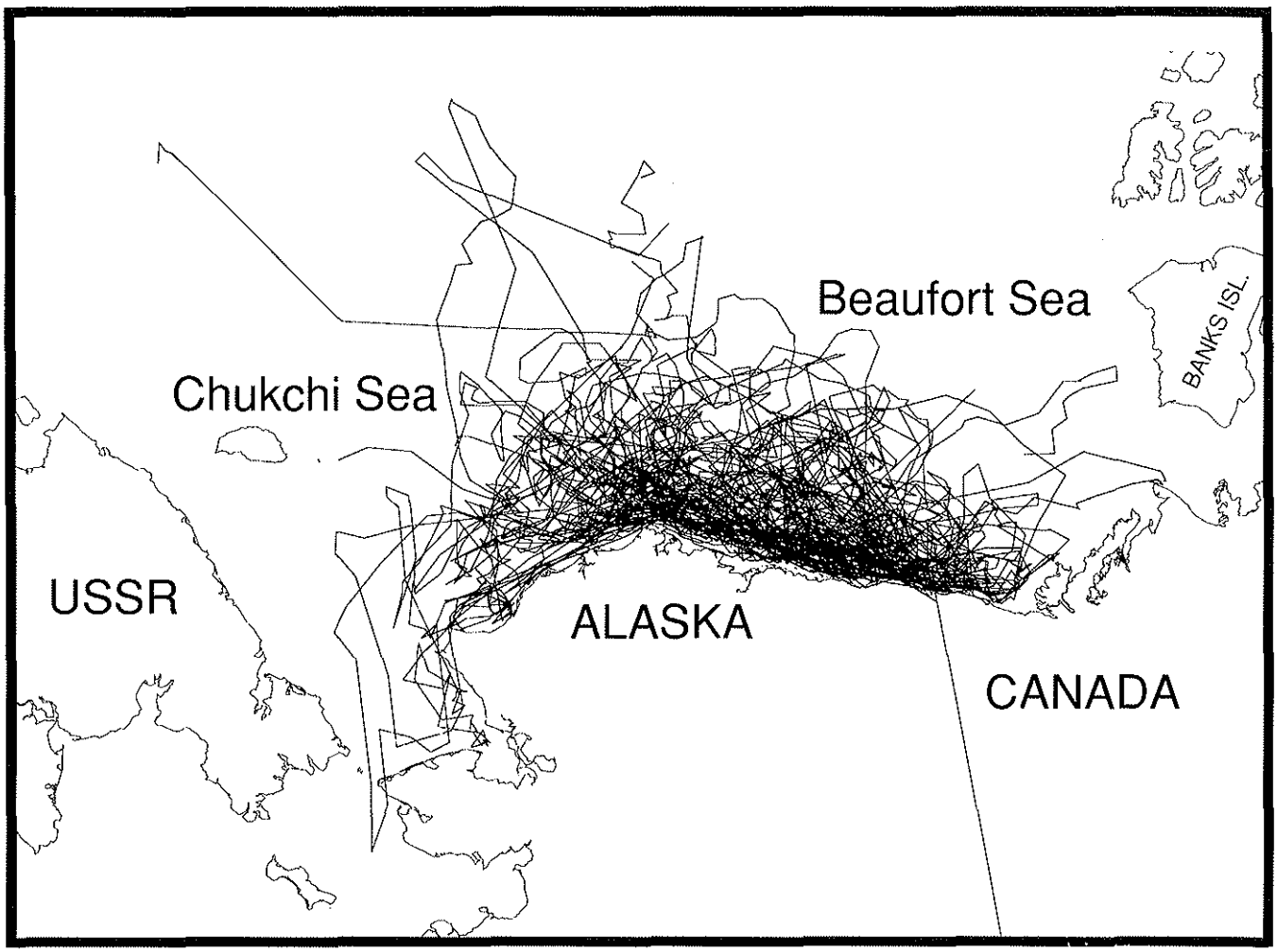


Figure 1. Movements of all polar bears followed with VHF (aerial) radiotelemetry during 1981 through 1988.

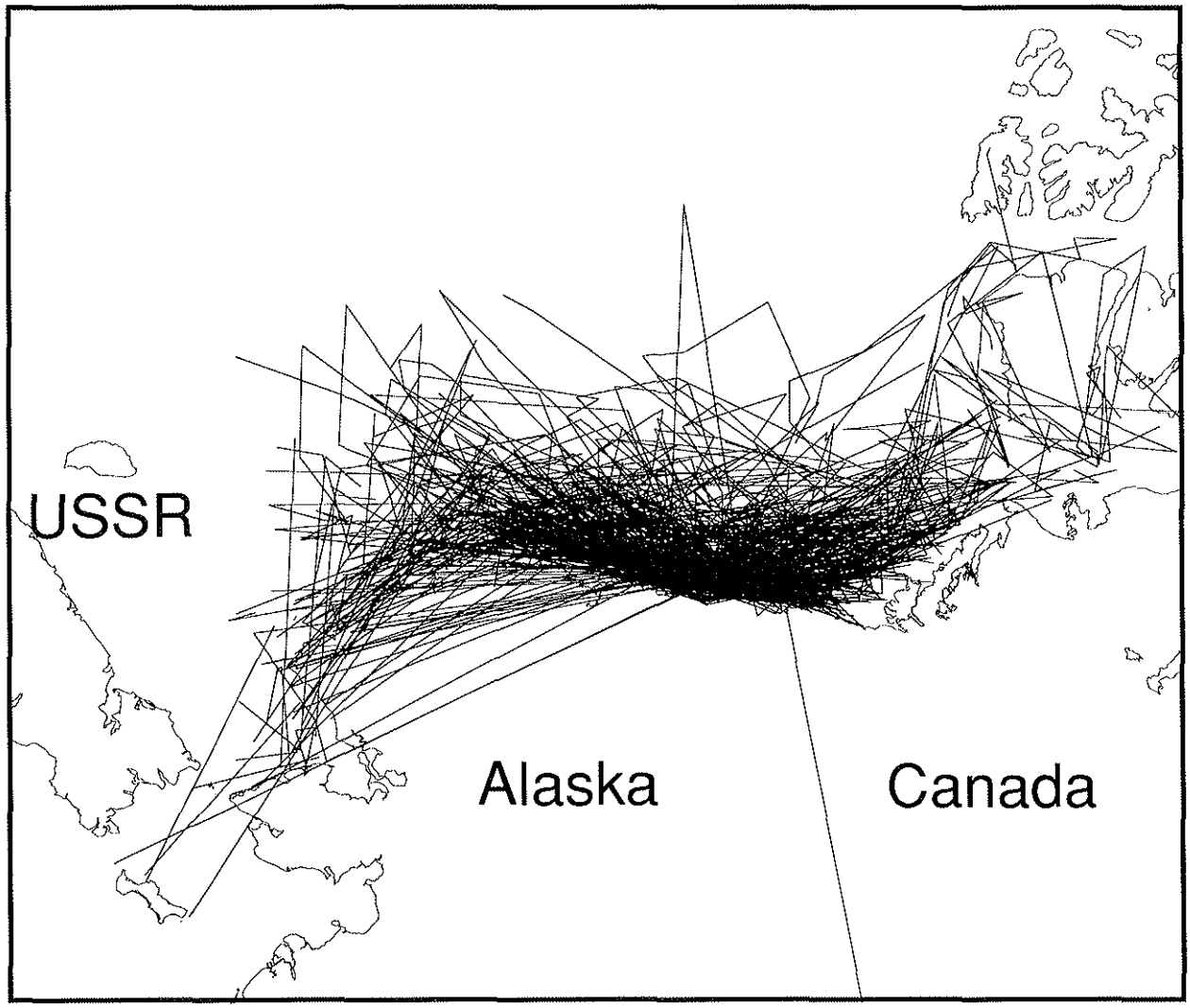


Figure 3. Movements of polar bear #6153 followed with VHF radiotelemetry between 1982 and 1986, and with satellite radiotelemetry during 1986-1988.

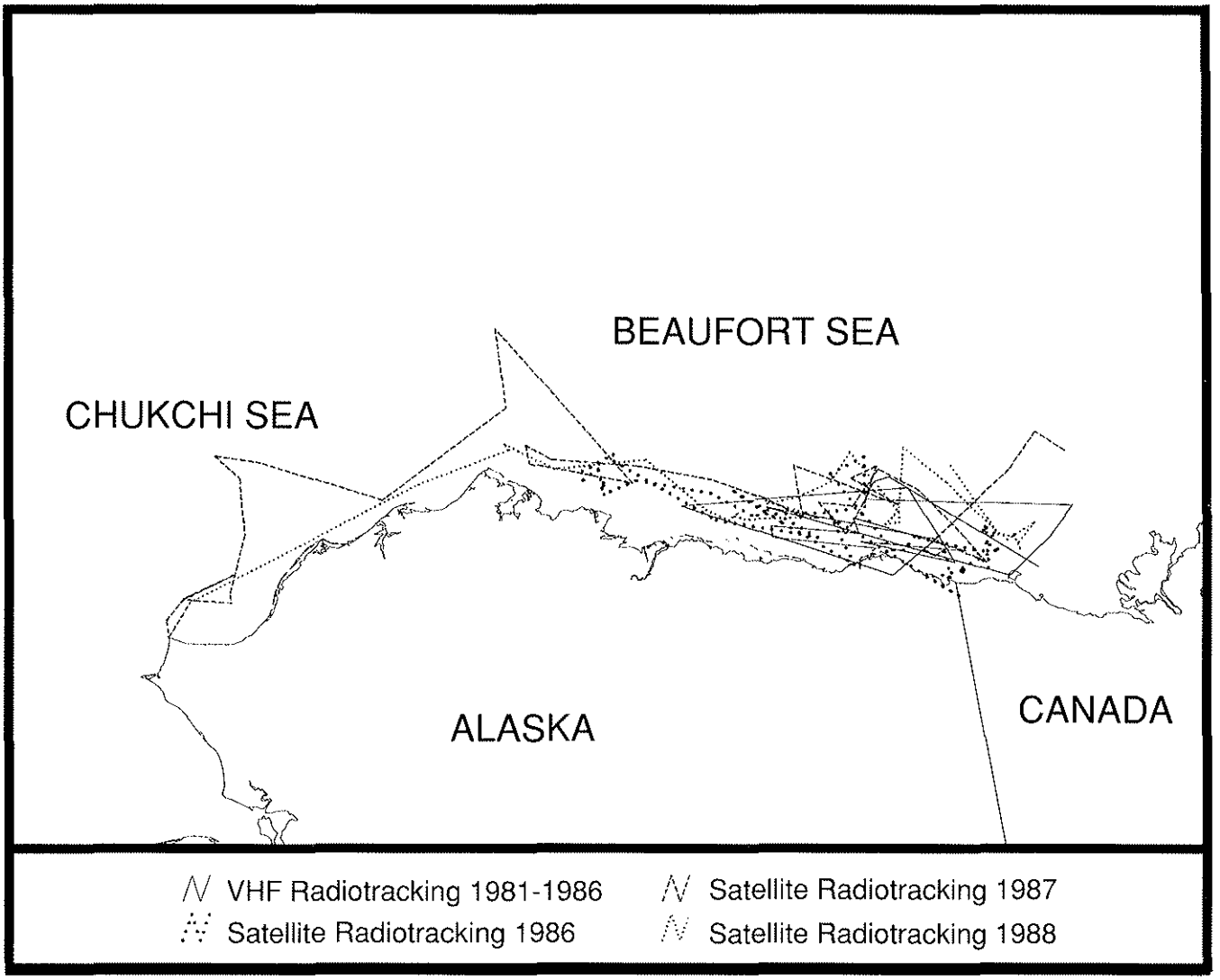
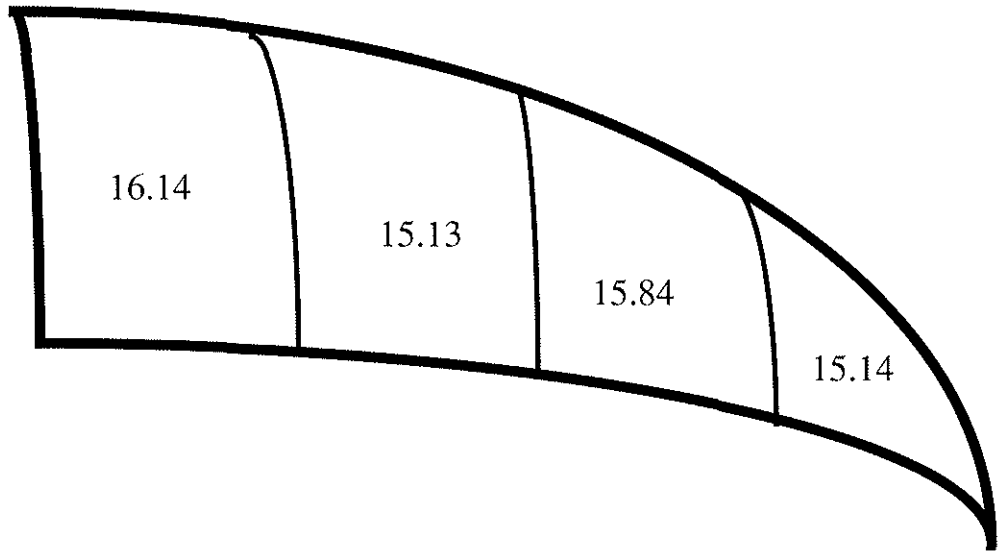
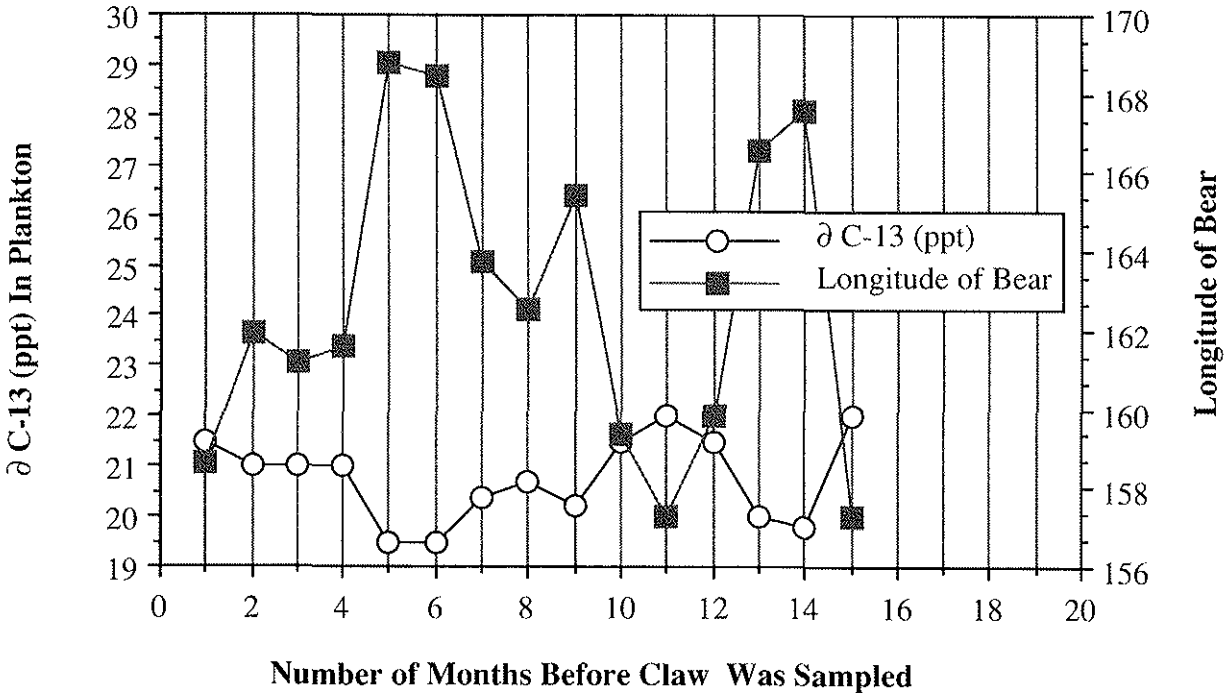


Figure 4. Mean monthly locations of polar bear #6599 during 15 months prior to the sampling of her claw. Approximate ∂ C-13 values in plankton taken from Schell et al. (1988). ∂ C-13 values for each claw segment sampled are shown in the diagram at the top of the figure. Note approximate corrrelation between plankton values and values for each claw segment.





Research on Polar Bears in Western Alaska 1986-1988

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Introduction

Research on polar bear ecology and population status in Alaska has been ongoing since 1967, and was a joint effort between the U.S. Fish and Wildlife Service (Service) and the Alaska Department of Fish and Game until passage of the Marine Mammals Protection Act (Act) of 1972. The research effort has been largely a federal program since then. In 1980, the Service began a program to closely monitor the harvest of polar bears by Native subsistence hunters in Alaskan waters. The program includes sealing skins, measuring skulls, collecting tooth samples for aging, and collecting biological tissues samples for laboratory analyses. The program annually documents the sex, age, chronology, and location of the polar bear harvest in Alaska.

Throughout the ongoing research program, western Alaska polar bear habitats lying south of Point Lay have received less emphasis than northern Alaska habitats. The research effort was concentrated at Barrow during the early years of the program, with less effort occuring at Cape Lisburne. In 1983, the research program was focused in northern Alaska with operations based at Barrow, Prudhoe Bay, and Barter Island. Use of conventional radio-telemetry and mark/recapture were emphasized during this time period, and the international nature of Beaufort Sea polar bears was established as shared between the U.S. and Canada. In 1985, the Service research program began using improved satellite telemetry technology on polar bears in the Beaufort Sea and data collection on movements was greatly enhanced.

Funding of the Service polar bear research was increased in 1986 and a western Alaska project was initiated during March 1986 with the deployment of satellite telemetry collars on adult females in the southeastern Chukchi Sea. This project was established because approximately 70% of the documented 1980-1986 annual harvest of polar bears occurred in western Alaska. Limited data were available for evaluating the impacts of this subsistence harvest on polar bears in western Alaska as specified in the optimum sustainable population (OSP) requirements of the act. To evaluate the effects of subsistence harvests on the polar bear population, the size of the parent population must be known. Also, to obtain estimates of size for a given population, the bounds of that population must be defined to establish survey areas and sampling efforts. During the early phases of the western Alaska polar bear project, designed to delineate the bounds of the population, it became apparent that the polar bear resource in western Alaska was seasonally shared with the Soviet Union. It was also apparent that any attempts to census western Alaska polar bears without including the Soviet territory would be of limited value because seasonal variation in habitat use patterns must be known to census the population and determine trend.

Objectives and Study Areas

Four main objectives account for the majority of the research being conducted on polar bears in western Alaska:

1. Delineate the polar bear populations that seasonally occupy the Bering and Chukchi seas in northwestern Alaska and the Beaufort Sea in northern Alaska.

2. Develop and refine methodology and time frame for censusing polar bears in Alaskan waters.

3. Determine size and trend of the polar bear population that seasonally occurs in the Bering and Chukchi seas of Alaska.

4. Determine the interrelationships between sea ice habitats and seasonal distributions of polar bears in the Bering and Chukchi seas.

The study area includes the northern Bering Sea, the eastern Chukchi Sea and the entire Beaufort Sea for objectives 1 and 2. The northern Bering Sea and the eastern Chukchi Sea are the study areas for objectives 3 and 4.

Methods

Objective 1

Bears are captured using helicopter immobilization techniques and each animal is weighed, measured, ear-tagged, and tattooed for permanent identification. Adult females are fitted with satellite telemetry collars and released at capture sites. Lentfer (1968), Larsen (1971), Stirling et al. (1980), Schweinsberg et al. (1982), and Stirling et al. (1985) described techniques for capturing and handling free-ranging polar bears. A minimum sample size of 20 satellite collared females will be maintained in both the western and northern study areas. Locational data are

collected using polar orbiting satellites and all locations are incorporated into geo-based computer files for computer assisted analysis of movements.

Fidelity of bears to activity areas will be evaluated by annually recollaring satellite-instrumented females. Blood samples collected from captured bears will be analyzed using mitochondrial DNA sequencing (Nei and Li 1979, Brown 1980, Ferris et al. 1981, Ferris et al. 1983, Shields and Wilson 1987) to determine degree of discreteness between the two sample areas. Procedures described by Shields and Wilson (1987) for estimating the percentage divergence between nucleotide sequences of mitochondrial DNA's will be used to assess the degree of genetic separation between the hypothized populations of polar bears. Carbon/nitrogen ratios of polar bear claws sampled during the capture program will also be analyzed to provide another index to discreteness (see presentation by Amstrup on carbon/nitrogen ratios).

Objective 2

Stratification testing will examine possible strata and include as a minimum shorefast ice, active ice, and pack ice habitats. These strata will be evaluated using numbers of polar bear tracks sighted along aerial transect lines as an index to polar bear abundance. Census methods to be investigated include line transect, belt transect, area counts and single season mark/recapture using marker darted bears and aerial relocation methods. Radio-collared females will be used to estimate sightability for the various census methods. Potential timing of census testing efforts will be assessed using satellite telemetry data from collared females. These data will be examined to determine if periods of polar bear concentrations occur that may be used to minimize the area covered during a census effort.

Objective 3

Using methods developed in the previous study, polar bears occurring in western Alaska waters will be periodically censused. Productivity of females will be measured by periodically relocating females with cubs several times per year to determine cub survival. Family groups would be captured and the cubs will be marked for identification in later recapture efforts. Age at first reproduction will be estimated by aging all captured females and the presence of cubs. A polar bear population model will be used to evaluate the status and trend of western Alaska polar bears, and the impacts of the annual subsistence harvest.

Objective 4

Ice habitat types will be determined using remotely-sensed data on ice types and distribution throughout the year. Polar bear locations will be determined using data from satellite telemetry collars attached to females. The two data sets will be combined in a geo-based computer information system and the relationships between polar bear movements and ice habitats will be examined. Ice habitat types and prey occurrence will be noted during polar bear capture operations. Denning locations of collared females will be determined from satellite telemetry data.

Results and Discussion

Capture and Marking

A total of 22 polar bears were captured during March 1986 in the southeastern Chukchi Sea. Operations were based at Kotzebue and 10 adult females were fitted with satellite telemetry collars. A fall capture program was attempted during November 1986 from Barrow, however, distribution of pack ice habitats far offshore and logistic considerations prevented capture of polar bears. Satellite telemetry performance was marginally acceptable, with 8 of the 10 transmitters failing prior to March 1987.

A total of 28 polar bears were captured during March-April 1987, in the northern Bering and eastern Chukchi Seas. Operations were based at Savoonga, Shishmaref, Kotzebue, and Cape Lisburne, and 13 female polar bears were fitted with improved satellite telemetry collars. Again, ice conditions during November 1987 prevented capture of polar bears during fall. Satellite telemetry performance was better with 7 of 13 collars functioning at recapture in March-April 1988.

A total of 49 polar bears were captured during March-May 1988 in the northern Bering and eastern Chukchi seas, including 2 bears (sow plus one 2-year old) originally marked in the Beaufort Sea . Operations were based at Savoonga, Shishmaref, Kotzebue, Cape Lisburne, and Barrow, and 24 female polar bears were fitted with satellite telemetry collars. Three collars were shed and 1 collar was ripped from the sow by her two 2-year old cubs three days after collaring. For the remaining sample of 20 satellite collared females, 3 collars failed at 9, 33, and 36 days post-deployment, three other collars are apparently malfunctioning, and 14 collars are functioning satisfactorily as of 20 October 1988.

Only 8 of the 97 polar bears captured in western Alaska during 1986-1988 were recaptures. This low recapture rate is due to two factors. Distribution of collared females during March-April often extends west of the 69th parallel and these animals are not available for recapture. Also, those females that den the following winter are apparently denning near Wrangel Island and are also not available for recapture. In addition to these distributional problems, the earlier satellite collars did not function for the full year and the beacon transmitters were also not performing as expected (re. reduced range and battery life).

A total of 24 family groups were captured during the 3 years of spring capture effort (Table 1). No litters of cubs of the year were encountered during the three years of capture. Litter sizes

varied between years with an overall mean litter size of 1.75 cubs per female. Survivorship of yearling cubs to 2 years of age was 100% for two family groups of 2 cubs each recaptured the following year. Another family group of 2 yearlings apparently survived to 2 years of age as the female was with a breeding male at the time of recapture and fresh tracks of 2 young bears were in the vicinity of the two adult bears, although the two cubs were not observed.

