The IUCN Species Survival Commission

Polar Bears

Proceedings of the 13th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 23–28 June 2001, Nuuk, Greenland

Compiled and edited by
Nicholas J. Lunn, Scott Schliebe and Erik W. Born

Occasional Paper of the IUCN Species Survival Commission No. 26

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Contents

Gerald W. Garner (1944–1998)

Dr Gerald W. Garner, a member of the IUCN/SSC Polar Bear Specialist Group, passed away on February 15, 1998. He leaves a legacy of outstanding accomplishment, typified by a career dedicated to ecological research. His studies have enhanced the conservation community's understanding of species and supported enlightened management actions to the betterment of wildlife resources. His contributions and publications extend beyond the subject of polar bears and include white-tailed deer, pronghorn antelope, caribou, wolf, brown bear, musk oxen and Pacific walrus.

In 1986, Dr. Garner began research on polar bears in the Chukchi and Bering seas for the U.S. Fish and Wildlife Service, Alaska Fish and Wildlife Research Center; now the U.S. Geological Survey/Alaska Biological Science Center. As the Polar Bear Project Leader, he was responsible for conducting population studies that defied meaningful field investigations owing to the vastness of the area and multiple, jurisdictional issues. His leadership and tenacity resulted in the substantial expansion of our scientific knowledge of polar bears in the Chukchi/Bering seas and, later, into other areas of the Russian high Arctic, Severnaya Zemlya Islands, the Laptev and Kara seas, the Novaya Zemlya and Franz Josef Land archipelagos, and the Barents Sea. He was instrumental in testing and developing aerial survey procedures for polar bears, in pioneering satellite telemetry of adult male polar bears, in developing aerial den survey procedures for Wrangel Island, as well as investigations of genetics, stock separation and potential viral sources of disease.

Gerald Garner earned a B.S. in Zoology/Wildlife Management from Oklahoma State University (1967) and an M.S. in Game Management from Louisiana State University (1969). Upon graduation, he worked as a wildlife biologist for Pennzoil Corporation, a game biologist for the Oklahoma Department of Wildlife Conservation and as a wildlife consultant. He returned to academia in 1973, earning a Ph.D. in Wildlife Ecology from Oklahoma State University in 1976. Following two years as an Assistant Professor at Sul Ross State University, Texas, he joined the U.S. Fish and Wildlife Service in Washington, D.C. in 1978. He transferred to the Arctic National Wildlife Refuge in Fairbanks, Alaska, as a Supervisory Wildlife Biologist, in 1980. His work developing baseline biological data on the wildlife resources of the refuge earned him the Secretary of Interior's Commendation Award. In 1986, he accepted the position of Polar Bear Project Leader (Western Alaska) for the Alaska Fish and Wildlife Research Center.

Gerald will be remembered for his commitment to seeking knowledge of the ecology of polar bears and other wildlife; for his staunch support of scientific inquiry; for his work ethic, devotion and dedication to research and conservation; and for an unwavering commitment to achieving these goals. His list of publications serves as a legacy to these accomplishments yet, by themselves, do not do justice to his contribution to science. His accomplishments will continue to serve as an example for peers, and for those who follow in his footsteps.

Malcolm A. Ramsay (1949–2000)

Dr Malcolm Alexander Ramsay, a member of the IUCN/SSC Polar Bear Specialist Group, was killed in a helicopter accident in the Canadian High Arctic on May 21, 2000 while returning to the field research station at Resolute, Nunavut at the end of a day of studying polar bears and seals.

Malcolm was a long-standing member of the Polar Bear Specialist Group. His PhD was with Dr Ian Stirling on the reproductive physiology and ecology of polar bears, and was completed in 1986. Malcolm was a full professor at the University of Saskatchewan and supervised a number of graduate studies. He and his students have contributed greatly to the body of knowledge on polar bear anaesthesiology, contaminants, hibernation, fasting, lactation, energetics, body composition, evolution and ecology. Malcolm also contributed research on ungulates, carnivores, other marine mammals, avian ecology, sharks, coral reefs, natural history, evolution, life history strategies and undoubtedly more. Malcolm's curiosity was matched only by his energy and enthusiasm for new ideas. He had 50+ publications, an active graduate and personal research program, and was a popular teacher at his University.

Malcolm's work was some of the most innovative and exciting research ever conducted on polar bears. Malcolm's colleagues and friends spanned scientific disciplines and were literally distributed across the world. He was a wealth of information on new techniques, new technologies, and was completely generous with his contacts, ideas, and suggestions. He did not seem to care about the usual politics or propriety issues associated with high profile research projects. He was as generous with his equipment and time as he was with his ideas and support. We all benefitted from Malcolm's work and, because of Malcolm's openness, his ideas and initiatives were not lost with him. Others are already taking much of his research forward, which is certainly what Malcolm would have wanted.

Although new faces and new ideas are already emerging, all will miss Malcolm's insight and critical mind. He has left us a shared memory that is all the more precious because it is ephemeral. Those of us present today will remember Malcolm as a friend even more than we will miss him as a colleague. This dedication acknowledges Malcolm as a valued colleague and honors him for his professional achievements. But for many (perhaps all) of us, it is much more. Most of us have shared the time of our lives, bad weather, small cabins, accepted the same risks and enjoyed the same wonders as Malcolm. We will miss his laughter, irreverent sense of humor, cheerfulness, generosity, energy, council, open spirit, goodness and friendship. The memory of Malcolm is something we share as a group and will carry forever. He was his own man, a good friend, and we mark his passing with respect and sorrow.