Movements

Satellite telemetry data indicate that polar bears occurring in the Bering and Chukchi seas are seasonal residents during November through March, but retreat northward with the pack ice during spring (April through May) and remain in the northern and northwestern Chukchi Sea from June through October (Fig. 1). These waters are adjacent to the Soviet coastline. Four female polar bears marked in the Chukchi Sea have apparently denned in the vicinity of Wrangel Island in Soviet territory during fall 1987, as indicated by satellite telemetry data. Denning of Chukchi/Bering Sea marked polar bears in U.S. territory has not been documented using satellite telemetry data. To date, no polar bear marked in either northern or western Alaska has permanently moved from one sea to the other. However, movements of polar bears marked in the Beaufort Sea into the Chukchi Sea have been documented. A Beaufort Sea polar bear moved into the northern Bering Sea during December 1987, but returned to the Beaufort Sea during spring 1988.

Movement patterns of marked Chukchi polar bears during 1988 were markedly different from movement patterns observed in previous years (Figs. 2-4). Eleven bears have shown similar patterns to previous years (Figs. 2-3), while six bears have moved into the central Beaufort Sea (Fig. 4). Four of these bears are potential breeders and it remains to be seen if they den in the Beaufort Sea area.

During the spring 1988 capture program, an adult female polar bear and her 2-year old offspring were both fitted with satellite collars. This family group was in the process of breaking up at the time of capture and the subsequent movements of the two bears is presented in Fig. 5. The two bears remained in close proximity until late spring and have since widely separated, with the adult female returning to the northern coastline of the Soviet Union, while the young female has moved into the central Beaufort Sea.

Biological Sampling

Two populations of polar bears may occur seasonally in the coastal waters of Alaska. In addition to the movement data provided by satellite telemetry, several other biological parameters of polar bears are being investigated to provide additional data for assessing the discreteness of polar bear captured in northern and western Alaskan areas. Blood samples are collected from each bear captured throughout Alaska. The potential use of mitochondrial DNA to measure degree of separation between polar bears captured in northern and western Alaska is being examined by cooperators at the University of Alaska. The following materials were extracted from an interim report provided by Gerald Shields, University of Alaska, Fairbanks.

Both the restriction fragment method (Shields and Helm-Bychowski 1988) and the cell-free cloning and rapid sequencing method (Saiki et al. 1985) were used to study the mitochondrial DNA of eight polar bear samples collected at different sites in Alaska. Samples were taken from two bears near Prudhoe Bay, two bears near Kotzebue, and four bears near St. Lawrence Island.

The restriction analyses involve exposure of the DNA to a number of restriction enzymes which cleave the DNA at specific recognition sites. Cut fragments are end-labelled with isotope, electrophoresed and analyzed. Identical DNAs will have identical fragment patterns. When mutations change recognition sites, a corresponding change will occur in the fragment patterns when individuals are compared.

During the course of this study, methodology became available by which DNA could be amplified from very small quantities of tissue including whole blood. This breakthrough allowed the amplification of DNA from frozen blood samples and eliminated the dependence upon subsistence harvested bears for tissue. The amplification technique involves the exponential replication of a target DNA sequence through successive priming reactions. After 40 rounds of amplification, a trillion copies of the target sequence can be obtained. The amplified product can then be sequenced. The cytochrome b gene of mtDNA from eight polar bears was amplified for this study.

The restriction fragment analysis is not yet complete. Thus far only a single polymorphism has been observed. Individual #2 from St. Lawrence Island differs from all other polar bears in the possession of a 4550 nucleotide y base pair fragment. All other bears lack this fragment and possess two smaller fragments of 2700 and 1850 base pairs. A 210 base pair sequence of the cytochrome b gene, which was amplified and sequenced from eight polar bears, showed that a single transition from guanine — adenine characterized individual #2. All of the seven other bears were identical.

There is essentially no genetic variation in the eight polar bears as assessed either by restriction fragment analysis of the entire mtDNA molecule or by sequencing of the cytochrome b gene. This suggests that the polar bear populations are young and that there may be gene flow between them. These data, although incomplete, do not suggest reproductive isolation and lack of gene flow between populations. In order to complete this study, other regions of the mtDNA genome must be studied (e.g., the displacement loop), and bears from other circumpolar regions must be included.

Carbon/nitrogen ratios of polar bear claw material is also being investigated by cooperators at the University of Alaska. The growth rate of polar bear claws is unknown and field marking claws of repeatedly captured polar bears will provide data to determine this rate and the usefulness of the C/N technique. Results of this research are reported by Amstrup.

Census Technique Development

During April and May of 1987, Service personnel counted polar bears observed along approximately 12,000 km of aerial transect lines in Alaska's Bering, Chukchi, and Beaufort seas. The purposes of these surveys were to evaluate a stratification scheme based upon ice types and to test several census methods (strip transect, line transect, and single season mark/recapture). Survey coverages of sample areas were not complete, but sampled variable portions of available polar bear habitats. Flights were in a Dehavilland Twin Otter aircraft fitted with special, large, viewing windows. Transects were flown at an altitude of approximately 100 m, and at approximately 200 km/h. Transect width was 1.6 km, however, effective strip width may have been as low as 0.8 km. There were two principal observers on duty during all flights. Only 14 sightings were made including a total of 24 polar bears.

Survey data are currently being analyzed and a summary report will be completed during winter 1988. Preliminary analyses have resulted in several tentative conclusions. Statistical analysis of aerial survey data are complicated by small sample sizes that result from the assumed low density of polar bears and the large size of their available habitat. Sample intensity (density of transects) within a given area appeared to influence the numbers of polar bears sighted. Sightability of polar bears in ice habitats is influenced by light conditions, aircraft altitude, and aircraft speed. The relationship between numbers of polar bears sighted during aerial surveys and the population size is currently unknown. The research program on determining the suitability of aerialsurveys for estimating population size of polar bears is continuing.

Habitat Use

Remotely sensed data on ice types, distributions, and movements are currently being analyzed with reference to concurrent locational data from satellite instrumented polar bears in the Bering and Chukchi seas. Location of denning activity is also being recorded via locational data from satellite instrumented polar bears. Locational data for polar bears were integrated into a Geographical Information System (GIS). Sources of remotely sensed ice data and other digitized ice data will be located in 1989, to use in the GIS for assessing habitat/polar bear interrelationships.

Satellite Telemetry Performance

The performance of satellite telemetry collars on polar bears was summarized in a presentation at the Tenth International Symposium on Biotelemetry in Fayetteville, Arkansas and is illustrated in Table 2 and Figure 6. The abstract of that paper is shown in Appendix 1.

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Table 1. Summary of litter sizes for polar bear family groups captured in western Alaska during spring 1986-1988.

	Yearlings			2-year olds			Totals		
Year	# groups	# cubs	X	# groups	# cubs	X	# groups	# cubs	X
1986	4	7	1.75	2	3	1.50	6	10	1.67
1987	4	8	2.00	2	4	2.00	6	12	2.00
1988	5	8	1.60	7	12	1.71	12	20	1.67
Totals	13	23		11	19		24	42	
X	1.77			1.73			1.75		

Appendix 1: Performance and Utility of Satelite Telemetry During Field Studies of Free-Ranging Polar Bears in Alaska

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Abstract

Satellite telemetry technology has been used during field studies of polar bears in Alaska since 1985. A total of 109 Platform Transmitter Terminals (PTT) have been deployed on free-ranging female polar bears that seasonally inhabit waters adjacent to the Alaskan coast. The PTTs transmitted locational and sensor data to TIROS-N polar-orbiting satellites during a duty cycle of 12 hours on/60 hours off in 1985, 1986, and 1987. Expected battery life was 13.8 months, and collars were normally removed and replaced with new or refurbished PTTs at 11-13 month intervals. Duty cycles were altered to 7-8 hours on/64-65 hours off in 1988 to prolong expected battery life to 19-21 months. Sensor data transmitted included PTT internal temperature, short term activity counts recorded at 60 second intervals, and long term activity counts for the preceding 24 or 72-hour period. Early failures of PTTs to fix location (less than 75% of expected battery life) were as high as 53% during 1985-1986. Subsequent improvements in PTT design, including better shock insulation, improved electronics, and an improved battery system have reduced early failures to 27% in 1987-1988. The harsh environment and the degree of abuse observed in recovered collars indicate that an unavoidable failure rate of 8-10% is inherent within 60 days after deployment on polar bears. A total of 18,000 locations and 201,000 sensor messages were received from female polar bears between May 1985 and June 1988. Polar bears that were marked in Alaskan waters have been located as far south as 60° N 168° W in the Bering Sea, as far west as 75° N 164° E in the East Siberian Sea, as far north as 79° N 166° W, and as far east as 70° N 127° W in the Beaufort Sea. Polar bears in the Beaufort Sea are shared with Canada, while polar bears in the Chukchi and Bering seas are shared with the Soviet Union. The international ranges of the two hypothesized populations have been documented. Satellite telemetry has detailed the large movement patterns of polar bear over these vast areas that were previously not available using other techniques.

Presented at Tenth International Symposium on Biotelemetry, 31 July-5 August 1988, Fayetteville, Arkansas. Proceedings to be published in late 1988.

Table 2. Proportion of Platform Transmitter Terminal (PTT) versions that were functioning at the beginning of 60-day intervals after deployment, and failed during that interval, exclusive of functioning PTT's removed from polar bears.

Function Type and Time	Satellite PTT Versions				
Interval (days)	2A	2B	3A	3B	3C
n	2	30	5	30	40
Locations:					
	<60d0	0.167 (5/30)	0.200 (1/5)	0.067 (2/30)	0.083 (3/36)
61 -120d	0	0.067 (2/30)	0	0	0
121-180d	0	0.133 (4/30)	0.200 (1/5)	0.100 (3/30)	NA
181-240d	0.500 (1/2)	0.100 (3/30)	0	0	NA
241-300d	0.500 (1/2)	0.067 (2/30)	0	0.107 (3/28)	NA
301-360d	0	0.080 (2/25)	0.200 (1/5)	0.333 (9/27)	NA
361d+	NA	0.053 (1/19)	0.400 (2/5)	0.320 (8/25)	NA
Recovered	2	11	0	4	NA
Sensor Data:					
	<60 0	0.133 (4/30)	0.200 (1/5)	0.067 (2/30)	0.083 (3/36)
60-120d	0	0	0	0	0
121-180d	0	0.133 (4/30)	0.200 (1/5)	0.100 (3/30)	NA
181-240d	0	0.067 (2/30)	0	0	NA
241-300d	1.00 (2/2)	0.033 (1/30)	0	0.107 (3/28)	NA
301-360d	0	0.080 (2/25)	0	0.333 (9/27)	NA
361d+	0	0.316 (6/19)	0.600 (3/5)	0.320 (8/25)	NA
#Recovered	2	11	0	4	NA

Figure 1. Movements of female polar bears fitted with satellite radiotelemetry collars in western Alaska.

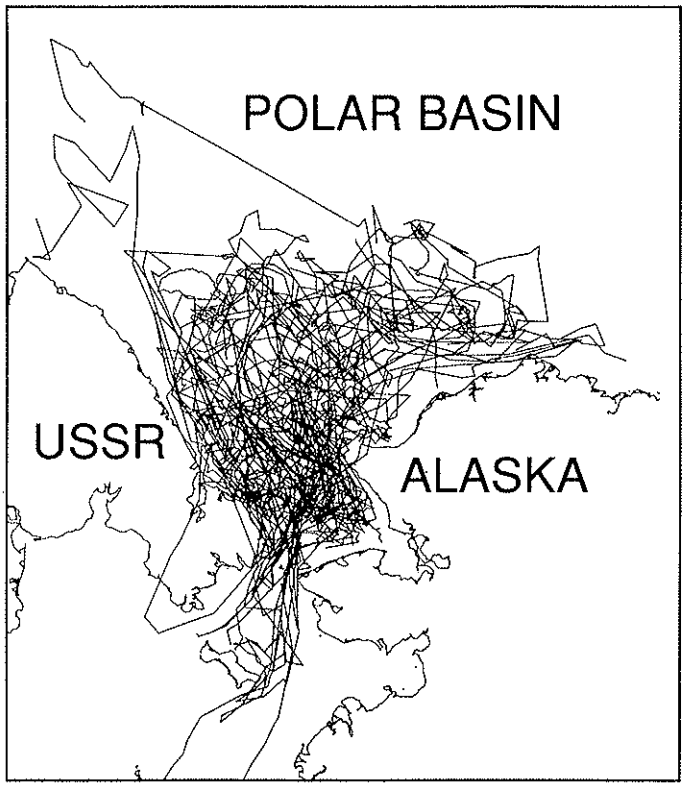


Figure 2. Movements of four female polar bears collared near St. Lawrence Island, March-August 1988, showing movements into the northwestern Chukchi Sea.

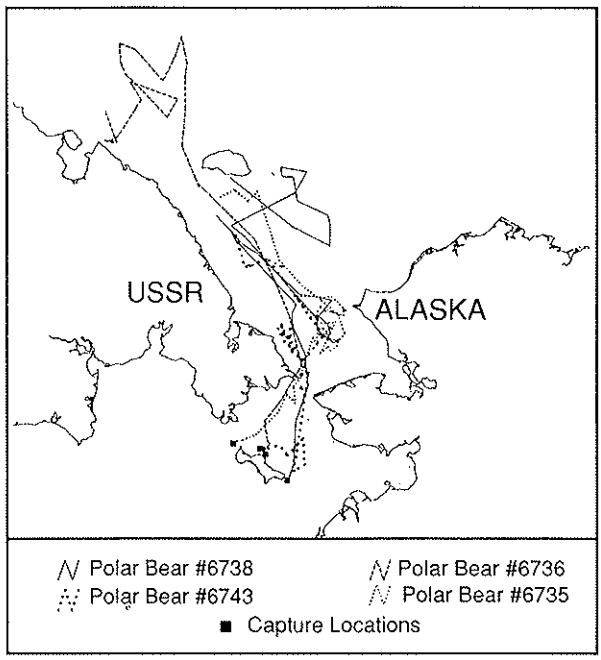


Figure 3. Movements of 5 female polar bears collared during the spring of 1988, showing movements into the north central Chukchi Sea.

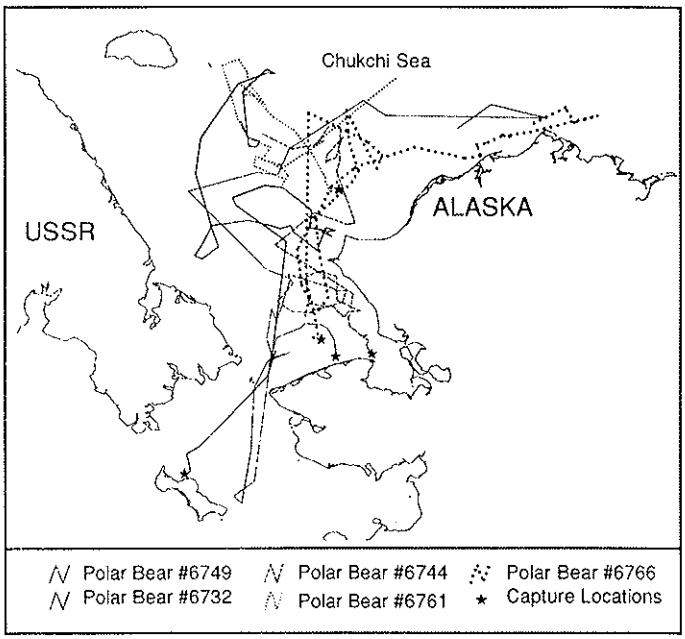


Figure 5. Concurrent movements of an adult female polar bear #6735 and her 2-year-old female cub #6734 between March and August 1988.

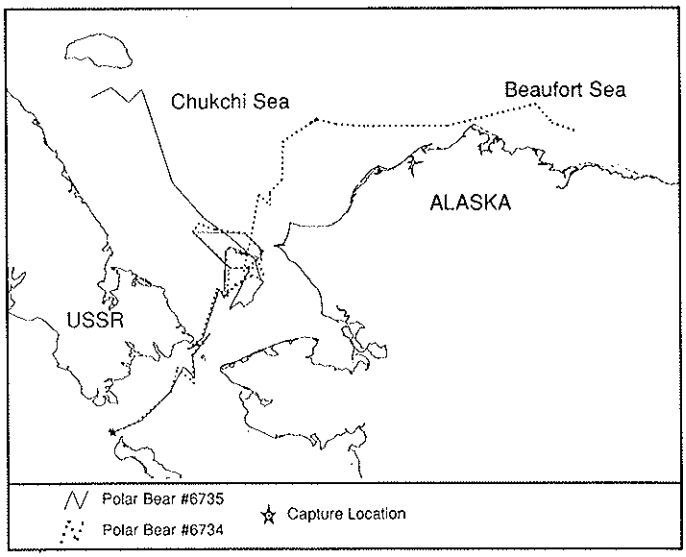


Figure 4. Movements of 4 female polar bears collared during spring 1988, showing movement into the western Beaufort Sea.

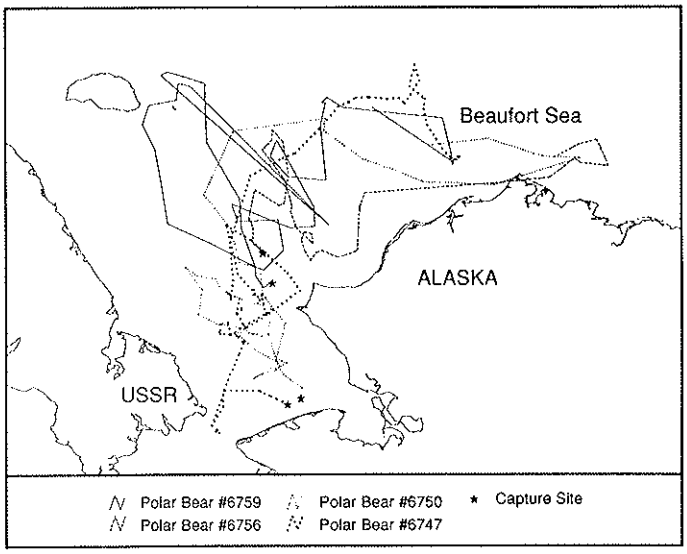
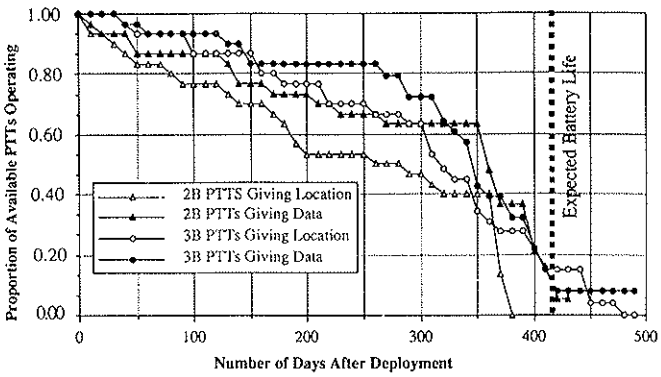


Figure 6. Summary of performance for 30 model 2B and 30 model 3B satellite radio transmitters (PTTs) attached to polar bears in the Beaufort, Chukchi, and Bering Seas between 1986 and 1988. Often, PTTs continue to transmit data for a period of time after signal strength has deteriorated below the threshold necessary to fix location. Also, some PTTs were recovered while still transmitting data or location information. Data illustrated are proportions of PTTs remaining on bears that are providing location fixes or data transmissions at the post-deployment times shown.



Summary of Polar Bear Management in Alaska

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Federal Regulations

The U.S. Fish and Wildlife Service (Service) is amending the Code of Federal Regulations (CFR) 50 Part 18 to establish marking, tagging and reporting regulations authorized under Section 109(i) of the Marine Mammal Protection Act (Act) of 1972. This action implements a 1981 amendment to the Act and will assist the Service in monitoring the subsistence and handicraft harvest of polar bear, Pacific walrus (*Odobenus rosmarus*) and sea otter (*Enhydra lutris*), and in obtaining essential biological data needed to manage these species. The action will also help control the illegal take, trade, and transport of specified raw marine animal parts. Previous harvest reporting was not mandatory, although, comprehensive harvest data was collected by local villagers hired by the Service starting in 1980.

The final rule to establish marking, tagging and reporting regulations was published in the Federal Register on June 28, 1988. On October 26, 1988 after an implementation period of 120 days, the new rule will become mandatory. There will be a 180-day period during which all stocks of raw, unaltered specified parts in the possession of hunters, registered agents and tanneries will be marked and tagged. Native hunters will have 30 days from the date of kill or acquisition to present all harvested specified parts for marking and tagging to a local representative. Skins and skulls may be frozen or thawed, but skulls must be detached from the hide. Failure of the Native hunters or possessor of the specified marine mammal parts and registered agents or tanneries to comply with the new rule could result in civil penalties not to exceed $10,000 for each infraction. Information obtained from the new program will be published for public review in the U.S. Fish and Wildlife Service Region 7 annual report to Congress.

Other polar bear management activities since the last meeting have remained essentially unchanged. The Marine Mammal Protection Act, which governs and funds research and management activities, is expected to be reauthorized for 5 years in the near future. A minor change in the requirements for importation of marine mammals for research or public display purposes is being considered. Other provisions related to polar bear management will remain the same as in the past.

The Act allows coastal dwelling Natives to take polar bears for subsistence purposes or for the creation of authentic Native handicrafts so long as the taking is not wasteful and the population(s) is not "depleted." A depleted population is one that is below its optimal sustainable population level (OSP). OSP is defined as the population level that will result in the maximum productivity of the population, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which it is a constituent element.

A population may be declared to be depleted by any of three methods: (1) the Secretary of the Interior after consultation with the Marine Mammal Commission and the Committee of Scientific Advisors may determine a population stock to be below its OSP; (2) a State with authority to manage marine mammals may determine a population to be below its OSP; or (3) a species or stock may be listed as an endangered species under the Endangered Species Act of 1973. One species, the North Pacific fur seal, was recently declared to be depleted when its population declined to 60% of contemporary high levels.

The leasing of offshore subsurface mineral rights continues. Coastal and offshore exploration developments, primarily related to oil and gas, have slowed recently in response to a downward trend in global oil prices and in part to an absence of discovered large volume reserves which are necessary to make development cost effective. The Arctic National Wildlife Refuge coastal plain, is an exception and represents an area of great interest and speculation by the oil industry. The U.S. Congress is required to determine whether development may occur. Actions which could influence future development in Alaska include: increases in crude oil prices, the discovery of new oil fields, Congressional consent to develop the Arctic National Wildlife Refuge.

The governer of Alaska announced in March 1988 that the State of Alaska would not seek management authority for marine mammals. Previously the State indicated an interest in resuming management authority. The State did indicate that a cooperative management plan approach should be developed and that the State and other interested groups or individuals should be incorporated into the procedure. The Service is currently evaluating the scope and procedures for developing comprehensive management plans in the near future.

Native Subsistance Harvest 1985-88

The Service has documented polar bear harvests by coastal dwelling Natives of Alaska since 1980. The State of Alaska collected harvest information from 1960 to 1973, when the Marine Mammal Protection Act was passed, which focused primarily on the sport harvest occurring at the time. From 1973 to 1979 the State continued to collect harvest data on an informal basis. Since that time the Fish and Wildlife Service has actively monitored the harvest along northern and western Alaska utilizing local representatives to tag skulls and hides and collect biological data and specimens. Although sealing and reporting were not required by law prior to 1973, the system of accounting for kills is believed to provide a comprehensive perspective of the magnitude of the harvest and a representative sample of biological parameters of bears taken in the harvest. Sex and age data were collected from 70% of animals harvested since 1980. The project leader conducted monthly trips to the villages that harvest bears.

Harvest Summary

Since July 1985, 344 polar bears have been harvested in 15 Alaskan villages (Table 1 , Fig. 1) or an average of 115 bears per year which is less than the 8-year average of 130. Harvest of bears by villages west of Pt. Lay (Western Area) comprised 71% of the take while Pt. Lay and the villages to the east (Northern Area) constituted 29% of the harvest. The designations "Northern" and "Western" are hypothesized and Service research personnal continue to address questions of stock separation.

Statewide, the component of the harvest for which sex is known was comprised of 64% males and 36% females (Table 1). The age-class composition of the harvest was 31% cubs, 28% subadults and 41% adults (Table 2). Some independent animals entering their third year of life may have been included in the cub category. The chronology of the harvest favors the months of November to January (44%) and March to May (41%) (Table 3). The remaining six months account for 15% of the harvest.

Recent harvest data are most useful when viewed from a historical perspective. From 1925-1953 the mean harvest of bears was 117 per year while during the 1954-1960 period an average of 158 bears were harvested. The sex composition was not noted for either era. The mean harvest for the 1960-1972 period was 260 bears of which an average of 63 (25%) were females. From 1973-1979 the mean harvest was 86 bears of which an average of 37 (43%) were females. From 1980-1988 the mean harvest was 130 bears of which 47 (36%) were females. Forty-five females and 8 bears of unknown sex were harvested during 1987-88. The percentage of the recent harvest comprised of females has increased while the net removal is less than for the 1960-1972 period. The removal during the 1960-72 period, by regulation and hunter preference, concentrated on larger adults and likely did not include dependent animals nor smaller subadult females to the degree of todays harvest.

Age composition of harvested animals has varied annually with a non-selective harvest. Mean ages of males and females killed between 1985-1988 were 6.1 and 7.3 (Table 4). Near shore harvests are now accounting for the take of older age animals which were absent from the harvest in the 1970's.

Western Area

The harvest in the area of the Chukchi and Bering seas accounted for 245 bears, or 71% of the statewide harvest. The male to female sex ratio was 63:37. Annual average age of harvested males ranged between 4.2 $\pm$ 3.3 and 7.1 $\pm$ 4.8 (Table 4). Female annual average ages ranged between 6.8 $\pm$ 4.8 and 7.4 $\pm$ 5.4. St. Lawrence Island accounted for 39% of the harvest from the area during the reporting period. The chronology of the harvest was primaily (87%) January to May. The availability of denning females to hunters was limited by ice conditions which restricted their movement during that period. Two family groups of two cubs of the year, were inadvertently taken during the spring of 1988.

Northern Area

The area of the Beaufort Sea, which encompasses the villages of Kaktovik, Nuiqsut, Barrow, Wainwright and Pt. Lay harvested 99 (29%) bears during the reporting period. The male to female sex ratio was 65:35 and showed wide variability among years (Table 1). Annual average age of the harvest ranged from 3.2 $\pm$ 1.1 and 9.1 $\pm$ 6.7 for males and 3.3 $\pm$ 1.2 and 9.7 $\pm$ 5.6 for females (Table 4). Harvests in this area is dispersed more generally through out the year with peaks occurring in the fall and spring (Table 3). Female bears searching for den sites are available to hunters during fall months. The area accounted for 88% of the statewide harvest during the September to November period.

Management of Polar Bears in the Beaufort Sea

Since the last Polar Bear Specialists Group meeting, an initiative by user groups in Canada and Alaska to jointly manage polar bears of the Beaufort Sea region was developed and implemented. The agreement is entitled, "Management Agreement for Polar Bears in the Southern Beaufort Sea" (Appendix 1).

The user groups signatory to the management agreement are the North Slope Borough in the United States and the Inuvialuit Game Council in Canada. In part, the rationale for the management agreement may be found in Article II of the Agreement on the Conservation of Polar Bears which states that contracting parties shall "take appropriate action to protect the ecosystems of which polar bears are a part," and the recent understanding that bears that occupy the area are indeed a shared resource. The

subject was addressed in the Proceedings of the Ninth Working Meeting of the IUCN/PBSG, August, 1985, Appendix 13, Resolution B, "Management of Internationally Shared Populations."

Motivated by a concern for the welfare of the population and recent research findings that indicate the nature and extent of interchange in the population and in recognition of the differences in management systems which exist in Canada and Alaska, the user groups embarked upon a coordinated management approach. Resolutions that adopted the draft management plan were passed on October 16, 1987 by the North Slope Borough and on November 19, 1987 by the Inuvialuit Game Council. Members advanced the draft plan to the village level for review and comment. The management agreement is a precedent setting first attempt by users in different jurisdictions to jointly manage a shared wildlife population. The management agreement was ratified on January 29, 1988, approximately 2 years after the first joint discussions on the subject.

The Management Agreement includes a listing of the objectives, definitions, regulations, terms for sharing population information and collection of data and duration of the agreement. The agreement stipulates that administration shall be by the Joint Commission that consists of two representatives designated by the Inuvialuit Game Council and the North Slope Borough Fish and Game Management Committee in consultation with a panel of technical advisors appointed by the Joint Commission. Annual review of biological findings and determination of sustained yield and allocation of the sustained yield between countries is required.

On October 17, 1988, the Joint Commissioners and technical advisors met to discuss terms of the cooperative allocation agreement. The objectives of the meeting were to describe the role of the technical committee, review biological information on polar bears of the area, describe approaches for determining and allocating the sustainable yield, develop methods to ensure compliance with the Management Agreement and provide recommendations to the Joint Commission. Recommendations including annual harvest rate per jurisdiction were developed along with the rationale for the recommendations.

Appendix 1: Management Agreement for Polar Bears in the Southern Beaufort Sea

SECTION II

AGREEMENT BETWEEN:

THE INUVIALUIT GAME COUNCIL
OF INUVIK, NWT, CANADA

AND

THE NORTH SLOPE BOROUGH FISH AND GAME MANAGEMENT COMMITTEE
OF BARROW, ALASKA USA.

The Inuvialuit of Canada and the Inupiat of the United States

Noting that both groups have traditionally harvested a portion of polar bears from the same population in the southern Beaufort Sea; and,

Noting that the continued hunting of polar bears is essential to maintain the dietary, cultural and economic base of the groups; and,

Noting that the maintenance of a sustained harvest for traditional users in perpetuity requires that the number of polar bears taken annually not exceed the productivity of the population; and,

Noting that the International Agreement on the Conservation of Polar Bears makes provision for cooperation in the research and management of shared populations; and,

Noting that nothing in this Agreement shall be read to abrogate the responsibilities of Federal, Provincial or State authorities under existing or future statutes; and,

Noting that the Inuvialuit and the Inupiat will have a long-term fundamental influence on the maintenance and use of this resource and that the efforts of other parties will also be required to ensure effective conservation;

Have Agreed as Follows:

ARTICLE I

Definitions

a) The species considered in this agreement is the polar bear (*Ursus maritimus*).
b) The area covered by this agreement is the southern Beaufort Sea from approximately Baillie Islands, Canada, in the east to Icy Cape, USA in the west.
c) The people covered by this Agreement are the Inuvialuit of Canada and the Inupiat of the North Slope of Alaska.
d) The settlements whose hunting practices may be affected by this Agreement are Barrow, Nuiqsut, Wainwright, Atqasuk and Kaktovik in the United States and Inuvik, Aklavik, Tuktoyaktuk and Paulatuk in Canada.
e) Sustained yield is a level of taking which does not exceed recruitment and is consistent with population ranges determined to be optimal and sustainable.
f) The Joint Commission shall consist of two (2) representatives designated by each of the Inuvialuit Game Council and the North Slope Borough Fish and Game Management Committee. The Technical Advisory Committee shall be appointed by the Joint Commission.

ARTICLE II

Objectives

a) To maintain a healthy viable population of polar bears in the southern Beaufort Sea in perpetuity.

b) To provide the maximum amount of protection to female polar bears.

c) To minimize detrimental effects of human activities, especially industrial activities, on important polar bear habitat.

d) To manage polar bears on a sustained yield basis in accordance with all the best information available.

e) To encourage the collection of adequate technical information on a timely basis to facilitate management decisions.

f) To further refine the eastern and western boundaries of the population of polar bears.

g) To encourage the wise use of polar bear products and by-products within the context of management on a sustained yield basis.

h) To facilitate the exchange of polar bear meat and products between traditional users in Alaska and Canada (Enabling legislation required).

i) To legalize the sale of polar bear hides and by-products by the traditional Alaskan users in Alaska (Enabling legislation required).

j) To facilitate the export of polar bear hides and other polar bear products from the Western Arctic of Canada into the USA (Enabling legislation required).

k) To consider at a later date a limited legalized Alaskan sport harvest of polar bears which emphasizes benefits to local hunters of the area (Enabling legislation required for Federal management).

ARTICLE III

Regulations

To conserve this population of polar bears, the Inuvialuit and the Inupiat have agreed as follows:

a) All bears in dens or constructing dens are protected.

b) Family groups made up of females and cubs-of-the-year or yearlings are protected. The birthdate of cubs is fixed at January 1 and cubs less than five feet (152 cm) in straight line body length are protected.

c) The hunting season shall extend from December 1 to May 31 in Canada and from September 1 to May 31 in Alaska.

d) The annual sustainable harvest shall be determined by the Technical Advisory committee in consultation with the Joint Commission and shall be divided between Canada and Alaska according to annual review of scientific evidence. Allocation agreements shall be negotiated and ratified prior to September 1 annually. Each signatory to this Agreement shall determine for itself the distribution of the harvest within its jurisdiction.

e) These regulations do not preclude either party from unilaterally introducing additional conservation practices within their own jurisdictions.

f) Any readjustment of the boundaries pursuant to the above may necessitate a readjustment of user allocations under the management plan.

g) The use of aircraft or large motorized vessels for the purpose of taking polar bears shall be prohibited.

h) Each jurisdiction shall prohibit the exportation from, the importation and delivery into, and traffic within, its territory of polar bears or any part or product thereof taken in violation of this Agreement.

i) Polar bears in villages during closed seasons should be deterred from the area.

j) Polar bears threatening human safety or property may be taken at any time of the year and may be counted against the village allocation as ascribed by the Joint Commission.

ARTICLE IV

Collection of Data and Sharing of Information

a) The following data will be recorded for each bear killed: sex, date and location of kill, and hunter's name.

b) The following shall be collected from each bear killed: an undamaged post-canine tooth, ear tags or lip tatoos if the tags are missing, other specimens as agreed to by the hunters of either jurisdiction for additional studies.

c) A summary of all harvest information from each jurisdiction shall be exchanged annually.

d) The number of collars deployed for research purposes shall be limited to the minimum number necessary to provide accurate population information.

ARTICLE V

Duration of Agreement

a) This Agreement shall enter into force when it has been signed by the representatives of both parties.

b) This Agreement shall remain in force unless either Contracting Party requests it be terminated.

c) Amendments to the Agreement may be proposed by either signatory and accepted or rejected by mutual agreement after consultation with the membership of the Inuvialuit Game Council and the North Slope Borough Fish and Game Management Committee.

The Alaskan signatories of this document have no authority, to find and do not purport to bind the North Slope Borough to any agreement which would otherwise be in violation of the exclusive federal treaty power established by the United States Constitution, but are acting solely as representatives of the local traditional user group of the polar bear resource in furthering the consultation, management, and information exchange goals of the International Agreement on the Conservation of Polar Bears.

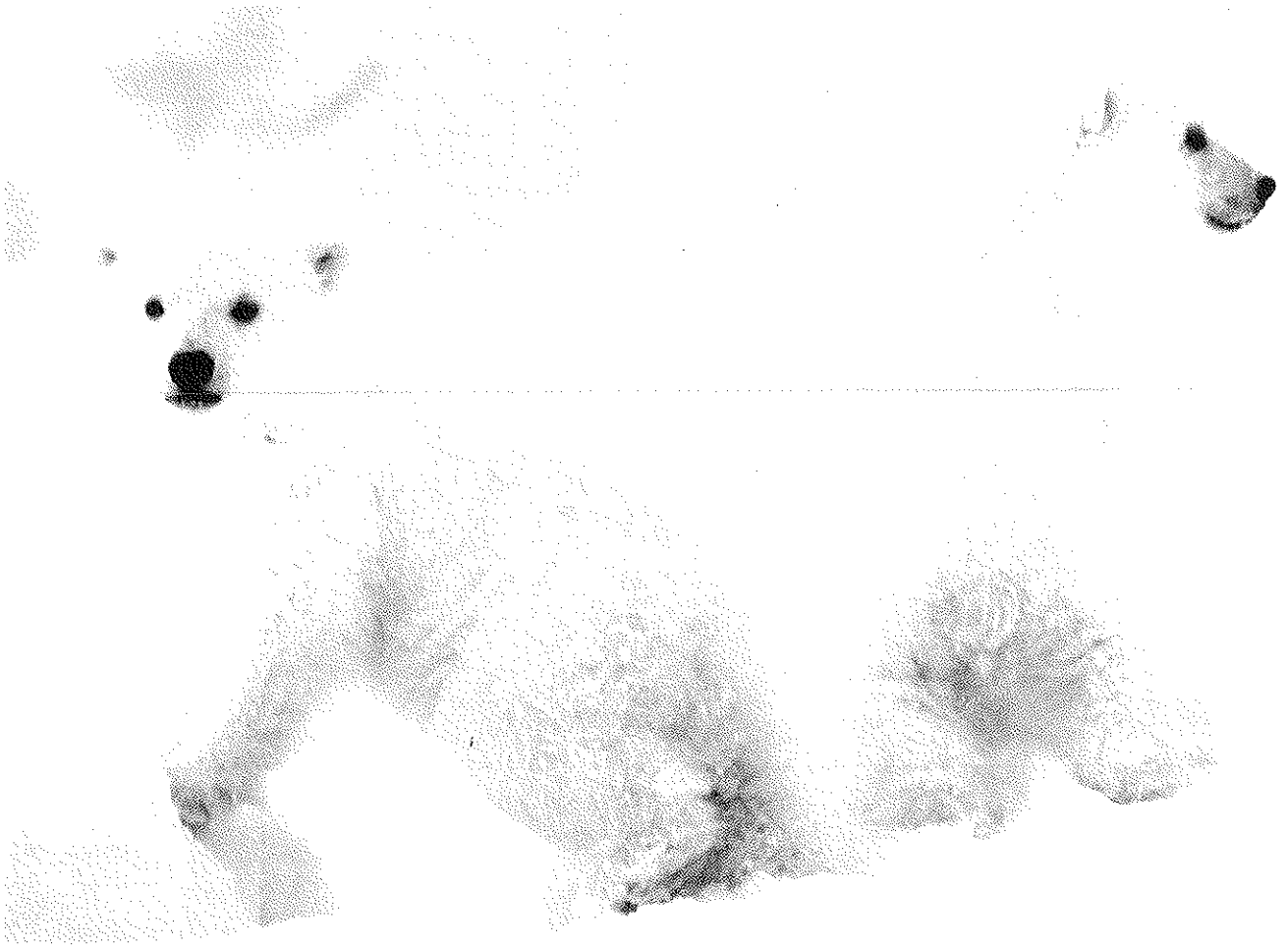
This document was signed on January 29, 1988 by the following persons (listed in alphabetical order):

Alex Aviugana, Chairman, Inuvialuit Game Council

Andy Carpenter, Vice-Chairman, Wildlife Management Advisory Council, (N.W.T.)

Benjamin P. Nageak, Director, Department of Wildlife Management

Nolan Solomon, Chairman, North Slope Borough, Fish and Game Management Committee



(Photo by Steven C. Amstrup)

Table 1. Annual sex composition of polar bear harvest in Alaska, 1985-89. Asterisk in upper part of the table indicates communities included in hypothesized Beaufort Sea management region.

Village	1985-86			1986-87			1987-88			1988-89			
	M	F	U	M	F	U	M	F	U	M	F	U	
Barrow*	1	2	9	4	8	7	8	2	3	13	12	19	(44)
Diomede	3	2	1	4	4		12	7		19	13	1	(33)
Gambell	11	3	3	9	11		11	12		31	26	3	(57)
Golivin					1						1		(1)
Kaktovik*	2	1		1		2	3	3		6	4	2	(12)
Kivalina			1	2			3	2		5	2	1	(8)
Kotzebue				3						3			(3)
Nome								3			3		(3)
Nuiqsut*	1	1		1					1	2	1	1	(4)
Pt. Hope	9	3	4	10	2	2	3	5		22	10	6	(38)
Pt. Lay*	2	3	2			1	1		1	3	3	4	(10)
Savoonga	12	5	1	4	1		7	4		23	10	1	(34)
Shishmaref	11	8	1	6			9	2	1	26	10	2	(38)
Wainwright*	5		2	8	2	3	7	2		20	4	5	(29)
Wales	6	4	1	5	2		4	3	2	15	9	3	(27)
Total	63	32 (120)	25	57	31 (103)	15	68	45 (121)	8	188	108 (344)	48	

LOCATION	SEX RATIO SUMMARY			
All Alaska	66:34	65:35	60:40	64:36
Beaufort Sea	61:39	58:42	73:27	65:35
Chucki Sea	68:32	67:33	56:44	63:37

Table 2. Age class of polar bears in the Alaskan harvest 1985-1988 (N=223).

Age Class	1985/86	1986/87	1987/88	Total
*Cubs #	31	18	20	69
%	33.7	24.7	34.5	30.9
Subadults #	26	23	14	63
%	28.3	31.5	24.1	28.3
Adults #	35	32	24	91
%	38.0	43.8	41.4	40.8

*Cubs include some 3rd year of life individuals which were independent of family groups.

Table 3. Annual chronology of polar bear harvest in Alaska, 1985-88.

Month	1985/86	1986/87	1987/88	Total	North No. (%)	West No. (%)
July	2	4	2	8	4 (50)	4 (50)
August	2			2	2 (100)	
September	4		2	6	6 (100)	
October	3	5	1	9	9 (100)	
November	9	15	14	38	32 (84)	6 (18)
December	7	6	23	36	4 (11)	32 (89)
January	38	22	12	72	7 (10)	65 (90)
February	14	5	1	20		20 (100)
March	19	6	17	42		42 (100)
April	4	15	34	53	10 (19)	43 (81)
May	16	20	8	44	14 (32)	30 (68)
June			5	5	3 (60)	2 (40)
Unknown	2	5	2	9		
Total	120	103	121	344	91 (27)	244 (73)

Table 4. Annual average age of polar bears harvested in Alaska, by geographic area, 1985-88.

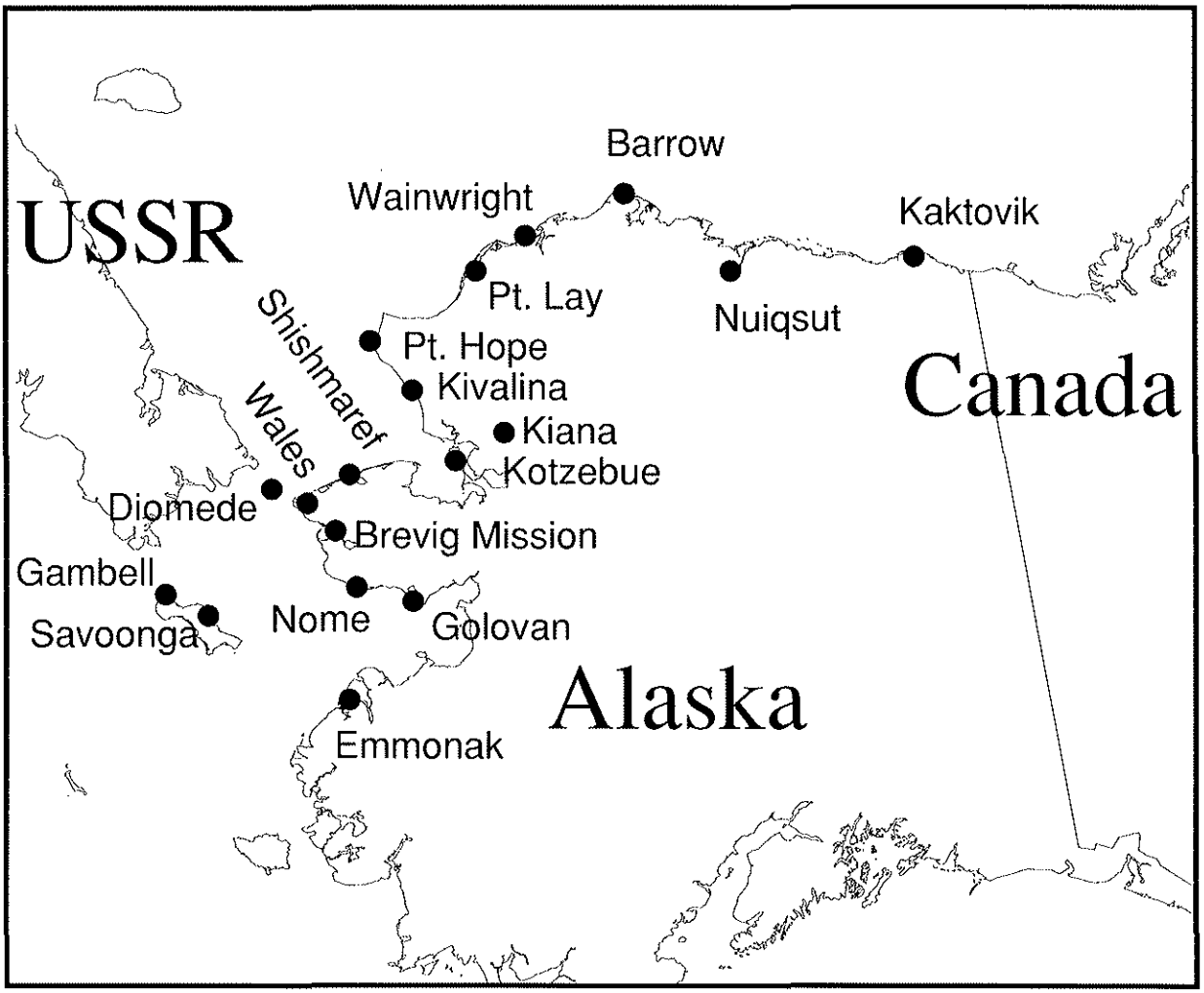
MALE

Region	1985/86	1986/87	1987/88
North X	3.2	6.4	9.1
S.D.	1.1	4.6	6.7
West X	7.1	6.2	4.2
S.D.	4.8	4.2	3.3

FEMALE

Region	1985/86	1986/87	1987/88
North X	9.7	7.9	3.3
S.D.	5.6	3.6	1.2
West X	7.4	6.8	7.4
S.D.	5.4	4.8	4.3

Figure 1. Locations in Alaska where polar bears were harvested. See text and tables for numerical breakdowns by location.



Distribution and Migrations of the Polar Bear in the Soviet Arctic in Relation to Ice Conditions

Belikov, S.E.[1], and Yu. A. Gorbunov[2]. [1]All-Union Research Institute on Nature Conservation and Reserves, State Committee for Nature Conservation, Sadki-Znamenskoye, Moscow M-628, USSR 113 628. [2]Arctic and Antarctic Research Institute, Bering St., 38, Leningrad, USSR 199 226.

Introduction

The Arctic and Antarctic Research Institute (AARI) examined relationships between ice conditions and distribution of polar bears in the Soviet Arctic between 1954 and 1986. Observations were made during ice air patrols in 1970-1986, and from vessels and drift-ice research stations in 1954-1986. Also, aerial and sea-vessel surveys were performed in 1980-1982 by the All-Union Research Institute on Nature Conservation and Reserves. Some questionnaire information was also obtained.

Aerial ice patrols were performed each month. Ice survey routes were preset, but were sometimes modified depending on the peculiarities in ice distribution. Nearly all Arctic areas from the Barents Sea to the Chukchi Sea were covered. Flights were most extensive in April when long daylight and favorable weather prevailed (Gorbunov et al. 1987). Figure 1 shows a typical April route.

Polar bear observations from the entire Arctic basin were recorded at the "Severnyi Polyus" drift-ice stations. The number of months of observations in different regions of the Arctic is shown in Fig. 1.

Aerial surveys were carried out in March-April 1980-1981 in the region of the Franz Josef Land (Belikov and Matveyev 1983) and in 1982 near Severnaya Zemlya (Belikov and Randla 1987). During these surveys the distribution of polar bears and their dens, pinnipeds and cetaceans were recorded.

Polar Bear Distribution

Summary of Aerial Survey Observations

In the Barents Sea polar bears and their tracks were sighted relatively evenly in most ice-covered water areas; but higher concentrations were apparent near Novaya Zemlya and Franz Josef Land. In the Kara Sea polar bears were most frequently observed in the west and along the east coast of Novaya Zemlya. The inlets to the straits Matochkin Shar and Yugorsky Shar appeared to be preferred areas. In winter bears frequently occur in the vicinity of the settlements of Dikson and Amderma. Comparatively rarely were bears observed on landfast ice formed at the north coast of the Taimyr Peninsula.

The density of polar bears is high in the Barents and Chukchi Seas and decreases to the Laptev Sea (Table 1). In the Laptev Sea polar bears were usually observed at the east coast of the Severnaya Zemlya and the Taimyr Peninsula. Infrequent observations were made in the region of the Novosibirskiye Islands in spring, summer and late winter. In October to December they were not observed here at all. In the central and eastern parts of the Sea the animals were registered only rarely and not in every year. Karpovich (1969) drew similar conclusions.

In the Chukchi Sea and in the eastern part of the East Siberian Sea in winter and spring polar bears occurred most frequently around Wrangel Island, in Long Strait and the southern part of the Chukchi Sea. In summer and fall they were distributed more diffusely. Polar bears are rare in winter and summer on the coast of the mainland, and in the Wrangel and the Herald Islands areas. They migrate past the islands commonly in spring and autumn and pregnant females enter or leave maternity dens at those times. An idea of the occurrence of polar bears near Wrangel Island can be given by the following data pertaining to various seasons of 1979-1984; in December to February, July to August, 44 bears of various sex and age groups were observed; in September to November, 122; in March to May, 1129 bears (Belikov et al. 1986).

We observed a relationship between the density of polar bear tracks (their number/100 km route) and the degree of the ice cover deformation (Shilnikov 1973). The tracks of polar bears were most often observed in the regions with increased ice deformation (Gorbunov et al. 1987). In the Chukchi Sea area and the eastern part of the East Siberian Sea in 1982-1984 the track density changed from 0 to 35.7 reaching the maximal values in the regions with the greatest deformation.

Special observations of the polar bear tracks carried out in 1984 (197 observations) revealed one more interesting peculiarity: most of the tracks (78%) were observed on young ice covering recent open water areas and where pressure ridges were common. Tracks were less frequent (21%) on land fast ice and rare in perennial ice (1%).

Summary of Ice Station Observations

Nearly 350 polar bears were observed in the 32 years of observations at the Severny Polyus Stations. Bears occurred most often (1.2 visits/mo) in the area north of Wrangel Island (Fig. 2). They were rarely observed in the central part of the Arctic Basin and in the areas adjacent to the coastal zone of the Canadian Arctic archipelago.

Polar bears visited ice stations most frequently from June to September (67%). In April and May we made 15% of the total observations, 11% in October to December, and 6% in January-April. There was also much year-to-year variation in the number of the polar bears visiting the stations. For example, Severny Polyus-6 Station which drifted 300-400 km to the north of Wrangel Island during April 1956 and April 1957 was visited by more than 40 polar bears. The Severny Polyus - 22 Station (Shift 7), situated in the same area, was visited in 1979-1980 by only 5 polar bears. Figures 3-6 summarize polar bear observations in various seasons at the Severny Polyus drift-ice stations and in aerial ice patrols.

Taking into account the ice conditions (Karelin 1952, Belinski and Istomin 1956, Kupetsky 1970), three physico-geographical regions can be singled out (Gorbunov et al. 1987); Western (from Spitsbergen to Severnaya Zemlya), Central (from the Taimyr Peninsula to 170° E), and Wrangelian (east of 170 E)°.

The Western and Wrangelian regions are characterized by the highest concentration of pinnipeds in the Soviet Arctic (Belikov et al. 1984, Uspensky and Shilnikov 1969). This is apparently due to a complex of biotic and abiotic factors. In the Wrangelian region, the ice conditions evidently play a rather important role. It is in these areas that annual ice with young inclusions occurred frequently. As shown above, such areas are frequently visited by polar bears. The ice cover in winter in many parts of the Barents Sea areas, at the coasts of the Franz Josef Land and Novaya Zemlya, in the south of the Chukchi Sea is broken with channels, cracks, and open water patches which attract pinnipeds and polar bears. One of the observations carried out in 1980 in the Franz Josef Land provided a significant indication of the fidelity of the pinnipeds and polar bears to the young ice patches. In the Wanderbildt Strait, in this archipelago, a passing ice-breaker formed a channel which immediately attracted a rather large number of seals, walruses and polar bears. It can be added that land fast ice at the island coasts in the Western and Wrangelian regions is ridged and usually covered with snow which contributes to the successful propagation of the ringed seal. Numerous channels and cracks in the ice in these regions also create favorable conditions for hunting by polar bears. It is not accidental that 87% of 170 polar bear observations in 1970-1984 occurred in these regions. There is little snow in the Central region, and the land fast ice is largely unbroken. Landfast ice is paralleled by a wide shore polynia and young ice zone (the Great Siberian Polynia). Beyond that the (mainly annual) drift ice is broken in some areas by channels and cracks. Aerial surveys, however, suggest few seals here. Weak development of forage resources, and unfavorable conditions for ringed seal reproduction may be responsible. The density of polar bears in this region is only 1/3-1/2 of that in the Western region and only 1/5-1/4 as great as that in the Wrangelian region.

Migration

Based on the analysis of chemical elements, Uspensky et al. (1985) identified 3 geographic groupings (western, central and eastern) of bears in the USSR. The information presented here, regarding distributions of bears and ice may help explain those divisions. An obvious explanation for segregation between Western and Central groups is lacking, but some conclusions regarding the more eastern group are in order. Belikov et al. (1982) concluded that the Aion Ice massif in the central part of the East-Siberian Sea is a natural boundary to the migration of the marine mammals. Even in summer, the Aion ice massif consists of packed perennial ice. Only a limited exchange of polar bears from west to east across the ice massif is apparently feasible.

As seen in Figures 3-6, the distribution of polar bears changes from season to season. This is especially characteristic of the eastern grouping. In January-March eastern bears concentrate in Long Strait in the southern part of the Chukchi Sea. They concentrate most heavily at the northern approaches to the Bering Strait where thinner ice with open water patches is formed. In heavy ice years many polar bears migrate to the northern area of the Bering Sea where hunting in thin and heavily broken ice is efficient. In April-May, as the break-up of ice cover proceeds, many bears migrate to the north and west. In May the northern part of the Bering Sea begins to be cleared of ice. Due to this, polar bears that moved there in winter begin to return to the Chukchi Sea. In June-September the bulk of the bears continue to shift to the north and west as the ice clears out of the southeast part of the Chukchi Sea. In August-September in the years with favorable ice conditions the ice clears in the eastern arctic from Long Strait and sometimes the entire Chukchi Sea and the south part of the East-Siberian Sea. The polar bears move to the north together with floes. Bears are frequently observed in the region of 75° N, later in the year, evidently, due to open water patches in the ice cover and favorable conditions for foraging.

In the years of heavy ice accumulation, in the seas of the eastern arctic, its southern regions are characterized by consolidated high pressure ice with numerous compressions and hummocks. Conditions for foraging become unfavorable and polar bears migrate to the north where the open water patches occur more frequently than in the coastal areas. Some polar bears in search of food go onto land and into settlements. In lighter ice years, the migration of the bears to the north is limited. Such variations in ice may explain the year-to-year fluctuations in numbers of the polar bears visiting the Severny Polyus Stations in the northern part of the area in summer. When the open water patches get covered with young ice in late summer and fall, the return migration of the polar bears to the south and east begins. This process probably starts in September with the beginning of stable ice formation in the Arctic Basin.

In the Barents Sea the seasonal location of the south-west, west and south boundaries of the polar bear distribution are determined by the position of the ice edge. The north boundary is located approximately 100-150 km to the north of Spitsbergen, Franz Josef Land, and Ushakov Islands and varies little from season to season. Polar bears spend little time in the Arctic Basin, where the ice conditions probably hinder feeding. On the other hand, hunting among the thin and broken ice of the northern part of the Barents and Kara Seas is productive. Polar bears migrate to the Arctic Basin only in particular years and only in summer when the northern part of the Barents Sea clears of ice. The south-west part of the Kara Sea is usually cleared of ice by September, and polar bears migrate to the north-east. In the years when the Novaya Zemlya ice massif, situated in the south-west part of the sea, separates from the ice in the north-east part of the sea, some polar bears apparently are not in time to migrate to the north-east, and many polar bears concentrate on the east coast of the Novaya Zemlya southern island. For example, on August 30, 1986 during the aerial ice patrol along the 180 km coastline of the Novaya Zemlya southern island, 41 polar bears were observed.

In conclusion, polar bear observations indicate a significant role of the ice conditions in their distribution and migrations. There are undoubtedly other important environmental factors which influence the spatial distribution and seasonal movements of polar bears, however.

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Table 1. Average density of the polar bears (number of individuals per 1000 km^2) in the Soviet Arctic seas and the adjacent regions of the Arctic Basin (by the results of observations during aerial ice patrol in April 1970-1984) (Gorbunov et al. 1987).

SURVEYED AREA	ESTIMATED DENSITY
Barents Sea	0.46
Kara Sea	0.43
Laptev Sea	0.17
East Siberian Sea	0.28
Chukchi Sea	0.72
Arctic Basin (regions adjacent to the Soviet Arctic seas)	0.19

Figure 1. Numbers of observations at the Severnyi Polyus ice drift stations, and approximate locations of aerial transect survey lines. Numerals in the squares indicate the number of months of observations from ice stations within the regions delineated by the bounds of each square.

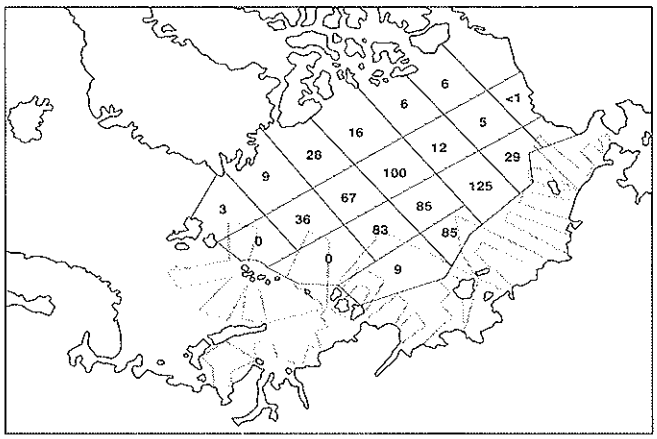


Figure 2. Numbers of polar bears seen in each of the regions covered by the Severnyi Polyus ice stations (upper figure), and the mean number per month (lower figure).

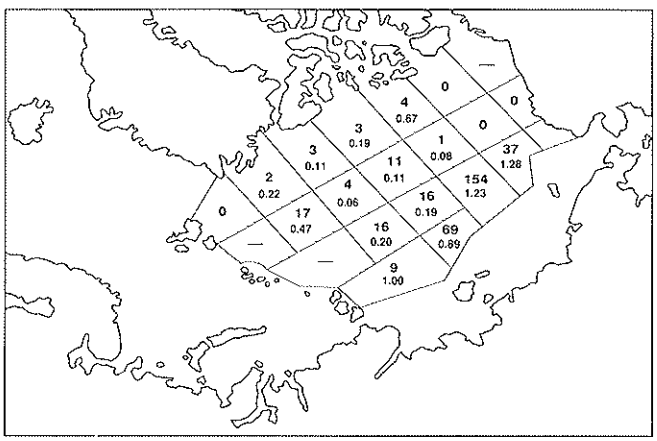


Figure 3. Summary of polar bear observations recorded in January February and March at the Severnyi Polyus Stations and during aerial ice patrols.

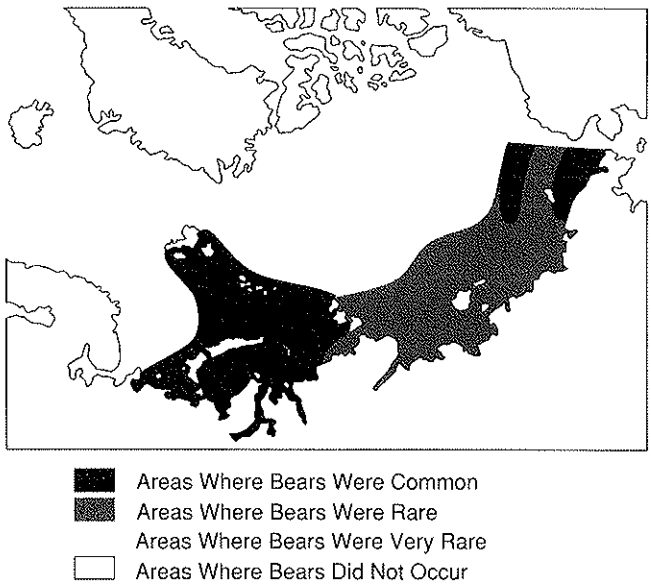


Figure 4. Summary of polar bear observations recorded in April and May at the Severnyi Polyus Stations and during aerial ice patrols.

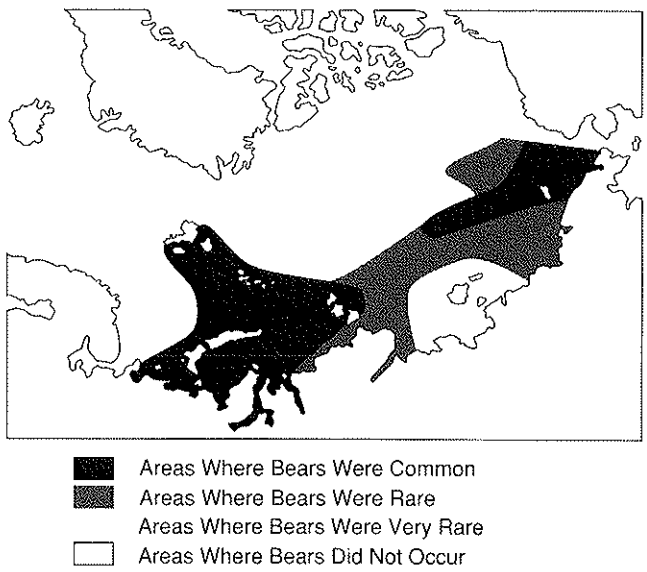


Figure 5. Summary of polar bear observations recorded in June, July, August and September at the Severnyi Polyus Stations and during aerial ice patrols.

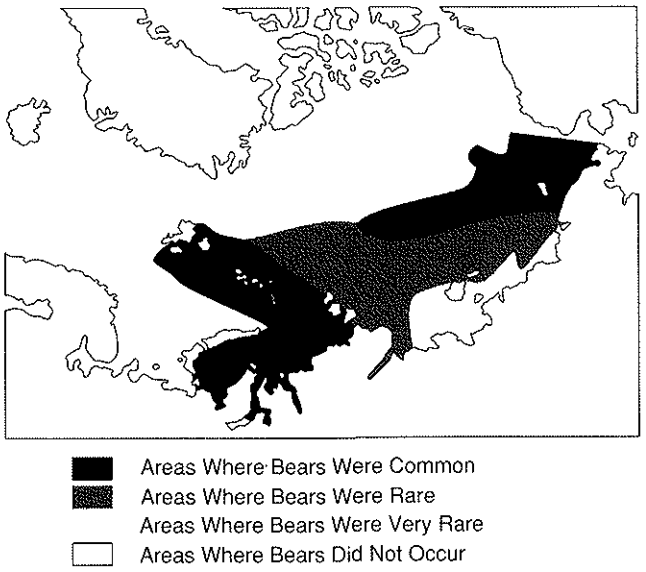
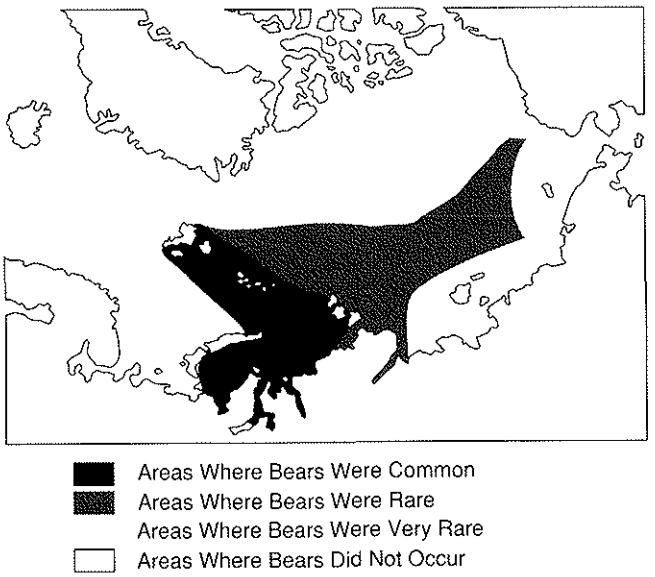


Figure 6. Summary of polar bear observations recorded in October, November and December at the Severnyi Polyus Stations and during aerial ice patrols.



Results of Aerial Counts of the Polar Bear in the Soviet Arctic in 1988

Belikov, S. E., N. G. Chelintsev, V. N. Kalyakin, A. A. Romanov, and S.M. Uspensky, All-Union Research Institute on Nature Conservation and Reserves, State Committee for Nature Conservation, Sadki-Znamenkoye, Moscow M-628, USSR 113 628.

Introduction

Polar bear observations have been obtained during previous ice patrols in the Soviet Arctic (Uspensky and Shilnikov 1969; Gorbunov et al. 1987). During aerial patrols of 1988, however, more rigorous designs were used by trained biological observers making possible more accurate estimates of polar bear abundance.

Materials and Methods

Counts were carried out from two fixed-wing aircraft, one of which flew in the eastern sector of the Soviet Arctic (the East-Siberian and Chukchi seas, the eastern part of the Laptev Sea, and the northern part of the Bering Sea); the other, in the western sector (the northern and eastern parts of the Barents Sea, the Kara Sea, the northern and western parts of the Laptev Sea) (Fig. 1).

Ice observations and polar bear counts were obtained from IL-14 aircraft. Transect speeds varied from 180 to 300 km/h; and altitude varied between 50 and 300 m. Portions of transects where the flight altitude was over 300 m were not included in the count routes due to the decreased probability of seeing polar bears at higher altitudes.

Observations of bears and their tracks, ice conditions where bears were sighted and observations of other animals were recorded. Time of sighting, width of the transect strip, distance to the bears sighted (only in the western sector) and group size were also recorded. If possible, the sex and the age group of the animals were determined. After each flight, data were mapped on the scale of 1:3,000,000 or 1:500,000.

Polar bear counting in the eastern sector of the Soviet Arctic was carried out by biologist-observer A. A. Romanov and a hydrologist-observer. In the western sector bears were counted by biologist-observers S. E. Belikov and V. N. Kalyakin. Counting, in the western sector, was possible only on the starboard side of the aircraft and the 2 observers alternated 2-3 hour-long observation periods. Marks on the wings were used to delimit the width of the transect strip. The hydrologists observing ice conditions from the port side of the plane also recorded sightings of the polar bears. However their sightings were considered only in the analysis of the distribution of the animals, not in calculations of the polar bear abundance.

Ice conditions in the eastern Soviet Arctic during 1988 were similar to the average perennial conditions. Cloud cover was practically absent; visibility during almost all flights was optimal (more than 10 km) which made it possible to use a transect strip 2 km wide. In the western Soviet Arctic the ice conditions in much of the study area changed markedly during the survey. The cause of the changes was a powerful 2 day storm which originated on 9 April south-east of the Taimar Peninsula and moved north-west through the study area. Visibility often deteriorated due to precipitation, fog, or haze during the western surveys. Thus, the width of the transect strip had to be reduced. In some sections counts were impossible; these sections were excluded from the calculations of the registration strip area. In other areas strip width was limited to 0.2 km.

To increase extrapolation accuracy, each region (east and west) was divided into smaller zones, following methods from Celintsev (1980). Zones were constructed by bisecting a line located equidistant from the 2 furthest points of a region. Within each primary zone, if there remained many transects, they were divided into smaller portions the same way. Subdivision stopped when we hadn't observed any polar bears within a count route through a selected area, or when dividing into two portions, transect lengths within one or both were less than 200 km. Finally, each zone within the eastern region was divided into "a" and "b" sectors. A "sample" included counts from all transects in each sector.

We distinguished three zones in Region I, two zones in Region II, one zone in Region III, five zones in Region IV, four zones in Region V, two zones in Region VI, and one zone in Region VII (Fig.1). Polar bear numbers within each zone were calculated as:

$$N_z = \frac{S_z}{2}\left(\frac{n_a}{q_a} + \frac{n_b}{q_b}\right) \qquad (1)$$

where N_z = estimated numbers of polar bears in Zone z; S_z = area of Zone z, n_a & n_b = bear numbers observed in "a" and "b" portions of the zone; q_a & q_b = area of the "count strips" in portions "a" and "b".

The standard error for abundance estimates of polar bears within a zone was calculated as:

$$m(N_z) = \frac{S_z}{2}\left(\frac{n_a}{q_a} - \frac{n_b}{q_b}\right) \quad (2)$$

Formula 2 is a transformation from the usual formula for a standard error, for an arithmetic mean of two values. Calculated results for N_z and $m(N_z)$ for each zone are listed in Tables 1 and 2.

In the eastern sector, we used a "count strip" of 2 km width (1 km from each side of the aircraft). In the western sector width of each "count strip" changed sometimes within a day because of frequent visibility changes, but we recorded the time and extent of width change. Therefore, we were able to keep track of strip width which varied from 0.2-2 km, and of areas where counts were not possible due to weather.

In each of the regions polar bear abundance was calculated as the total numbers of bears estimated for the zones of each region:

$$N_r = \sum_z N_{rz} \quad (3)$$

where N_r = abundance estimates in Region r, N_{rz} = extrapolated numbers in Zone z of Region r, calculated by formula (1). The standard error of Nr was calculated as:

$$m(N_r) = \sqrt{\sum_z m^2(N_{rz})} \quad (4)$$

where $m(N_{rz})$ is a value of a standard error for abundance estimates in Zone "z" of Region "r", calculated by formula (2). The regional calculations are summarized in Table 1 and 2.

Polar bear numbers within a "count area" of the eastern sector were calculated as the total of bear abundance estimates in Regions I, II, and III, abundance in the western sectors was the total of abundance estimates in Regions IV, V, VI, and VII. Statistical error of abundance estimates for the sectors were calculated by a formula which is similar to the formula (4).

Results

In the eastern sector flights were carried out from 20 to 31 March. A total of 135 hours were flown covering a distance of 18,050 km (transect distance over land subtracted). Flights in the western sector were carried out in two stages: March 20-29 and April 8-17. Most second stage flights followed the routes of the first stage. Total flying hours were 179, and 33,670 km were covered (transect distance over land subtracted).

In the eastern sector we observed 20 polar bears: seven single bears, two pairs of adult animal, four females with one-year-old cubs. One family pair was followed by a large male. The observations in the west sector yielded 49 polar bears: 22 single bears, 9 females with one-year-old cubs, 3 females with 2 cubs (in one case the cubs were the young-of-the-year). Most polar bears were sighted around Wrangel Island, Long Strait and in the southern part of the Chukchi Sea. In the western sector, most were seen in the southwest Kara Sea, at the eastern coast of the Taimyar Peninsula, in the coastal areas and sounds of Franz Josef Land. These are traditional places of occurrences of the polar bear in late winter. Unusually, many bears as well as pinnipeds were observed in the northern part of the Laptev Sea adjacent to Severnaya Zemlya. In the previous years' ice patrols they rarely were observed here. It should be noted, however, that the ice conditions during the 1988 observations (numerous ice-free water patches and channels) were extremely favorable for hunting by polar bears.

Nineteen percent of individuals observed were within 10 km from a nearest shore; 29% were observed at distances of 10-50 km; 11% at 50-100 km; and 41% were observed 100-500 km from shore. This distribution on the whole characterizes the fidelity of the polar bear to the coasts and the significant decrease in density with increasing distance from the shore.

The values of polar bear abundance calculated for each region, for the eastern and western sectors and for the whole count water area are given in Tables 1 and 2. Also given are statistical errors and confidence limits.

When visibility was good in the western sector we counted bears within a strip of the maximum width of 2 km (they were counted from one side only in the western sector). Such a width substantially decreased the probability of observing polar bears in the outer part of the strip in comparison to the near parts of a strip. During the survey, our observers recorded perpendicular distances between the observed bear and corresponding transects. We could estimate a value of effective width for a "count strip" with these distances and then obtain the coefficient to correct for underestimation in a distant part of a "count strip". Burnham et al. (1980) showed that an effective width of a "count strip" for half-normal function of detection, is calculated:

$$W = \int_0^B \exp\left\{-\frac{H}{C}\right\}^2 dH \quad (5)$$

where H= the distance between an animal and a transect; B = the distant boundary (width) of a limited "count strip" and C = a parameter.

Since a mathematical expectation for detection distance is calculated:

$$E(H) = \frac{1}{w}\int_0^B H \exp\left\{-\frac{H}{C}\right\}^2 dH \quad (6)$$

We can calculate dependence:

$$W = f[E(H)] \quad (7)$$

for different C values. This dependence could be approximated by the function:

$$W = BT(0.79 + 0.21T^5) \quad (8)$$

where

$$T = \frac{2E(H)}{B} \quad (9)$$

is an auxiliary parameter. When using expressions (8) and (9) we could obtain the formula for estimated count efficiency "A":

$$A = W/B = T(0.79 + 0.21T^5), \quad T = 2\bar{H}/B \quad (10)$$

where $\bar{H}$ is the mean value for distances between animals and transects.

When polar bears were counted from one side of the aircraft within a strip of width B=2 km, we recorded 18 single bears as follows (Distance/# Sightings): 0.25/1; 0.3/3; 0.35/1; 0.4/2; 0.5/4; 0.8/1; 1.0/1; 1.2/1; 1.5/2; 2.0/1. Additionally, 6 females with one cub were observed at distances of 0.3, 0.4, 0.5, 0.6, 1.5, 2.0 (km). Two females each accompanied by two cubs were also observed at distances of 0.8 and 1.5. The mean value sighting distance for these observations was $\bar{H}$=0.85 km. Therefore, T=0.85 and A=0.75. Eight sightings were recorded in strips with width less than or equal to 1 km. Underestimation, which depends on greater distances from animals, was absent. The mean weighted values of count efficiency, therefore, were 0.75 and 1.0, and the mean count efficiency is:

$$\bar{A} = (0.75¥26 + 1.0¥8)/(26 + 8) = 0.81 \quad (11)$$

Thus, a correction coefficient for a count in the western sector is:

$$K = 1/\bar{A} = 1.23 \quad (12)$$

Table 2 shows corrected values for numbers and standard errors within the western sector. The counts were obtained by multiplying the calculated values by the correction factor K = 1.23. Within the eastern sector, all counts were carried out within a strip of permanent width B=1 km (from each side). A correction for distant underestimation was not introduced.

Polar bear numbers in the entire "count area" were calculated as the total of the estimates in the western and eastern sectors. A standard error for the total numbers was calculated by a formula similar to formula (4).

The lower confidence limit for number estimates of polar bears in the eastern and western sectors and in the entire "count area" (confidence level=0.95), was calculated by the formula:

$$N_L = N^2/[N + 1.64m(N)] \quad (13)$$

The upper confidence limit (confidence level=0.95) was calculated:

$$N_U = N_L + 3.28m(N) \quad (14)$$

Formulae (13) and (14) take into account non-negativity of the N value, and provide some higher values than the usual formula based on normal distribution. These values are listed in Tables 1 and 2.

Rather high standard errors of polar bear abundance estimates resulted from low numbers of sightings (50), and from patchy distribution of bears within "count zones". The uneven distribution of bears within larger areas (interzonal) does not influence estimatation accuracy due to use of separate extrapolation for each zone.

Recommendations

To increase accuracy, counts should be carried out from both sides of survey aircraft. In the regions of high bear density more transects should be established (approximately proportionate to the square root of the population density). It should be noted that this condition is impossible to satisfy in the observations of the polar bears during aerial ice patrols, because their routes are standard and not related to density and distribution of the polar bears. None the less, the perennial concurrent counts of animals including the polar bears traditionally carried out by the aerial ice patrols make it possible to assess trends in abundance, and reveal the variations in the distributions of the polar bears and pinnipeds. To obtain more accurate values of the polar bear abundance, special counts should be done periodically with the increased extent and optimal distribution of the routes. Polar bear tracks also should be recorded to provide additional information on distribution with respect to other biotic and abiotic factors. Experiments should be performed to determine the numbers of polar bears within the survey area but not observed because of ice cover conditions or other factors.

Bays and coves on the coast, straits between islands, and some land areas where the bears can occur as well as offshore should be sampled. In the presence of large glaciers the aerial counts from single-engine aircraft and light helicopters become impossible due to heavy winds blowing from the glacier surfaces. Therefore, we recommend use of either twin-engine aircraft or sufficiently powerful helicopters able to fly under polar conditions and successfully overcome the heavy wind and satisfy the requirements imposed on the counts and flight safety. In the USSR these requirements are met by MI-8 helicopters and AN-74 twin-engine turboprop airplanes which also make possible a comparatively slow flying speed (under 300 km/h). To assure all data are recorded, the observer must have a colleague who records data as he calls them out. To avoid fatigue observer and recorder observers should periodically change places.

Observers must be able to tolerate prolonged flights (10-12 h) in fixed-wing airplane or helicopter. Preliminary training flights under the supervision of an experienced observer should be carried out to identify the width of the registration strip and the distance to the animals. It is also recommended that various ancillary means (marks on the wings, clinometers etc.) be used to facilitate the determination of the distance to the animal sighted.

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Table 1. Polar bear abundance estimates in the eastern sector of the Soviet Arctic.

Region	Zone Number	# of Individuals in Subzones n_a	n_b	Area of Strip q_a	q_b	Area of Zone Km^2 X1000	Bear Numbers N	Standard Error m(N)	Lower CI N_L	Upper CI N_U
I	1	1	1	720	1290	104	113	32		
East	2	0	2		480	126	263	263		
Siberian Sea	3	5	0	600		61	254	254		
Subtotal							630	366		
II	1	3	5	1290	1356	102	306	69		
Chukchi Sea	2	0	2		1140	370	325	325		
Subtotal							631	332		
III	1	1	0	1188		79	33	33		
Bering Sea	Subtotal						33	33		
	Totals From Eastern Sector						1294	495	794	2418

Table 2. Polar bear abundance estimates in the western sector of the Soviet Arctic, and pooled estimates for the entire survey area.

Region	Zone No.	# of Individuals in Subzones n_a	n_b	Area of Strip Km^2 q_a	q_b	Area of Zone Km^2 X1000	Bear Numbers N	Standard Error m(N)	Corrected Numbers N*	Corrected St. Error m(N*)	Lower CI N_L	Upper CI N_U
IV	1	3	6	3266	2422	237	364	71	.	.	.	.
	2	4	6	2572	1232	147	471	243	.	.	.	.
Kara Sea	3	0	3	.	791	30.6	58	58	.	.	.	.
	4	1	0	945	.	34.2	18	18	.	.	.	.
	5	0	1	.	1109	56	25	25	.	.	.	.
Subtotal	.	.	.	.	.	.	936	261	1151	321	.	.
V	1	3	1	1285	1152	95.4	153	70	.	.	.	.
Laptev Sea	2	0	1	.	685	97.2	71	71	.	.	.	.
	3	1	1	1710	2584	131.4	64	13	.	.	.	.
	4	1	1	1031	220	79.2	218	141	.	.	.	.
Subtotal	.	.	.	.	.	.	506	173	622	213	.	.
VI	1	0	1	.	556	43.2	39	39	.	.	.	.
Barents Sea	2	1	5	1192	1242	144.9	352	231	.	.	.	.
Subtotal	.	.	.	.	.	.	391	234	481	288	.	.
VII												
Arctic Basin	1	1	8	1130	1853	106.1	276	182	.	.	.	.
Subtotal	.	.	.	.	.	.	276	182	339	224	.	.
	.	.	.	.	Totals From Western Area				2593	530	1938	3676
	.	.	.	.	Grand Totals				3887	725	2980	5358

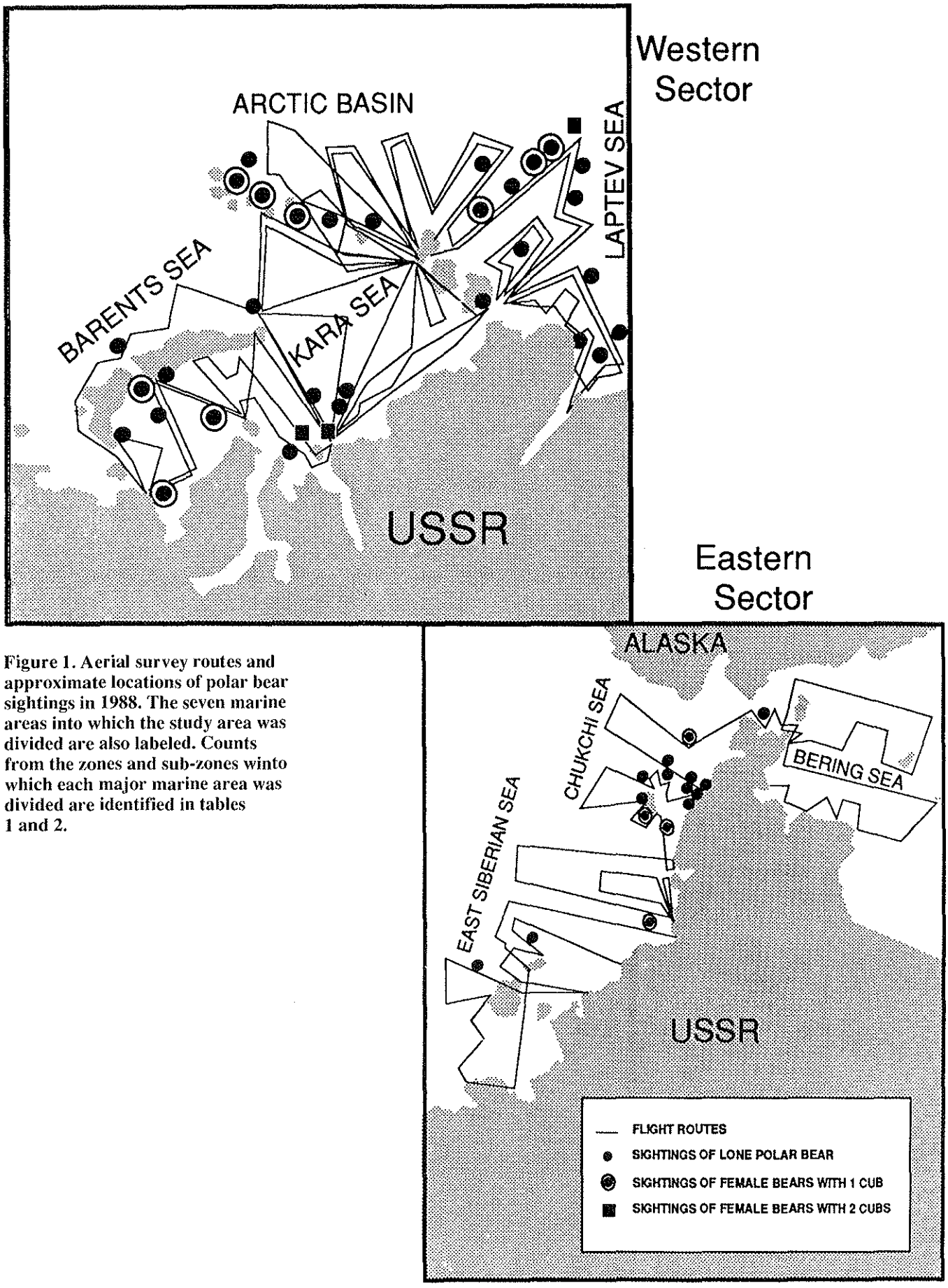

Figure 1. Aerial survey routes and approximate locations of polar bear sightings in 1988. The seven marine areas into which the study area was divided are also labeled. Counts from the zones and sub-zones winto which each major marine area was divided are identified in tables 1 and 2.

The Use of Geochemical Methods for the Differentiation of Polar Bear Geographical Groupings

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Introduction

Knowledge of the distribution of animals and the segregation of geographical groupings or stocks is necessary for proper wildlife management. Such knowledge is especially important for mobile animals with uneven distributions. The polar bear (*Ursus maritimus*) may be the best example of such a species. A circumpolar inhabitant, polar bears are capable of extensive migration in the ice fields of the Arctic basin. Although the polar bear is the largest predator in the world and occupies relatively unsettled habitats, it can not be considered safe from human perturbations. The rapid economic development of the Arctic performed by many countries may affect polar bears not only by direct mortality (hunting, shooting) but also by reducing forage resources, altering habitat, and environmental pollution. Polar bears may be particularly susceptible to such effects because they are relatively few in number and reproduce very slowly (Larsen 1978, Stirling et al. 1978). Because of this potential susceptibility the polar bear has been classified as "vulnerable" by IUCN.

Polar bear protection and management policies are determined by the nations to which its habitats belong. For such policies to be realistic, geographical groupings of the species must be understood. The presence of geographic groupings of polar bears is indicated by marking programs (Jonkel 1970, Larsen 1971, Lentfer 1974). Conversely, attempts to reveal the territorial groupings of polar bear by the morphological data have failed as yet (Chernyavsky 1969, Manning 1971).

Recently, it has been shown that geographical variations among groups, populations, species, and higher organization levels can be revealed by analyzing the element composition of tissues. These differences were found, for instance, in the analysis of avian shell and plumage (Golovkin et al. 1978, Kensall and Calaprice 1972), and mammalian hair (Franzmann et al. 1975). The theoretical premise of these works was the hypothesis that in animal tissues the accumulation of elements is determined by evolutionary factors and the alimentary link between the chemical composition of organisms and the geochemistry of a landscape (eg. Vernadsky 1920, Underwood 1971, Kovalsky 1974). The first attempt at revealing polar bear geographical groupings in the Soviet Union based on chemical composition of bone tissue (Uspensky et al. 1985) was encouraging. As a result, three geographic groupings, Western (the Barents and Kara Seas), Central (the Laptev and East Siberian Seas) and Eastern (the Chukchi and Bering Seas) differing in the content of four trace elements - potassium, titanium, nickel and aluminum were identified.

In this work we tested the efficiency of the method by analyzing the polar bear spatial groupings in the Canadian Northwest Territories where Canadian researchers had hypothesized, from biological observations, eight zones of polar bear habitat (Urquhart and Schweinsburg 1984). Material for analysis was provided to us from three of those zones.

Acknowledgements

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Material and Methods

Bone tissue (lower jaw) of 78 polar bears was selected for analysis because it is less subject to short-term changes in the composition than hair, skin and other soft tissues. The specimens were cut by a trepanning drill, 11.3 mm diameter, from sections of jawbones under the molariform teeth. Specimens were analyzed with a TEFA 6111 X-ray fluorimeter (EG&G ORTEC, USA) for the content of phosphorus, calcium, zinc, iron and strontium. Irradiation time was equal to 4,000 s. The results of the X-ray spectral analysis were output in pulses the intensity of which was proportional to the element contents in the specimens. The data obtained make it possible to assess the relative content of each element in polar bear bone tissue.

Data processing was carried out in two stages. First, samples were processed without knowledge of their geographic origin. All specimens were characterized by normal distribution of the elements, and anomalies were examined with the Henry method

of smoothed cumulants (Gurevich et al. 1968) widely used in geochemical prospecting. The Henry method presupposes the restriction of the background area by the standard deviation from the average to both sides. Using this method, three categories were identified for each element: 1) background levels; 2) those with increased content of an element; and 3) with decreased content of an element. We then compared the anomalous specimen groups with the territorial groupings singled out in biological observations. According to R. Schweinsburg, the material was collected at eight geographical points (Fig. 1) representing, in his opinion, four groupings of bears. The distribution of points into groupings and the number of specimens are shown in Table 1. The geographically determined groupings were compared pairwise for the content of the elements in the specimens using Student's "t" test.

Results and Discussion

The results of the element analysis are shown in Table 2. Descriptive statistics (Table 3) revealed low variability of all examined elements within groups. Initial analysis suggested increased strontium levels in Group 4 (66.7% of the specimens in group 4 had high strontium (Sr) content and 61.5% of all specimens with elevated Sr were in group 4) Many animals rich in zinc (Zn) were observed in Group 3 (53.8%) and many Group 2 animals were high in iron (Fe)(58.3%). The latter group also included a large share of the bears with high concentration of Sr and Zn (84.6% and 75.0%). Animals high in Sr and Zn comprised a small percentage, of all specimens characterizing Group 2 (29.7% and 16.2%, respectively). No trends in calcium or phosphorus were observed among any groups.

The Henry method determined strontium and zinc were the most efficient elements for segregating groups. Pairwise comparison of the groups by a Student's "t" test confirmed the results of the preliminary analysis and showed differences among all groups except 1 vs 3 and 4 in strontium content ($P < 0.05$) (Table 4). Zinc levels varied between groups 1 and 3, 1 and 4, and 2 and 3 only ($P < 0.05$). The bivariate separation of groups on the basis of strontium and zinc (Fig. 2) and the absence of correlation between Sr and Zn suggest this difference is not accidental.

Without geochemical background of the habitats of the bears examined in this study, we are unable to discuss the causes of the observed variations. Nevertheless it is noteworthy that the geographic distances between clearly distinguished Groups 1, 2 and 4 are very small (about 300 km). Within Group 2, however, where the material was collected in three points also separated by about 300 km, the intragroup differences were insignificant ($P > 0.05$).

Group 4 deserves special mention. Work on the polar bear in the Canadian Northwest Territories (Urquhart and Schweinsburg 1984) points out that this entire region is divided into 8 zones in each of which, theoretically speaking, an isolated population of the polar bears can exist. The break-down into zones has been carried out for the differential management in each zone. Although Group 4 is located at the boundary of other zones, our chemical analyses suggest it could be considered separate for management purposes.

In conclusion, our analyses suggest important differences in chemical composition of bone tissues of polar bears. These differences appear to be related to geographic location from which bears were collected. If differences detected among tissues of polar bears can be linked to geographic variation in sources of these micro-elements, the procedures described here will be useful in differentiating stocks of polar bears in northern Canada and worldwide.

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Table 1. Locations and numbers of samples used for geochemical analysis of bone tissue from polar bears.

Group	Specific Location of Sample	Sample Size
1	Whale Cove	1
	Rankin Inlet	1
	Coral Harbour	4
2	Gjoa Haven	7
	Spence Bay	16
	Pelly Bay	14
3	Clyde Inlet	23
4	Repulse Bay	12

Table 2. Contents of five elements (in conventional units) in the samples taken from jaw bones of polar bears in the Canadian Northwest Territories.

Group	Sample Location	Specimen Number	P	Ca	Fe	Zn	Sr
1	1	0523	0.83	81	1.00	3.31	51.2
	2	7811	1.36	109	1.30	4.70	46.6
	3	0136	1.39	127	0.02	4.32	42.0
	3	0491	1.43	116	0.51	4.39	36.5
	3	0493	1.65	122	0.28	4.18	58.7
	3	0494	1.47	119	0.44	4.93	60.6
2	4	0211	1.5	121	0.60	4.59	49.0
	4	0213	1.65	122	1.34	5.16	38.3
	4	0554	1.73	122	0.30	3.34	34.1
	4	7817	1.33	115	1.34	5.39	41.3
	4	7818	1.64	127	1.08	4.66	40.6
	4	7819	1.58	124	0.13	4.30	54.4
	4	7820	1.84	128	0.66	3.86	38.8
	5	0468	1.54	115	1.00	4.43	32.6
	5	0473	1.70	125	0.80	3.92	46.2
	5	0475	1.64	126	0.52	5.23	28.4
	5	0476	1.72	122	1.18	3.52	40.4
	5	0478	1.89	123	0.19	4.62	38.5
	5	0479	1.59	118	0.96	5.56	33.4
	5	0480	1.59	134	0.20	4.60	43.3
	5	0481	1.60	124	0.28	4.34	41.7
	5	0482	1.44	110	1.21	4.44	39.0
	5	0483	1.47	109	0.58	5.06	38.2
	5	0486	1.56	125	0.45	5.42	28.8
	5	0487	1.60	124	0.75	5.26	47.0
	5	0488	1.57	125	0.38	5.53	34.9
	5	7826	1.37	126	0.91	4.90	43.1
	5	7828	1.78	138	0.85	7.66	39.4
	5	7830	1.48	116	1.89	5.21	38.1
	6	0344	1.49	121	0.49	5.21	34.2

Table 2. (cont.) Contents of five elements (in conventional units) in the samples taken from jaw bones of polar bears in the Canadian Northwest Territories.

Group	Sample Location	Specimen Number	P	Ca	Fe	Zn	Sr
2 (cont.)	6	0346	1.74	127	0.05	3.85	59.2
	6	0347	1.84	122	0.69	6.10	54.2
	6	0348	1.61	125	0.36	4.76	37.2
	6	0349	1.30	106	0.24	5.85	44.9
	6	0350	1.35	107	0.60	5.22	27.9
	6	0351	0.61	53	0.40	1.84	19.0
	6	0352	1.31	118	0.72	4.78	41.6
	6	0353	1.17	98	0.27	4.28	33.8
	6	7821	1.93	137	0.94	6.94	40.4
	6	7822	1.49	116	1.39	3.61	53.4
	6	7823	1.40	117	1.96	5.34	29.6
	6	7824	1.55	121	0.25	3.61	36.9
	6	7825	1.58	122	0.08	3.63	36.1
3	7	0063	1.69	136	0.59	5.91	36.8
	7	0065	1.46	123	1.24	5.76	64.6
	7	0066	1.73	126	0.46	6.46	45.1
	7	0067	1.54	126	0.94	6.10	47.9
	7	0068	1.44	117	0.42	4.96	38.4
	7	0069	1.62	128	0.53	4.58	52.6
	7	0078	1.27	101	0.40	4.05	34.8
	7	0079	1.71	127	0.16	4.76	35.5
	7	0080	1.67	127	0.38	6.27	49.8
	7	0081	1.51	125	1.84	7.12	37.9
	7	0084	1.57	120	0.16	4.10	48.3
	7	0085	0.37	48	1.30	4.23	47.2
	7	0086	1.51	124	0.93	5.51	41.2
	7	0088	1.47	128	1.92	8.34	48.3
	7	0089	1.68	132	1.01	6.22	46.7
	7	0090	1.53	119	0.36	4.73	40.6
	7	0091	1.56	117	1.11	4.06	53.8
	7	0095	1.72	117	0.24	5.35	48.4
	7	0096	1.91	128	0.48	5.36	54.6
	7	0097	1.53	126	0.50	6.36	45.0
	7	0098	1.47	124	1.16	4.83	55.0
	7	0099	1.52	117	0.11	3.48	53.8
	7	0104	1.46	115	0.87	4.54	42.1

Table 2. (cont.) Contents of five elements (in conventional units) in the samples taken from jaw bones of polar bears in the Canadian Northwest Territories.

Group	Sample Location	Specimen Number	P	Ca	Fe	Zn	Sr
4	8	0379	1.29	101	0.63	3.94	61.3
	8	0381	1.54	118	0.51	5.46	71.0
	8	0383	1.53	108	0.47	5.79	54.3
	8	0384	1.36	115	0.16	4.91	61.7
	8	0385	1.37	113	0.68	5.08	56.3
	8	0386	1.67	127	0.16	4.98	59.5
	8	0387	1.18	98	0.57	6.58	44.6
	8	0389	1.62	118	0.28	4.00	65.6
	8	0390	1.94	131	0.46	5.87	58.9
	8	0391	1.70	134	1.06	8.60	19.6
	8	0393	1.18	97	0.84	4.76	32.8
	8	0394	1.32	125	0.25	6.05	62.8

Table 3. Mean concentrations of the elements, standard deviations, coefficients of variation, and standard errors of the means for each group.

Group	Parameter	Concentrations of the Elements				
		P	Ca	Fe	Zn	Sr
1	Mean	1.36	112	0.59	4.30	49
	Std. Dev.	0.28	16.5	0.5	0.56	9.4
N=6	C.V.	0.20	0.15	0.80	0.13	0.19
	Std. Error	0.11	6.7	9.2	0.23	3.8
2	Mean	1.55	119	0.7	4.76	39
	Std. Dev.	0.23	13.8	0.48	1.04	8.16
N=37	C.V	0.15	0.12	0.68	0.22	0.21
	Std. Error	0.04	2.27	0.08	0.17	1.34
3	Mean	1.52	119	0.74	5.35	47
	Std. Dev.	0.28	17.1	0.51	5.5	57
N=23	C.V.	0.19	0.14	0.69	0.22	0.16
	Std. Error	0.06	3.56	0.11	0.24	1.55
4	Mean	1.48	115	0.51	5.5	57
	Std. Dev.	0.23	12.6	0.27	1.26	10.2
N=12	C.V.	0.16	0.11	0.54	0.23	0.18
	Std. Error	0.07	3.64	0.08	0.36	2.96

Table 4. Pairwise comparisons of chemical compositions in the groups from which polar bears were harvested.

Group	Degrees	Students "t" Value and Level of Significance				
Number	Freedom	P	Ca	Fe	Zn	Sr
1 vs 2	41	1.58	0.97	0.53	1.58	2.43[b]
1 vs 3	27	1.28	0.96	0.69	3.16[c]	0.68
1 vs 4	16	0.90	0.40	0.41	2.80[b]	1.50
2 vs 3	58	0.37	0.40	0.30	2.01[a]	3.44[c]
2 vs 4	47	0.91	0.88	1.77	1.86	5.28[c]
3 vs 4	33	0.49	0.82	1.80	0.35	3.02

[a] $P<0.05$, [b] $P<0.02$, [c] $P<0.01$

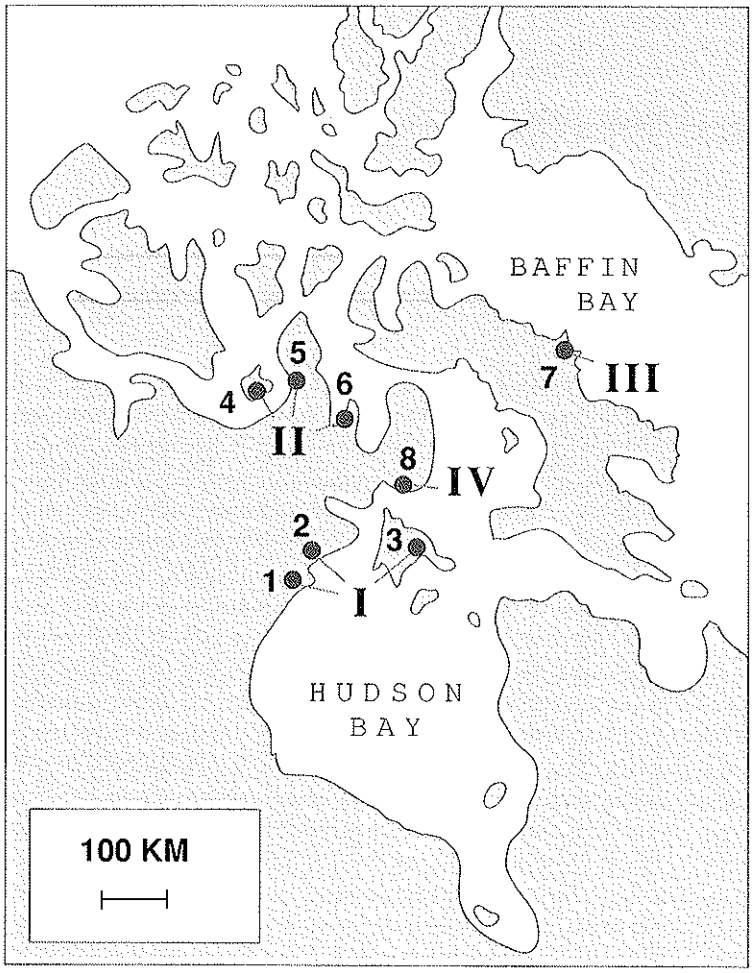

Figure 1. Distribution of the points from which specimens were collected, and designation of the 4 groups of polar bears in the Canadian Northwest Territories which the specimens were thought to represent.

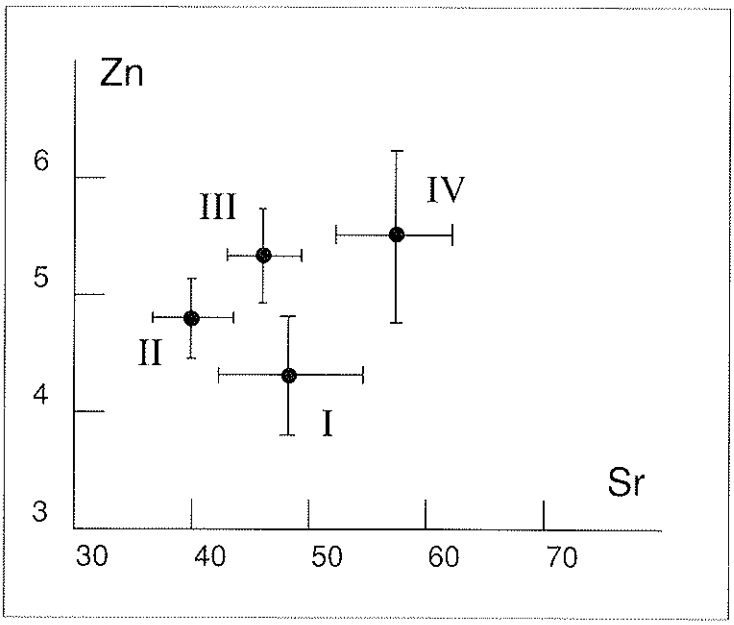

Figure 2. Distribution of samples from the hypothesized groups of polar bears in the Canadian Northwest Territories with respect to concentrations of Zinc and Strontium. Bars represent ±2 Standard Errors from the mean.

Reproduction and Sexual Behavior of Polar Bears (*Ursus maritimus* Phipps) in the Kazan Zoobotanical Garden

<Translated from Russian by P. Hagevold, Norwegian Polar Research Institute, Oslo>

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Introduction

The polar bear (*Ursus maritimus* Phipps, 1774) has been entered into the Red Book of the IUCN and of the USSR as "vulnerable". By the end of the 1970s the total number of polar bears in the wild had increased to about 25,000 individuals (Sokolov 1986). By 1 January 1985 about 300 individuals were kept in zoos around the world, about 40 of these are in the USSR (Sosnovski 1987). In 1982, 75 bear cubs were born in 39 zoos worldwide, of which 38 survived. In 1983 48 bear cubs were born in 34 zoos, of which 13 survived. In 1984 61 bear cubs were born in 34 zoos, of which 32 survived. (Anon. 1984, 1985, 1986). In 1987 11 bear cubs were born in the zoos of the USSR, of which 2 (18%) in the Kazan' Zoo survived (See Appendix for more information on polar bear productivity and survival in zoos of the USSR).

Clearly, breeding polar bears in captivity is difficult. Females often refuse to bring up young, and new-born cubs are sometimes eaten. Cases have been reported of females dying after birth. In order to understand the causes of problems in keeping polar bears in captivity a coordination of the work of all zoos possessing the species is necessary. With the blessing of the International Union for Conservation of Nature (IUCN) through the publishing of the International Pedigree Book of the Directors of the Zoological Gardens (IUDZG), the Rostock Zoological Garden (GDR) has been commissioned to keep accounts for the Pedigree Book of Polar Bears. The first International Pedigree Book of Polar Bears with data beginning 1 January 1980, has been released. Since 1963 the Rostock Zoo has brought up 30 polar bear cubs, an achievement which has obtained wide recognition throughout the world.

Despite of the potential for successful breeding of polar bears in captivity there is very little information on sexual behavior during the breeding season. Sexual behavior is of interest because it is related to segregation of the species. Related species in natural conditions usually do not interbreed. Interspecific differences in behaviour, including selection of a sexual partner from members of its own species, seem to be favourable for the species. Sexual isolation is one of the manifestations of the more general phenomenon - reproductive isolation (Menning 1982), and may constitute a "behavioral barrier to hybridization between species and populations". Hybrids, which are easy to obtain in captivity, occur quite rarely in nature. This is because behavioral mechanisms, providing normal pair bonding, cease to function, when males and females of different species are kept together in absence of a sexual partner of one's own species (Hind 1975). Thus several species of bears kept together have been known to produce cross-breeds. The following crosses have been successful: polar bear x brown bear (*Ursus maritimus x Ursus arctos*), black bear x polar bear (*Ursus americanus x Ursus maritimus*), black bear x brown bear (*Ursus americanus x Ursus arctos*), brown bear x sloth bear (*Ursus arctos x Melursus ursinus*), sloth bear x Malaya bear (*Melursus ursinus x Helarctos malayanus*) (Puschmann 1983). In the zoological garden of Lodz (Poland) 36 crossbreeds of polar bear x brown bear (*Ursus maritimus x Ursus arctos*) have been obtained since 1961 of which 2 stem (1.1) from a hybrid couple (Generation F_2). The experience obtained by crossing polar bears and brown bears shows that both species interbreed well, propagate, and bear fertile progeny (Sosnowski and Kowalska 1986). This paper reports observations of the sexual behavior of polar bears in the Kazan' Zoobotanical Garden as well as of reproduction in captivity.

Material and Methods

Observations were made during 10 years in the Kazan' Zoobotanical Garden. A male called "Umka", born 1975 and caught on Wrangel Island, was paired with a female called "Diksa", and taken from a den in February, 1974 on Dikson Island. Both the cubs reached sexual maturity in the conditions of the Kazan' Zoobotanical Garden. In addition, a female "Masha", born 1973, came from the Riga Zoo in 1985. Visual observations of the behavior of the polar bears were made before, during, and after estrus.

Results and Discussion

Reproduction of Polar Bears

In the period 1978 to 1987 11 polar bear cubs were born in the Kazan' Zoobotanical Garden, three were born dead and eight were raised successfully. Table 1 enables us to draw the following conclusions:

1. In the Kazan' Zoobotanical Garden estrus extends goes on from March 13th to April 27th with a total duration from 8 to 23 days. In the Leningrad Zoo estrus has been observed from February 10th to June 13 (Kost'jan 1954, Andreyevskaja 1987). In nature the mating period lasts from March to August (Kishchinsky 1974, Perry 1966).

2. The mean litter size was 1.57. There was one cub in 27% of the litters, and two cubs in 73%. In the zoos of the USSR, twins occur in 60 to 63% of the litters (Chutorjanski and Nemov 1969). On Wrangel Island 50% of the lactating bears had two cubs each according to information from S. M. Uspensky.

3. The first litter was stillborn in both the females.

4. The duration of pregnancy varied from 207 to 272 days. In the Leningrad Zoo the duration ranged from 174 to 320 days (Kost'jan 1954, Andreyevskaja 1987). Variation in the duration of pregnancy may be allowed by delaying implantation until just before the female enters the den (possibly even in the den). In such a case it is possible to assume that the fertilization of the female takes place during the period not only of the vernal, but also of the aestival heat. This peculiarity has been elaborated in polar bears apparently as a consequence of the uncertainty of meeting a male (Uspensky 1977).

5. Births occurred between November 17th to December 9th. In the Leningrad Zoo the births occurred from October 10th to December 30th (Kost'jan 1951, Andreyevskaja 1987).

6. In captivity the females come into heat every other year; if the cub dies, birth is possible the following year.

According to Tsalkin (1936) polar bears reproduce once in 3 years. According to Uspensky and Chernjavski (1965) polar bears reproduce every third year. In this connection these authors remark that in case of removal of 2 to 3 month old cubs the female may come into heat every other year. Khutorjanski and Nemov (1969) assume that polar bears reproduce once in two years based upon material from zoos.

In Soviet zoos reproduction in female polar bears has been observed up to age 24 years. In the Zoological Park of Detroit two polar bears gave birth at the age of 38 years and 2 months, but the cubs did not survive. A female at the age of 35 years and 11 months successfully bore one young. This female exceeds the other highest known reproductive age in captivity in the USSR by 11 years and 11 months (Latinen 1987).

In the Kazan Zoobotanical Garden the female "Diksa" reached sexual maturity at the age of 4 years, and "Umka" at the age of 3 years. Data on the age at sexual maturity of female polar bears are contradictory in the literature. For instance, according to Tsalkin (1936), sexual maturity at Franz Josef Land occurs at the age of 2 to 3 years, and according to Parovshchikov (1964) sexual maturity occurs at the age of 3 to 4 years. Data from zoos give different ages of occurrence of sexual maturity in polar bears. According to Kost'yan (1954), it occurs at the age of 5 years, but according to Khutorjanskij and Nemov (1969) at the age of 4 to 5 years.

Sexual behavior

Sexual behavior in polar bears begins to manifest itself with the occurrence of sexual maturity. It is expressed in a sexual ritual - including stimuli and responses of tactile, olfactory, visual, and auditory nature. This sexual ritual manifests itself in play, by sounds, and in tactile mutual exchanges, which leads to neural and hormonal responses, resulting in preparation of the genitals for coitus and fertilization.

In the Kazan' Zoobotanical Garden bears are given sprouted oats with fish fat 2 weeks before the assumed term of the oestrus.

Knowing the polar bear as an eternal wanderer (Uspensky 1977) we stimulate the active movements of our bears with the presence of a partner, with automobile tires to play with, as well as by a basin with water, which relieves overheating, which is not an insignificant influence (Kishchinski 1974), on sexual activity. It has been noticed that during the pre-oestral period the bears prefer to slake the thirst with snow.

According to our observations females become excited, renounce food, and their external genitals swell noticeably 5 to 22 days before the start of coupling. They become aggressive towards a male. At this time they often urinate; the smell of the urine excites the male, which excitedly walks along the cage and utters sound resembling moans/groans. In nature three to four males, usually the strongest and oldest ones, follow in the tracks of one female during the heat, attracted by the smell of the urine (Perry 1966). Aggression is later replaced by playfulness. The male licks the excretions of the female. The bears bask together in the snow, and the male is aggressive towards surrounding males.

According to our observations heat in polar bears in the Kazan' Zoobotanical Garden starts from mid-March to the end of April (Table 1), heat in nature - from March to August (Kishchinski 1974, Perry 1966). Heat is not difficult to detect because it is accompanied by vocalizations that may be heard all over the zoo. In nature males are irritable and aggressive during the coupling, and furious fights take place between them and their rivals. Sometimes the female does not remain indifferent during the coupling, but actively helps the one she likes best (Kishchinski

1974). Breeding in polar bears is rough. Perry (1966) observed several male bears with penis bones that had broken and imperfectly mended.

Something similar was observed in the Moscow Zoo by Afonskaja and Krumina (1958) when a male and two female polar bears were kept together. The male "Pet'ka" was offensive to the female "Zinka" except around the time of coupling. Also after coupling with the other female "Masha", both the male and "Masha" began to show aggression towards "Zinka", which "Masha" took for a rival.

During the sexual act all five reflexes are involved in a male polar bear: approaches, embracing reflex, erection, copulative reflex, and ejaculation. It should be mentioned that the first three reflexes were observed in subdued form as early as the beginning of December.

The duration of the coupling is from 25 to 30 minutes. It takes place in the following order: first the male approaches the female from behind and sniffs her. Then he lies with his belly on to her back, embracing her with his forepaws by the belly; he presses towards the hind part of the female and introduces his penis into her vagina with copulative movements, which according to observations last for 8 to 30 seconds. The frequency of the copulative movements during the first ten minutes of the sexual act goes on with different intervals, their total number equalling five. At this the female sometimes tries to tear herself away and bites the male in the neck, but he squeezes her more strongly with his forepaws, and bites her around the neck.

The orgasm in both the partners occurs with an interval of 0.5 to 0.3 minutes and lasts for 2 to 3 seconds; the bodies vibrate. The female utters an interrupted, gurgling roar; both of them shut their eyes. During coitus orgasm takes place 20 times, the interval between the orgasms being in the beginning reduced to 30 seconds and increasing towards the end. Figure 1 presents a graph of the sexual behavior of the polar bears "Umka" and "Diksa" during a coitus on April 13th, 1987 (time 08.12-08.42) in the Kazan' Zoobotanical Garden. Coupling requires much energy, and they breath heavily. After the coupling a semitransparent liquid of a yellow shade usually flows out of the genitals of the females, forming a small pool, which she licks up. Ordinarily the urine of the female is transparent. Together with assistant professor of the chair of obstetrics of the Kazan' Veterinary Institute M. G. Miroljubov we have detected (under 40X magnification) sperm cells in this liquid from the genitals of a female brown bear after a coitus.

After the coupling the male slakes his thirst by eating snow, and he watches the female. The female then becomes aggressive towards the male. The impatience towards the male during the heat may be so strongly pronounced that the two partners have to be kept separately and are put together only during the coupling. The coupling takes place no more than three times a day and may be with different intervals.

Thus, all the three stages of the sexual cycle: stimulation, braking, and equilibration (Ermasenkov 1983) are characteristic of the polar bear kept in captivity. After the stage of stimulation the signs of sexual stimulation in the females disappeared, and a negative sexual reaction to the male arose. This reaction was afterwards replaced by indifference.

In conclusion it may be said that:

1. The polar bear may successfully reproduce in conditions of captivity.

2. For the performance of serious works on the breeding of polar bears in zoos it is necessary to create a group of reproducing bears, in connection with which cooperation between zoos should play a great role.

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The author extends thanks for received information of the from A. N. Filanovich, Leningrad Zoo.

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Table 1. Annual periods of breeding behavior—characterized by copulation, the dates of birth, and the number and sex of cubs produced by two female polar bears in the Kazan' Zoobotanical Garden from 1978 to 1987. A "d" specifies that the indicated number of cubs were produced, but were still-born or did not survive.

	Female #1: "DISKA"		Female #2: "MASHA"	
Year	Copulation Period	Date of Birth (#Males/#Females)	Copulation Period	Date of Birth (#Males/#Females)
1978		23 Nov. (2d)		
1980		1 Dec. (2/0)		
1982	16 Mar.-1 Apr.	17 Nov. (1/0)		
1984	30 Mar. --6 Apr.	21 Nov. (1/1)		
1985				22 Nov. (1d)
1985			13 Mar. - 4 Apr.	9 Dec. (1/0)
1987	5 Apr. - 27 Apr.	19 Nov. (0/2)		

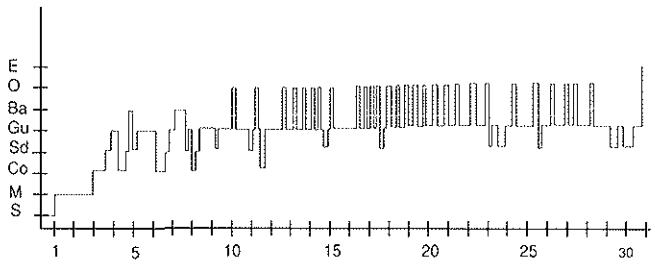

Fig 1. Graph showing coital interactions between male polar bear "Umka" and female polar bear Diksa in the Kazan Zoobotanical garden 13 April 1987. Interactions occurred between 0812 and 0842 hours. S = start of observation, M = mounting, Co = copulation, Sd = sat down, Gu = got up, Ba female tries to break away, O = orgasm, E = end of observation period.

Appendix: Breeding of Polar Bears (*Ursus maritimus*) in the Zoos of the Soviet Union

A. V. Malev (Kazan Zoo), V. S. Andreyevskaya (Leningrad Zoo), I. V. Egorov (Moscow Zoo), G. M. Nekrasova (Perm Zoo), T. M. Golubetseva (Rostov/Don Zoo), E. D. Tkachenko, T. E. Lysenko (Kharkov Zoo).

In 1889 the first polar bear cubs were born in captivity in the USSR at the Moscow Zoo. Polar bears have reproduced regularly in Leningrad Zoo since 1932. From 1932-1987 113 cubs were born in captivity in the USSR. The total number of the young born in Soviet zoos through 1988 was 224, 66 of them reached the adult age, the fate of 16 is unknown. Reproduction of Polar bears has been recorded for the Zoos of Kazan, Leningrad, Moscow, Perm, Rostov/Don and Kharkov. The average survival rate was 38.9% (n-9), ranging from 0 (Perm) to 72.73% (Kazan). Litter size per female varied from 1.46 (n-22) in Rostov to 1.92 (n-12) in Kharkov, the average figure being 1.66 (n-32) per year.

Mating took place in the period between January 25 to June 13. The estrus period varied from 1 day to 43, the average being 11.2 (n-104). Births took place from October 10 to December 31. Pregnancy lasted 165-316 days, the average being 234.77 (n-151).

Between 1970-1987 zoos in the USSR produced 176 cubs, 51 of them reached the mature stage. The least number of the survivors was 1 (1971), the largest was 5 (1975; 1980), the survival rate was 2.83 (n-18) cubs per year. The average birth rate is 9.78 (n-18), ranging from 17 (1970) to 4 (1986). The survival rate varied from 8.33% (1971) to 62.5% (1980), the average annual figure being 31.46% (n-18).

Results of Aerial Counts of the Polar Bear Dens on the Arctic Coasts of the Extreme Northeast Asia

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Introduction and Methods

Wrangel and Herald Islands, in northeast Asia, are known to be major polar bear denning areas. Polar bears also are known to den on the Arctic coast of the mainland and adjacent islands. Until now, however, the only information available for denning along the coast of the mainland has been anecdotal.

In 1985 the staff of the State Reserve "Ostrov Wrangelya" (Dr. V. I. Pridatko) and the Chukchi State Regional Hunting Inspection (Drs. E. P. Shevchenko, I. V. Kalmykov) carried out the first aerial reconnaissance of polar bear dens on the mainland coast. Results of that work were presented at the XI All-Union Symposium "Biological Problems of the North" in Yakutsk. In 1986-87 the surveys were repeated by staff of the Reserve: Drs. P. V. Maryukhnich, M. S. Stishov and A. A. Kalinin. In 1985, the counts were made from 25 March-3 April in the Medvezhyi Islands and along the coast from the estuary of the Kolyma River to Laurence Bay. In 1986, counts occurred from 21 March-4 April, and covered the area from Schmidt Cape to Laurence Bay. In 1987, the area from Billings Cape to the estuary of the Amguema River was covered from 5-7 March and between 17-21 March the Medveshy Islands and on the coast from the estuary of the Kolyma River to Laurence Bay were covered. In 1988, from 29 March-1 April, the area from Bolshoi Baranov Cape to Laurence Bay was surveyed. The counting time coincided with the peak emergence of dens in Wrangel and Herald Islands. All counts were carried out from a MI-8 helicopter, at 50-100 m altitude, and speeds of 120-200 km/h. The entire coastline was surveyed (excluding the lowland coasts of Kolyuchin Bay), as were likely denning areas (e.g., foothills facing the sea, large river valleys, isolated mountain massifs) inland from the coast. Interior and coastline survey routes were approximately comparable in length. Thus the total coastal zone surveyed during the 4 years was 8-10 to 30-40 km wide, from the Kolyma River estuary to Laurence Bay including all coastal islands (Medvezhyi, Aion, Bolshoi Rautan, Malyi Rautan, Shalaurov, Idlidlya, Kolyuchin).

Results

In total, 60 dens were found, 5 of which may not have been maternity dens. The presence of two more dens was detected by tracks. Specific observations by area follow:

1. Medvezhi Islands: The Medvezhi Islands were surveyed in 1985 and 1987. In 1985 no signs of polar bears were found. In 1987, however, we sighted 12 dens, 3 of which were probably only temporary structures. Seven dens (including two of the possible temporary structures) were located in the northern part of Pushkarev Island. Three were on Chetyryokhstolbovoi Island; one on Lysov Island and one (possibly temporary) more on Krestovksky Island. A polar station staff worker informed us in 1979 about three dens on Chetyryokhstolbovoi Island.

2. The Kolyma River estuary to the Bolshoi Baranov Cape: The coast here is characterised by capes of varying height (Medvezhyi, Letyatkin, Bolshoi Baranov) and open coves with lowland shores. The area was surveyed completely in 1985 and 1987. In 1988, the Bolshoi Baranov Cape was inspected. Despite the effort, only one den, located at the eastern edge of Baranov cape, was found.

3. Krestovoye Plateau to Nagleynaya Mountain: This foothill plain, within the Kyttyk Penninsula, is 15 to 60 km wide with multiple river valleys. The valleys are characterized by multiple thermokarst hollows and precipitous, furrowed, loose-rock shores. In 1985 and 1987 the entire coastline and foothills as well as the surface of the plain were surveyed. No dens were sighted in 1985. In 1987 two dens were observed to the west of the Rauchua River: under a bank precipice and in a gully several kilometers inland. Also the tracks of a female bear with cubs leading from the mountains to the sea were observed.

4. Aion Island: This island is similar in structure to the plain described in "3" of which it is a fragment. According to local residents, 1-3 bears usually den here. In 1985 we found 2 dens under the precipices of the south shore of the island; 1 more was recorded on the south-west shore. In 1987 1 den was found on the west and 1 more on the east coast (near to the Achekuul' Cape). According to questionnaire data, dens are frequently found in the small islands (Ryyandranot and Chenkul') at the north coast of Aion Island.

5. Chaun Bay: Despite extensive precipitous shores with well-developed snow-banks, no tracks of polar bears were found within the entire stretch of the bay's coast from the Kyttyk Peninsula to the Shelagsky Cape, including the Bolshoi Rautan and Malyi Rautan Islands.

6. Shelagsky Cape to Nol'de Bay: This is a predominantly mountainous coast with foothill plain fragments and rock precipices in Shelagsky Bay, Kiber Bay, Shalaurov Bay and the west coast of Nol'de Bay. The region was surveyed for three years. Only one den was found, in 1987, at the south-eastern extremity of the Kiber Cape.

7. Aachim Cape to Kuveyem River: The mountains come close to the shore of this foothill plain only at Lyaller Cape. Elsewhere, the plain is 5-20 km wide. One den was found, in the Yakanvaam River valley 15 km inland. In 1987 one den was observed on the shore of the low Aachim Peninsula; two dens, in the Pegtymel' River valley approximately 20 km inland; and two , under the shore precipices between Lyaller and Billings Capes and near Yakan Cape. According to questionnaire returns, in 1984 one den existed in the Aachim Cape.

8. Rypil'gin Lagoon to Nutauge Lagoon: This is a foothill plain 10-60 km wide with shoreline characterized by numerous lagoons. Steep rock banks are available only in the Schmidt Cape area where the mountains come very close to the shore. In 1985 2 dens were found in the spurs of the Ekvyvatapsky Ridge approximately 20 km inland. In 1987 2 dens were found in the Amguema River valley 25-30 km inland; 1 den, on the spit of the Nutauge Lagoon. In 1988 1 den was found on the shore of the Kinagtokintangkin Lagoon in the area of the Leningradskoye Plateau. Information from local people suggests polar bears also den in the Schmidt Cape: on the Weber Cliff and the slopes of the Chernaya Knoll.

9. Vankarem Cape to Kolyuchin Bay: Here, rocky capes: Vankarem, Onman, and Kalanaut alternate with coastal lagoons which have mountainous shores. In 1985 no dens were found. In 1987, 2 dens were sighted under the rocks of the Onman Cape. In 1988, 3 dens were observed: one at Onman Cape, one on the coast of te Vankarem Lagoon, and one on the slope of Vatan Mountain.

10. Kolyuchin Island: No dens were found in 1985. In 1986 and 1988 3 dens were sighted under the rocks of the north-east shore and one was sighted there in 1987.

11. Belyak Spit to Netten Cape: This predominantly lowland lagoon coast has a single precipitous cape: Dzhenletren. In 1985 1 den was found on the shore of the Neshkan-Pil'khin Lagoon at the foot of Eletkun Mountain. In subsequent years no polar bear dens were observed.

12. Serdtse-Kamen' to Uyelen: A predominantly mountainous north-east coast with rocky precipitous shores, formed in the spurs of the Genkanyi Ridge. In 1985 eight dens were recorded: 5 at Inkigur Cape, and 3 at Inchoun Mountain. All dens were located in the snow banks under the coast rocks. In 1986 1 den was registered between Uyelen and Inchoun and 2 dens in the region of the Inkigur Cape. No dens were found herein 1987; in 1988 1 den was sighted in the area of the Chegitun River; 1 more between the Chegitun and Utavgem Rivers in the mountains 7-8 km inland.

13. Dezhnev Cape to Laurence Bay: This eastern coast of the Daurkin Peninsula is similar in structure to the previous area. One den located on the steep rocky slopes or at their foot was observed here each year: in each 1985 and 1988 a den was located at Peek Cape; in 1986, at Dezhnev Cape; and in 1987, at Nunyamo Cape. The tracks of a female bear with cubs, and approximate locations of two more dens: to the south of the Peek Cape and in the region of the Seryi Cape were recorded in 1985.

Discussion

These results suggest that polar bears den along almost the entire coast. According to the data of 1985 and 1987 when the entire coastal area was surveyed, the mean occurrence of dens along coastal and inland survey routes was 1.2 - 1.7 per/100 km of coastal zone. Regional mean observation rates (dens/100 km) were: Kolyma River estuary to Chaun River (including Aion Island), 0-1; for the coast from the Shelagsky Cape to Kolyuchin Bay (including Kolyuchin Island), 0.3-2.0; including to the west of Schmidt Cape, 0.5-2.0; to the east, 0-3.0; for the coast of the Daurkin Peninsula, 0.3-3.0. As seen, the order of magnitude is similar, but the maximal values slightly increase going from the west to the east. Observation rates were consistently higher on the Medvezhyi Islands than in other coastal areas. In 1987 9-12 dens were found on the approximately 100 km of coast surveyed there. For comparison 25-30 dens/100 km occur on the western, southern and eastern shores of Wrangel Island. Thus, dens were observed 2-3 times more frequently on Wrangel Island than in the Medvezhyi Islands, and 10 times more frequently than in the west of the mainland coast. The difference is even more impressive as compared with the Herald Island where up to 20 dens may be sighted on only 20 km of coastline.

Of 60 dens found on the mainland areas 50 (83%) were located along the coastline in the snow-banks under the shore precipices and rocks or at the shore slopes. The remainder of the dens, found inland, were mainly on the mountain slopes facing the sea and separated from it by the foothill plains, or in river valleys. The proportion of dens found inland varied with the character of the coast. About 14% of the dens were inland in the region from the Kolyma River estuary to Chaun Bay where precipitous shores predominate, but 45% were inland on the coast from the Shelagsky Cape to Kolyuchin Bay where lowland lagoon shores predominate. Only about 5% of located dens were inland on the Daurkin Peninsula which is characterized by mountainous rocky shores. In the Medvezhyi Islands and Kolyuchin Island all dens found were along the coastline. The ratios of coastal to interior dens may be biased because we achieved complete coverage of coastal areas during our surveys whereas much interior habitat was not sampled. Inland survey routes were designed to cover the most suitable

denning habitats rather than all possible habitats. Nevertheless the trends suggested by these ratios may reflect preferences for denning areas. Recall that on the coasts with lowland lagoon shores unsuitable for polar bear denning, the occurrence of the dens inland was greater than that in areas with precipitous coastlines.

During 1985 and 1987, when the entire coast was surveyed, the total number of dens seen was similar (19 and 21) but their distribution was different. The distribution patterns of the dens sighted during those years "mirror" each other. In 1985, about half the dens were registered in the Daurkin Peninsula; only 1 was observed on the coast from Sheagsky Cape to Rypil'gin lagoon, and none in the Medvezhyi Islands. In 1987 only one den was found in the Daurkin Peninsula; 9 on the coast from the Shelagsky Cape to the Rypil'gin Lagoon; 3 from the Chaun Bay to the Kolyma River; and 9-12 in the Medvezhyi Islands. To explain this situation, two hypotheses can be offered: First, annual variation in the distribution of polar bear denning may depend on ice, snow and weather conditions, which are variable from year to year. Secondly, the counts of 1987 were carried out, on average, 10 days earlier than those of 1985. Therefore, the existing differences may be explained by the time difference of peak emergence from dens which appeared to be later in eastern areas than in western areas. This view is appears reasonable because the eastern regions of the study area are more southward than the western regions and, more subject to the warming effects of Pacific waters. Accordingly, in the east the coastal areas freeze later, creating other conditions favorable for polar bear denning. The second hypothesis seems more likely and is corroborated by the observations of 1988 which were carried out exactly the same time as in 1985. In 1988, 9 of 11 dens were sighted to the east of the Vankarem Cape. None were found, however, along the coast from the Billings Cape to Bolshoi Baranov Cape.

Year-to-year changes in the total number of dens in the mainland coastal areas did not seem to be great. Surveys conducted on the coast east of Vankarem Cape in 1985, 1986 and 1987 during the same time period, produced 9, 7 and 9 sightings of dens. In 1985, 1987 and 1988 we sighted 19, 16 and 11 dens, respectively, from Bolshoi Baranov Cape to Laurence Bay, (i.e., along the entire coast studied except the region of the Kolyma River estuary and the Medvezhyi Islands where in 1988 no counts were performed). These differences may depend more on the number of observers (3 in 1985, 2 in 1986, and 1 in 1988) than they do on the numbers of bears or dens avaialble to be sighted. .

Our findings are still insufficient for a precise determination of the total number of dens on the coast. Point estimates can be made, but any estimate obtained is likely to be low, because many dens were undoubtedly missed, and inland areas were poorly covered. In our calculations we will use the indices obtained during perennial counts of polar bear dens on Wrangel Island; the simultaneous ground and aerial surveys established that 60-80% of dens open at the time of a survey are counted. The observations of den emergence in the same areas during the whole period showed that at peak emergence, occurring in Wrangel Island in late March-early April, one third to half of all dens are open (Belikov et al. 1977). The course of the calculations depends on which hypothesis about differences in the distribution of dens at various years we accept. Allowing for the coincident den emergence in the entire region, no fewer than 50-75 female bears den annually in the territory surveyed. If the hypothesis regarding temporal differences in emergence from dens in the western and eastern areas is invoked, and if we use Billings Cape as a boundary, we obtain a minimal estimate 1.5-times-higher or 80-120 dens: 20-30 in the Medvezhyi Islands; 25-40, on the coast from the Kolyma River estuary to Billings Cape (including Aion Island) and 30-45, to the east from Billings Cape. In the latter case, correspondingly, the distribution of dens on the regional scale should be relatively constant.

Conclusions

In summary, it can be concluded that the Arctic coast of northeast Asia is a region of regular propagation of polar bears which den along its entire extent. The highest concentrations of dens occur in the Medvezhyi Islands, the north-east coast of the Daurkin Peninsula and, to a lesser degree, on the coast from Vankarem Cape to Kolyuchin Island. The total numbers of the female bears denning on the coast exceed earlier estimates of 20-25 dens on the entire coast of the East-Siberian Sea (excluding the Novosibirsk Islands) and the coast of the Chukchi Sea (Uspensky and Chernyavsky 1965). Our recent data clearly refute the general belief that almost all polar bear dens in the region discussed are concentrated on Wrangel and Herald Islands with a relatively insignificant proportion on the mainland. Up to 250 dens have been counted in each of several recent years on Wrangel and Herald Islands. Thus those two islands are extremely important from the standpoint of polar bear reproduction. From 50-120 mainland dens may be estimated for the region; so denning on the mainland USSR must also be considered important.

Results obtained during the past four years, suggest the need for continued studies. Attention in the future should be focused on the problem of the time of emergence of bears from dens, and year-to-year spatial variation. Several counts in different periods of the same year will be necessary, as will greater survey efforts in interior areas (Chelintsev 1977). The elucidation of these problems would provide a more accurate idea of the distribution and total number of dens on the coast. Regularly scheduled surveys of smaller sample areas, then, would document trends.

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Polar Bear Populations in the Soviet Arctic: Current State, Studies and Management (1985-1987)

Uspensky, S. M. and S. E. Belikov. All-Union Research Institute on Nature Conservation and Reserves, State Committee of Nature Conservation, Sadki-Znamenskoye, Moscow M-628, USSR 113 628.

Population Definition and Status

Recent studies based on trace element analysis of polar bear bone tissue (Uspensky et al. 1985) identified three geographic groupings of polar bears in the Soviet Arctic. The Western Group inhabits the Barents, Kara, and Greenland Seas including Spitsbergen, Franz Josef Land, Novaya Zemlya and apparently the western part of Severnaya Zemlya. The approximate size of the population based upon estimates by Larsen (1986) is 3000-5000 individuals. In spring (April-May) animals of this group migrate to the north and east. In late summer when ice cover is minimal, their distribution within the habitat area is the most uniform. In autumn (September-October) they migrate to wintering areas in the Greenland, Kara and Barents seas. Maternity denning of pregnant females occurs mainly on the eastern part of Spitsbergen (Kong Karls Land, 100-125 dens; Franz Josef Land (100-150 dens; and the Novaya Zemlya (about 50 dens) (Larsen 1985) (Belikov and Matveyev 1983) Numbers of bears in this group apparently increased during the last 10-15 years. However, the increase is not as great as might have been expected in view of the ban on polar bear hunting in the USSR after 1956, restrictions on hunting in Norway after 1957 and the Norwegian ban on polar bear hunting after 1973.

The Central Group of polar bears in the Soviet Arctic inhabits the Laptev Sea and the western part of the East-Siberian Sea. Polar bear observations obtained during ice patrols (Belikov and Gorbunov 1990—this volume) suggest the central group is smaller than the Western and Eastern Groups. The main wintering area of these animals is apparently the Great Siberian Polynia in the Laptev Sea. In summer the animals are distributed more evenly. Pregnant females den in the Severnaya Semlya Islands (about 30-50 dens), on the coasts of the Taimyr Peninsula and the adjacent islands (about 30 dens), in the north of the Novosibirsk Islands (about 50 dens), and on the inland coast of Yakutia and adjacent islands (about 20 dens).

The Eastern Group inhabits the eastern part of the East-Siberian Sea, the Chukchi Sea, and the northern part of the Bering Sea. Winter concentrations occur near Wrangel Island, in Long Strait, and the southern part of the Chukchi Sea. In April-May the bears migrate to the north-west (this migration is well known in the region of the Wrangel Island). The return autumn migration occurs in September-October. The size of the eastern group is estimated to be 2500 (M. Taylor, personal communication) to 7000 (Lentfer 1976) individuals. Spring aerial survey estimates for the Chukchi Sea (except its east and north), the East-Siberian Sea (except its north) and the northern Bering Sea were 1310-2670 individuals. This group of polar bears increased noticeably during the past 10-15 years, despite the annual harvest of 100-200 individuals from northwestern Alaska (Gorbunov et al. 1987). Approximately 200 females from this group den each year on Wrangel Island, and up to 50 den on Herald Island. Also 50-120 dens are annually found on the coast of the Chukchi Peninsula and the adjacent islands (See Stishov 1990—this volume).

Management of the Populations

The complete ban on hunting of polar bears, effective after 1956 in accordance with a special decree of the Russian Soviet Federative Socialist Republic (RSFSR) Council of Ministers and confirmed in 1975 by a decree of the USSR Council of Ministers, remains in force. The polar bear has been entered in the Red Book of the USSR (second edition) as a rare species (category III); and also as a rare species, in the Red Book of the RSFSR. The only permissible use remains the restricted capturing of the live bears by special licenses issued by the Chief Directorate of Hunting and Reserves, the RSFSR Council of Ministers. In 1985 the total capture was 10 bear cubs, 3 were taken in 1986; no bears were captured in 1987. Two "problem" bears were killed in 1983; 6 in 1986; and 18 (including 8 in the Magadan Region) in 1987. In 1985-1987 four cases of illegal hunting of polar bears were reported. In accordance with the Model Rules of Hunting in the RSFSR, the fine for illegal shooting of polar bear is 700 roubles.

In light of increased numbers of bears, especially the Eastern Group and an increasing frequency of polar bear intrusions into settlements, the nature conservation authorities in the USSR are proposing the following management changes: Change the status of the western and eastern groups of polar bears in the Red Book of the USSR from category III to category V (restored species). Increase the removal of "problem" individuals from the population (primarily, in the Chuckchi Peninsula). Implement a limited hunt of the polar bears from the Western and Eastern Groups within the strictly limited quota subject to future agreements with Norway (Western Grouping) and the USA (Eastern Grouping).

Studies

As in the previous years, polar bear studies in the USSR were carried out by the All-Union Research Institute on Nature Conservation and Reserves (RI) in Moscow. Geographic distribution and population status were the priority study topics.

Geographic distribution was analyzed using geochemical methods Vernadsky (1920). The concentration of trace elements in tissues of organisms is determined by evolutionary factors and by the features of their habitats under static conditions. In other words the chemical composition of tissues correlates with the geochemistry of the landscape: Bone tissue, in which concentrations of elements are less volatile than in other tissues, was used for the analyses. The specimens, taken from sections of the lower jaw of the animals, were analyzed for the content of 42 chemical elements by both spectral semiquantitative and more precise X-ray fluorescence techniques (Uspensky et al. 1985). Concentrations of elements (potassium, titanium, nickel, and aluminum) suggested division of polar bears of the Soviet Arctic into the 3 groups discussed earlier. Similar results were obtained during the analysis of the bone tissue of the polar bears inhabiting the Canadian Arctic (See Golovkin et al. 1990—this volume).

To determine the abundance and distribution of polar bears the RI, together with the Chief Directorate of Hunting and Reserves, the RSFSR Council of Ministers, and the Arctic and Antarctic Research Institute carried out aerial counts of the polar bears (in 1987 in the east of the Soviet Arctic and in 1988 in the entire Soviet Arctic) simultaneously with ice patrols. Such work was also carried out in previous years, and special efforts occurred in 1962, 1967, 1968 (Uspensky and Shilnikov 1969), and 1970-1972, and 1974-1984 (Gorbunov et al. 1987). We concluded that aerial counts of polar bears over large areas show promise for determining the distribution and abundance of polar bears. Procedures, however, need improvement (See Belikov and et al 1990---this volume).

The RI continued the collection and analysis of responses to questionaires sent to drift-ice polar stations, arctic airports and settlements, and others known to have worked in arctic regions. A copy of the questionaire and associated information is replicated in table 1. The RI together with the Arctic and Antarctic Institute also carry out analysis of the distribution and migrations of the species in relation with ice conditions (see Belikov and Gorbunov 1990—this volume).

Personnel of The State Reserve "Ostrov Wrangelya" carried out systematic studies of the ecology and behavior of polar bears: including regular counts of bear dens and other sightings, and collection and analysis of data on propagation, nutrition and migrations (see Stishov 1990—this volume).

Some Zoological Gardens of the USSR (Moscow, Leningrad, Kazan, Tallin, Kiev, Kaliningrad) carry out studies directed at the improvement of the polar bear upkeep, breeding and veterinary practice. The Zoological Institute, USSR Academy of Sciences (Leningrad) performs the studies of the species evolution (See Małyov 1990—this volume).

The Institute of Animal Evolutionary Morphology and Ecology, USSR Academy of Sciences (Moscow) carries out the task studies on the morphology and ethology of the polar bear. Although preliminary, studies by A. V. Shubkina may suggest behavioral differences among carnivores that could be important for managers.

Future Priorities

Special attention in the future will be given to the development of the theoretical bases of improving polar bear population management, specifically: verification of population structure, analysis of distribution, abundance, population dynamics, prevention of conflict situations between polar bear and man and continuation of the works on trace element analysis of the polar bear bone tissue. We suggest that it would be desirable to carry out comparative analyses of bone tissue of the animals from the entire Arctic (analyses can be carried out by the Soviet investigators). Aerial counts of polar bears on the ice and aerial ice patrols will be continued. Because aerial counts may allow assessment of long term trends we suggest cooperative, simultaneous counts by all jurisdictions.

In accordance with the Soviet-Norwegian agreements, we also propose the participation of the researchers of the RI in cooperative polar bear studies in Spitsbergen and correspondingly, within the Soviet-US agreements on joint/cooperative works on polar bears in the Chukchi and Bering Seas.

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Table 1. Registration form for ground observations of polar bears in Soviet Arctic Regions.
Name of observer .....
Address of observer .....

Observation No.	Date and Time	Location	Group size and compositions	Behavioral observations	Tags or Marks	Other comments

Notes: The log book (form) should be supplemented with a schematic map of the region of observations. The place on the map where the bears or the group of bears were sighted should be marked with the number allotted to the observation in the log book (form).

If a female bear with cubs or a group of adult animals were sighted, the group is allotted one number.

Column 4 should indicate whether a lone large animal was sighted, or a lone small animal, or a female bear with cubs. In the latter case, the number of cubs and their age (cubs of the year, yearlings or older) should be mentioned.

Column 5 should include the observations of the animal behaviour, hunting, travel, direction of movements, reaction to man and unknown objects. The weather and ice conditions during the observations should also be included here.

Of special interest are the observations of tagged bears. The tags should be described (metal or plastic; in both ears or one ear; size and colour of the tags and the collar (if any); numerals and other designations on the hair, their size and colour.

In column 7 all the cases of locating the dens (occupied the given year or previous years) are to be introduced, their exact location, description, date of opening the den, leaving the den by the family, number of cubs in the family.

Observations should be sent to:

All-Union Research Institute on Nature
Conservation and Reserves,
Sadki-Znamenskoye, M-628,
Moscow, 113628, USSR.

Appendix 1

Agenda of the 10th Meeting of the IUCN/SSC Polar Bear Specialist Group, Sochi, USSR, 25-30 October 1988

I. Introductory remarks from the hosts.

II. Election of the meeting chairman and selection of the meeting secretary.

III. Adoption of the agenda.

IV. Discussion of the future role of the IUCN in the polar bear specialist group.

V. Production of the minutes and other documents stemming from the meeting.

VI. Summaries of research and management by country.

VII. Cooperative Research and Management.

VIII. Special topics.

IX. Discussion and identification of future research and management priorities.

X. Future objectives and actions of the Group.

XI. Schedule and Location of the next PBSG meeting.

XII. Identification of full members of the PBSG.

XIII. Election of a new chairman.

Appendix 2

Minutes of the 10th Meeting of the IUCN/SSC Polar Bear Specialist Group, Sochi, USSR, 25-30 October 1988

October 25

I. Introductory Remarks from the Hosts.

A. The meeting was opened at 2:00 p.m., 25 October 1988 by the present chairman of the IUCN Polar Bear Specialist Group (PBSG), Steven Amstrup.

B. On behalf of the hosts, the director of the Biosphere Caucasus Nature Reserve, Nikolai T. Timuchin, extended a warm welcome to all those present at the meeting. He thanked everyone for coming to Sochi for this important meeting, and encouraged all participants work and learn together. He also encouraged everyone to take time to enjoy the community of Sochi, and the surrounding countryside.

C. An introduction was delivered by S. M. Uspensky who congratulated all the members on the Twentieth Anniversary of the Group, and suggested that a summary of work conducted since 1969 should be developed. Dr. Uspensky then introduced all the participants at the meeting Members of the PBSG present included: I. Stirling, and M. Taylor, of Canada; E. W. Born, of Denmark; O. Wiig, of Norway; S. Amstrup, G. Garner, and S. Schliebe, U.S.A.; S. Belikov, and S. Uspensky, of the U.S.S.R. Invited specialists present were: R. Hansson, and P. Prestrud, Norway; A. Golovkin, Yu. Gorbunov, A. Malyov, and M. Stishov, of the U.S.S.R. Full addresses of the PBSG members and invited specialists are given in Annex 1.

D. S. Amstrup explained that an IUCN representative was not able to attend this meeting, as had occurred in the past, due to funding restrictions and scheduling conflicts.

II. Election of the Meeting Chairman and Selection of the Meeting Secretary.

A. S. Amstrup was elected as the meeting chairman.

B. S. Uspensky agreed to act as cochairman and to organize the recording ofnotes during the meeting.

III. Adoption of the Agenda.

A. Discussions were held regarding topics not listed on the original agenda, and a final agenda "as shown below" was adopted.

IV. Discussion of the Future Role of the IUCN in the Polar Bear Specialist Group.

A. Past achievements were discussed, and the effectiveness of the group was reemphasized.

B. The future role of the group, relative to IUCN, and the International Agreement for the Conservation of Polar Bears was discussed. It was agreed that the effectiveness of the group could only be enhanced by continuing ties to IUCN, and the continued use of the polar bear agreement as a guideline.

V. Production of the Minutes and Other Documents Stemming from the Meeting.

A. All the members concluded that the proceedings should be of high quality.

B. S. Amstrup agreed to prepare the minutes and edit the manuscripts for publication in one proceedings volume.

C. O. Wiig offered to work as Co-editor, and offered support in replication, translation, and word processing.

VI. Summaries of Research adn management by Country

A. Canada

I. Stirling and M. Taylor briefly reviewed polar bear management and research in Canada 1985-87. Subjects covered included: cooperative studies, a computerized data bank, modelling, new immobilizing drugs, collection of blood samples, toxicology and monitoring of pollutant levels in polar bear tissue, polar bear - human interactions, and population research in Hudson Bay and Foxe Basin. Research on immobilizing drugs, tetracycline marking, and hunting, by indigenous people were extensively discussed. Of special interest to the Soviet participants were coordination of

data bases on polar bear, access to and exchange of information, and advanced technology.

B. Denmark

E. Born submitted a report on polar bear research and management in Greenland during 1985-1988. The report included discussion items on: tissue sample analyses for heavy metal contamination, a summary of current knowledge of the occurrence of polar bears in eastern Greenland and adjacent seas, information on polar bear harvest, denning sites, collection of biological samples, harvest statistics, amendments to hunting regulations and future research needs. Organo-chlorine and heavy metal contamination of marine ecosystems appeared to be the problems of greatest general interest.

A summary of a new paper on non-metrical characteristics of polar bear skulls by Poul Henrichsen was also presented. Born requested that Soviet, American, and Canadian experts help Henrichsen in interpreting results from Wrangel Island-Chukchi Sea, St. Lawrence Island-Northern Alaska, and the Canadian management zones-E-G.

C. Norway

O. Wiig submitted reports on research and management in Norway. Research has been financed through the Norwegian Polar Research Institute, Ministry of Oil and Energy. Polar bear surveys were conducted on the southeast coast of Spitsbergen during spring 1986. Ten maternity dens were located, indicating the importance of the area as maternity dening habitat for Svalbard polar bears. The problem of bear-human interactions, particularly disturbances of denned bears by noise and vibration from activities related to hydrocarbon exploration and petroleum activities in Norwegian waters was discussed.

Organo-chlorine contamination and the possibility of comparing samples of tissues from several countries (the U.S.S.R., Norway, U.S.A.) was discussed.

R. Hansson submitted a summary of polar bear migration studies conducted in southern Svalbard during 1987. The high concentration of bears in this area makes it an important "mating area". Hydrocarbon exploration and production in this area may consequently affect the Svalbard polar bear habitats.

P. Prestrud reported on management of the polar bear in the Svalbard area. Industrial development, tourism, petroleum activities and exploitation of the biological resources in the Barents Sea are the main threats to the population: To cope with this problem "A system for analysis of environment and industrial development" has been developed which is similar to the Canadian "Beaufort Environmental Monitoring System" (BEMP). A working management system has been developed. Meeting participants agreed that this system was a step in the right direction, because the basic question in management and research is often to choose what problems are most serious and what kind of research is most relevant.

D. U.S.A.

G. W. Garner presented a summary of research on polar bears in Western Alaska from 1986-1988. Four main objectives of the research are to: Delineate the polar bear populations that seasonally occupy the Bering and Chukchi Seas; develop methodology for censusing polar bears; determine the size and trend of the Chukchi polar bear population, and to determine relationships between sea ice, habitat selection and seasonal distribution of polar bears in the Bering and Chukchi seas. Considerable discussion ensued regarding census techniques, satellite telemetry, and DNA sequencing.

S. Amstrup submitted a report on research on polar bears in Northern Alaska. The main objective of that research is to determine the status of the species in the Beaufort Sea and adjacent areas (population size and definition, feeding ecology, maternity denning, status relative to carrying capacity).

S. Schliebe presented a summary of polar bear management in the Beaufort Sea. He pointed out that an initiative by user groups in Canada and Alaska to jointly manage polar bears of the Beaufort Sea region was developed and implemented. The agreement is entitled "Management Agreement for polar bears in the southern Beaufort Sea". The user groups signatory to the Management Agreement are the North Slope Borough in the United States and the Inuvialuit Game Council in Canada. Content of the Agreement includes a listing of the objectives, definitions, regulations, terms for sharing population information and collection of data and duration of the Agreement.

E. U.S.S.R.

S. Uspensky and S. Belikov reported on state studies and management of polar bear populations in the Soviet Arctic. They recommended that the following be considered for future priorities:

a) Improvment of polar bear population management.
b) verification of the population structure of the species.
c) analysis of the population distribution, abundance and dynamics.
d) prevention of bear/human interactions.

A. Golovkin reported on the use of geochemical methods for the differentiation of polar bear geographical groupings. It has been shown that the differences in animals at the groups, species, sub-population and population levels, can

be revealed by analyzing the element composition of the tissues. There was a discussion on the advantages and disadvantages of this approach in population identification. The members suggested this research should be continued and tissues should be exchanged. The representatives of the USSR were chosen as focal points for such international studies. Belekov also summarized the results of some new research being conducted by A. V. Shubkina on the comparative ability of the polar bear to operate with the empirical dimensionality of figures.

October 26

During the day, members of the polar bear group were treated to a tour of the greater Sochi area. The evening, then, was filled with informal discussions in small groups, which served to lay the ground work for more detailed discussions to follow.

October 27-28

VII. Cooperative Research and Management.

During the discussions on 'Cooperative Research and Management' the following issues were covered, those proposing the issues are shown in ( ):

A. Joint census and marking on Wrangel Island (scientists from U.S.S.R. and U.S.A.). Studies on polar bear ecology (proposed by Garner, Amstrup, Belikov).

B. Population numbers and the impact of harvesting.

C. Simultaneous census by national efforts (where using comparable methods), and further exchange of the results (proposed by Uspensky).

D. Exchange of necessary information, including data on polar bear harvesting (Schliebe).

E. Joint management of polar bear populations in the Barents Sea (Norway/U.S.S.R.) and in the Chukchi, Bering and Beaufort Seas (U.S.S.R./U.S.A./Canada) (Schliebe).

F. Advanced computerizing methods common for all countries which can help to unify national data on polar bears (Golovkin).

G. Satellite telemetry for research in polar bear migrating (Wiig).

H. Exchange of blood, bone etc. specimens collected from as many areas as possible throughout the polar bear range. (The Soviet Union shall coordinate the collection of bone tissues, because of its lead in that area of research. Canada should receive soft tissue samples from all areas that can be used in contaminant analysis. A bank of tissues would be created which would help a series of investigations and developing methods of their treatment. M. Tayler: Suggested developing methods of conservation and transportation of samples, and to think over the arrangement of such a bank.)

I. A proposal on sperm freezing was not supported.

J. Develop a census index similar to those established for brown and grizzly bears. (R. Hansson and M. Taylor).

K. M. Taylor proposed to enter an item 'resolutions' in the agenda of the future meeting.

VIII. Special topics.

A. Developments in aerial survey for polar bears.
Problems concerning aerial census and satellite telemetry were covered in many papers. PBSG members recommended that attention to aerial survey be increased, and methods be improved. Testing and sharing of methods and simultaneous timing of surveys in international areas were deemed necessary.

B. Developments in satellite radiotelemetry.
G. Garner pointed out that satellite telemetry technology has been used during field studies of polar bears in Alaska since 1985. A total of 109 platform transmitter terminals have been deployed. A total of 18,000 locations and 201,000 sensor messages were received from female polar bears between May 1985 and June 1988. Polar bears in the Beaufort Sea are shared with Canada, while polar bears in the Chukchi and Bering Seas are shared with the U.S.S.R. The international ranges of the two hypothesized populations have been documented. Satellite telemetry has detailed the large movement patterns of polar bears over these vast areas that were previously not available using other techniques. It was unanimously agreed to expand the use of this advanced technology especially in international waters.

C. Population modelling.

M. Taylor summarized research on mathematical models to simulate polar bear population dynamics. Efforts have continued in several areas: 1) estimations of various life history parameters based on age structure of the harvest, 2) estimation of population size, 3) projection of population trends. The support to continue comparisons of different modelling approaches as a research tool was expressed by all members.

An important point to note is that: All existing models underscore the importance of adult female survival to population estimates.

D. Maternity Denning.
Amstrup presented recent maternity denning studies. At least 150 female Alaskan polar bears should seek maternity dens each year. In total during the spring of 1988, researchers located 4 dens and evidence of 2 others within the bounds of ANWR and 3 dens plus evidence of one other west of

ANWR. The 1987-88 data corroborated the past observations that most dens of collared bears are on the pack ice. Recent data also suggest differential success of land and sea dens in favour of females using land dens.

Stishov reported on the aerial counts of polar bear dens on the extreme north-east coast of the USSR). Up to 250 dens have been registered in the Wrangel and Herald Islands. The total numbers of females denning on the coast exceed the earlier suggested estimate of 20-25 dens on the entire coast of the East-Siberian Sea, (excluding Novosibirsk Island and about 15 dens on the Chukchi Sea coast).

Y. A. Gorbubov pointed out several features of sea ice and land form that might encourage more sea ice denning in the Beaufort Sea than in other areas.

E. Carbon/nitrogen stable isotope studies.

S. Amstrup reported on studies on stable isotopes of carbon in the claws in evaluating population definition and discreteness. Claw samples from bears of western Alaska waters were consistently heavier isotopically than samples from northern Alaska. It appears that the isotope ratios in the claws of polar bears present a chronological record of where the bear fed in the past. A series of samples taken from various locations along the long axis of a bear's claws might indicate where the bear had been at various times during the preceding year. After extensive discussion, the PBSG found this approach to be very promising and a very good subject for further study.

F. Bear-Human Interactions.

Many papers presented problems with bear/human interactions from different points of view (immobilization, hunting, marking etc.). The topic of "Problem Bears" gave rise to the most intensive discussion, including possibilities of control, interaction prevention; will "problem" bears appear to be a major subject of hunting. Problems of polar bear hunting were discussed: quotas, native subsistence harvest, public attitude towards harvest.

Recommendations to avoid conflicts focused on five areas - alertness, avoidance, attractants, detection and deterrents. Responses of humans should vary in relation to the type of behaviour displayed by a polar bear.

IX. Discussion and identification of future research and management priorities.

There were extensive discussions on the two last sessions and during round-table talks on priorities for research and management of polar bears, which resulted in resolutions. Programs on future research and improved management of polar bear populations were discussed.

X. Future objectives and actions of the Group.

M. Taylor noted that the present PBSG is too closed: more associated scientists should participate in its future discussions. S. Amstrup stressed the value of the contributions from the Soviet scientists this year, and hoped that their participation would continue strong in the future. E. Born proposed that participant papers be distributed about a month before the meeting so that all could read them in advance, allowing have much more time for discussion.

XI. Schedule and Location of the next PBSG meeting.

It was agreed that there is not a need to meet at two-year intervals. Meetings will be held every 3-4 years, and should be held in conjunction with other biological congresses (I. Stirling), e.g. Biological Association Congress in North America, 1992 (E. Born).

The most suitable times for meeting are summer and winter, since field work is conducted during spring and autumn. (S. Amstrup). Midwinter is the most desirable for Soviet participants (S. Belikov).

XII. Identification of full members of the PBSG.

Discussion of membership appointments. The subject of corresponding members was raised. M. Taylor proposed to forward the list of the corresponding members to the IUCN.

S. Amstrup suggested that the membership matter should be addressed as a priority by the new chairman.

XIII. Election of a new chairman.

Eric W. Born of Denmark was nominated by S. Uspensky as the new chairman of PBSG; the members agreed unanimously. S. Amstrup was acknowledged and thanked by the participants for his term as chairman, and his work in preparation for the present meeting.

S. Amstrup thanked Dr. Uspenski and all the Soviet participants for arranging the terrific venue, for the spectaular tours that were arranged, and for the wonderful hospitality.

Appendix 3

List of Participants

(in alphabetical order by Jurisdiction)

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Appendix 4

Resolutions drafted by the IUCN Polar Bear Specialists Committee during the 10th annual meeting in Sochi, USSR, 25-29 October 1988

1. Coordinated international efforts towards research and management of polar bears.

The IUCN Polar Bear Specialist Group

Recognizing That Article II of the Agreement on the Conservation of Polar Bears (Agreement) states that contracting parties shall take appropriate action to protect the ecosystem of which polar bears are a part; and,

Recognizing That Article VII of the Agreement states that contracting parties shall consult with other parties on the management of migrating polar bear populations and exchange information on research and management programs, research results and data on bears taken; and,

Recognizing That industrialization of northern nearshore and offshore areas and its concomitant growth in human numbers represent potential threats to polar bear habitat, and thus to polar bears; and,

Recognizing That many northern indigenous people depend on polar bears for their culture and economy; and,

Noting That considerable progress has been made recently in the conservation of the shared populations of polar bears in the southern Beaufort Sea as a result of international cooperation in research, and through the development of a joint management agreement by the indigenous people who hunt polar bears from the countries;

Therefore urges that the affected countries immediately take more action steps to coordinate research, environmental assessments, and management of shared polar bear populations in the Chukchi and Bering seas, Baffin Bay and Davis Strait, Greenland Sea and the Barents Sea.

2. Selective harvest of male polar bears.

The IUCN Polar Bear Specialist Group

Recognizing That article II of the International Agreement on the Conservation of Polar Bears states that the contracting parties — Shall take appropriate action to protect—denning sites—and—manage polar bear populations in accordance with sound conservation practices based on the best available scientific data; and,

Recognizing That recent research on mathematical modeling of polar bear population dynamics clearly show that the survival of adult females is the most important sex and age class for the maintenance of population viability; and,

Recognizing That the traditional skills of indigenous people often result in a selective harvest favoring adult males,

Therefore recommends that contracting parties which permit the harvest of polar bears encourage selective harvest of males rather than females by all appropriate means.

3. Histological analyses.

The IUCN Polar Bear Specialist Group

Recognizing That Article II of the International Agreement on the Conservation of Polar Bears states that contracting parties shall take appropriate action to protect the ecosystem of which polar bears are a part; and,

Recognizing That industrialization of northern nearshore and offshore areas and increases in global pollution are affecting arctic marine ecosystems; and,

Noting That analysis of organochlorine contaminants in tissues of polar bears in several arctic areas of Canada has identified significant increases between 1969 and 1984;

Therefore recommends that polar bear tissues be collected from as many areas as possible throughout the circumpolar range of polar bears, at approximately 5-year intervals, to monitor changes in concentrations of these substances on arctic marine ecosystem.

4. Petroleum development and activities in the Barents Sea.

The IUCN Polar Bear Specialist Group

Recognizing That the USSR and Norway share a common population of polar bears which occupy the Barents Sea; and,

Recognizing That the population occupying the Barents Sea presently is the least affected population of large carnivores in the world; and,

Recognizing That both the USSR and Norway are in the initial stages of petroleum development in the area of the Barents Sea; and,

Recognizing That polar bears are known to be vulnerable to oil pollution and disturbances related to petroleum activity and other human activities; and,

Recognizing That the present ecological problems in the Barents Sea may affect the polar bears negatively,

Therefore recommends that coordinated polar bear impact assessments and monitoring programs be conducted by the USSR and Norway in the Barents Sea, and that necessary biological information be exchanged.

5. Problem bears in the USSR.

The IUCN Polar Bear Specialist Group

Recognizing That the conservation authorities in the USSR are contemplating a future harvest of polar bears in the western Soviet Union; and,

Recognizing That this group belongs to a shared population; and,

Recognizing That this polar bear population may presently be exposed to less human impacts than any other,

Therefore urges conservation authorities in the USSR to try to solve their management problems first with deterrent methods that may maintain the unique character of this population. Further, that management problems should be addressed in accordance with the International Agreement on the Conservation of Polar Bears. The PBSG recommends management measures affecting this population should be approached through consultation with Norway.

6. Biochemical analysis of microelements contained in bone tissue of polar bears.

The IUCN Polar Bear Specialist Group

Recognizing That the Internatinal Agreement on the Conservation of Polar Bears requires that, Each contracting party—shall manage polar bear populations in accordance with sound conservation practices and based on the best available scientific data; and,

Recognizing That definition of subpopulations is fundamental to management; and,

Recognizing That preliminary studies on microelements occuring in bone tissues conducted by scientists in the Soviet Union offer promise in identifying subpopulations; and,

Recognizing That continued efforts to empirically discern subpopulation is necessary to a comprehensive management regime;

Therefore recommends that priority be established for the coordinated collection of bone specimens from potential subpopulation from all circumpolar countries; and,

Further recommends that the Soviet Union coordinate the collection effort, analysis and publication of results.

7. Technique development and coordinated study efforts.

The IUCN Polar Bear Specialist Group

Recognizing That the International Agreement on the Conservation of Polar Bears requires that each contracting party—shall manage polar bear populations in accordance with sound conservation practices based on the best scientific data; and

Recognizing That accurate estimates of the size of polar bear populations are essential for their management; and,

Recognizing That continuing, multi-year mark and re-capture studies of polar bears for the purpose of monitoring population status are very expensive,

Therefore recommends that scientists from all countries strive to develop new alternative methods for estimating population size (and other parameters) such as aerial surveys, use of biomarkers, improved mark and re-capture designs, and radiotelemetry.

Further recommends that when proven techniques are developed; regular, coordinated, and simultaneous surveys and studies, em-

ploying those techiniques, must be conducted by all parties in order to periodically assess the status of the world's polar bear stocks.

8. Joint research and management programs between USSR and USA in Bering and Chukchi Seas.

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—consult with other parties on the management of migrating polar bear populations and exchange information from research and management programs; and,

Recognizing That the USSR and USA share a common population of polar bears which occupies the Bering and Chukchi Seas; and,

Recognizing That the USA is currently harvesting polar bears from the population and that the USSR is considering harvesting polar bears from the population; and,

Recognizing That both the USSR and USA have active but separate research and management programs on the polar bear population in the Bering and Chukchi seas; and,

Recognizing That cooperative research and management programs between the USSR and USA on polar bears in the Bering and Chukchi seas are highly desirable;

Therefore recommends that a joint research and management program for polar bears in the Bering and Chukchi Seas be developed between USSR and USA scientists and managers. The initial program should include the exchange of scientists between the two countries and the development of a coordinated research program beneficial to both parties.

9. Use of aircraft and large motored vessels.

The IUCN Polar Bear Specialist Group

Recognizing That article IV of the International Agreement on the Conservation of Polar Bears (Agreement) states that —The use of aircraft and large motorized vessels for the purpose of taking polar bears shall be prohibited; and,

Recognizing That the USA and Greenland (Denmark) currently lack specific and comprehensive regulations which address the methods and means of taking polar bears; and,

Recognizing That in Alaska, polar bears have been taken recently with the aid of aircraft; and,

Recognizing That in Greenland indigenous peoples have used large motorized vessels, to a small degree, to harvest polar bears; and,

Recognizing That the intention of the authors and signatures of the Agreement is to prevent potential abuses regarding the mode of transportation in the taking of polar bears,

Therefore recommends that contracting parties take all steps necessary to curtail, as expeditously as possible, the use of aircraft and large motorized vessels for the purpose of taking polar bears within their jurisdiction.

10. Machine data storage, processing and analysis.

The IUCN Polar Bear Specialist Group

Recognizing That the advances in computer-assisted data processing and analysis that have been developed specifically for polar bear research and management, and;

Recognizing That sharing of data and software is greatly facilitated by compatible machine and data formats,

Therefore recommends that the contracting parties develop effective and appropriate computerized data handling and analysis systems to insure efficient and accurate communication of data and analysis programs.

11. Participation in future meetings.

The IUCN Polar Bear Specialist Group

Recognizing That the governments of Canada, Norway, Denmark, USA, and USSR signed the International Agreement on the Conservation of Polar Bears (Agreement) formally recognizing that the special responsibilities for the protection of arctic flora and fauna could best be accomplished through international cooperation; and,

Noting That article VII of the Agreement states that the contracting parties shall conduct national research programs on polar bears—and—exchange research results, data, and other information on research and management programs;

Recommends That the governments of the parties ensure that their polar bear scientists are able to participate fully in future meetings of the IUCN Polar Bear Specialist Group, to ensure the maximum international exchange of research and management information on polar bears, as was intended when the agreement was signed.

12. Thanks to the USSR for hosting of the Tenth Working meeting of the IUCN/SCC Polar Bear Specialist Group.

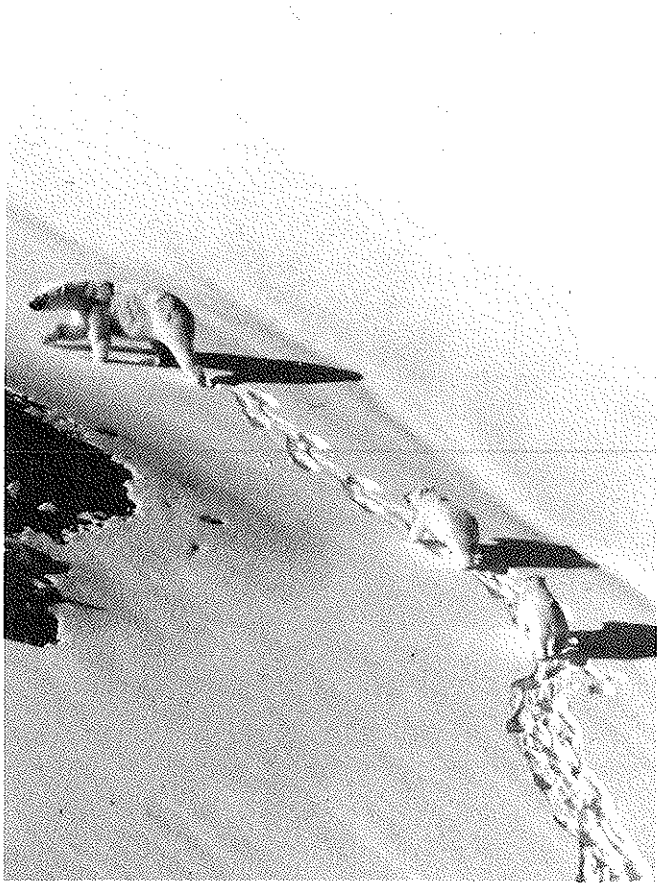
The IUCN Polar Bear Specialist Group

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 contributed to the success of this meeting; and,

Recognizing That for the first time the meeting was held in the Soviet Union,

Therefore Gratefully extends its thanks to the All Union Research Institute of Nature Conservation and Reserves, and the Polar Bear Meeting Organization Committee for their diligent efforts and warm hospitality in organizing and conducting this productive meeting on the Twentieth Anniversary of the founding of the IUCN Polar Bear Specialist Group.



(Photo by Ray Schweinsburg)

Other Occasional Papers of the IUCN Species Survival Commission

1. Species Conservation Priorities in the Tropical Forests of Southeast Asia. Edited by R.A. Mittermeier and W. R. Konstant, 1985, 58 pp, £7.50, U.S. $15.00.
2. Priorités en Matière de Conservation des éspèces à Madagascar. Edited by R. A. Mittermeier, L. H. Rekotovao, V. Randrianasolo, E. J. Stirling and D. Devitre, 1987, 167 pp, £7.50, U.S. $15.00.
3. Biology and Conservation of River Dolphins. Edited by W.F. Perrin, R. K. Brownell, Zhou Kaiya and Liu Jiankang, 1989, 173 pp, £10.00, U.S. $20.00.
4. Rodents, A World Survey of Species of Conservation Concern. Edited by W. Z. Lidicker, Jr., 1989, 60 pp, £7.50, U.S. $15.00.
5. The Conservation Biology of Tortoises. Edited by I. R. Swingland and M. W. Klemens, 1989, 202 pp, £12.50, U.S. $25.00.
6. Biodiversity in Sub-Saharan Africa and its Islands, Conservation, Management and Sustainable Use. Compiled by S. N. Stuart and R. J. Adams, 1990, 242 pp, £12.50, U.S. $25.00.

Previous Proceedings of the Meetings of the IUCN/SSC Polar Bear Specialist Group

1. Proceedings of the Technical Workshop, Grand Canyon, U.S.A. 16-18 February 1983. 72 pp, £3.50, U.S. $7.00.
2. Proceedings of the 9th Working Meeting, Edmonton, Canada, 9-11 August 1985. 152 pp, £4.50, U.S. $9.00.

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