Foreword

Following the First International Scientific Meeting on the Polar Bear, which was held in Fairbanks, Alaska in 1965, the Polar Bear Specialist Group was formed to co-ordinate research and management of polar bears. Eight years following the First Scientific Meeting, the international *Agreement on the Conservation of Polar Bears and Their Habitat* was signed by the Governments of Canada, Denmark, Norway, the Union of Soviet Socialist Republics, and the United States. Article VII of the Agreement states that "The Contracting Parties shall conduct national research programmes on polar bears, particularly research relating to the conservation and management of the species. They shall as appropriate co-ordinate such research with research carried out by other Parties, consult with other Parties on the management of migrating polar bear populations, and exchange information on research and management programmes, research results and data on bears taken."

As part of their commitment to fulfil the intent of the Agreement, representatives of all five signatory nations, together with invited specialists, attended the 13th Working Meeting of the IUCN/SSC Polar Bear Specialist Group that was held 23–28 June 2001 in Nuuk, Greenland and hosted by the Greenland Institute of Natural Resources. The Specialist Group reviewed overall progress in research and management of polar bears since the previous meeting (Oslo, 1997) and identified priorities for future studies. They recognized the need for more proactive management, not only to address limitations in our knowledge of polar bear population dynamics, but also because new information indicates that the greatest future challenges to the conservation of polar bears may be ecological change in the Arctic as a result of climate change and pollution. The complexity and global nature of the issues will require a great degree of international co-operation and development of diverse and new approaches to address these issues.

These 13th proceedings provide an overview of the ongoing research and management activities on polar bears in the circumpolar arctic. Together with the previous twelve proceedings, they provide an historic record of the international effort in protecting polar bears from over-harvest and document more recent concerns of threats arising as a consequence of increased human activities in both the Arctic and in regions far beyond the realm of polar bears.

Funding for the publication of these proceedings was provided by the Canadian Wildlife Service, the Greenland Institute of Natural Resources, the Norwegian Polar Institute, the Nunavut Department of Sustainable Development, the U.S. Fish and Wildlife Service, and the U.S. Geological Survey.

N.J. Lunn, S. Schliebe and E.W. Born
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Agenda

Thirteenth Working Meeting of the IUCN/SSC PBSG
Nuuk 23–28 June 2001

Saturday 23 June 2001

10.00 **1 Opening and administrative issues**

1.1 Introductory remarks/comments from the hosts

1.2 Opening of the meeting (Alfred Jakobsen, Minister of Health and Environment)

1.3 Introduction of participants

1.4 Election of the meeting chairman

1.5 Selection of meeting secretary for recording notes from the meeting

1.6 Review of draft agenda, adoption of final agenda

1.7 Production, format and dedication of published proceedings from the meeting

1.8 Election of ad hoc "editors" for compilation of proceedings

1.9 Election of group to draft press release

1.10 Presentation of draft resolutions

2 Summary of research and status of populations by nation. Future research priorities

2.1 Canada

12.00 Lunch

13.00 2.2 Greenland/Denmark

2.3 Norway

2.4 Russia

2.5 USA

Sunday 24 June 2001

09.00 **3 Summary of management by nation**

3.1 Canada

3.2 Greenland/Denmark

3.3 Norway

3.4 Russia

3.5 USA

12.00 Lunch

13.00 PBSG members meeting

15.00 Public seminars in Katuaq: Climate change and polar bears (Ian Stirling)

Contaminant studies on polar bears (Andy Derocher)

Co-management of polar bears in Canada, Alaska, Russia: perspectives from native and governmental co-managers (Charlie Johnson, Larry Carpenter, Bert Dean)

17.30 Midsummer arrangement at "*Biologstationen*"

Monday 25 June 2001

09.00 **4 New bi-/multilateral agreements related to polar bears**

4.1 Canada-USA

4.2 Russia-USA

4.3 Norway-Russia

4.4 Greenland-Canada

12.00 Lunch

13.00 **5 Environmental issues**

5.1 Effects on polar bears of toxic chemicals

5.2 Report on immune system effects

5.3 Report on Alaska work

5.4 Other studies

5.5 Research priorities

6 **Issues pertaining to the Agreement**

6.1 Habitat conservation

6.2 Other issues

Tuesday 26 June 2001

09.00 **7 Workshop of population assessment and standardization of methodologies**

7.1 Overview of essentials for status determination (Mitch Taylor)

7.2 Summary of population delineation methods (Mitch Taylor, Steve Amstrup)

12.00 Lunch

13.00 7.3 Summary of enumeration: aerial survey (Andy Derocher, Michael Kingsley)

7.4 Summary of enumeration: mark-recapture (Steve Amstrup)

7.5 Estimation of vital rates (Mitch Taylor)

7.6 Summary of harvest monitoring (Mitch Taylor, Erik Born, Scott Schliebe)

17.45 Boat trip aboard *Immanuel*

Wednesday 27 June 2001

09.00 7.7 Sustainable yield and risk management (Mitch Taylor)

12.00 Lunch

13.00 7.8 Population modeling and risk assessment

Thursday 28 June 2001

09.00 **8 Status report**

8.1 Tabling of draft status reports by jurisdiction

8.2 Review, discussion and recommendations for status report

12.00 Lunch

13.00 **9 IUCN**

10 Issues handled by the Chairman 1999–2000 (future Red List linkage to workshop and status report topics)

11 Evaluation of the future status of the PBSG. Future objectives and actions of the PBSG. Next meeting

12 Election of a new chairman of PBSG

13 Adoption of the status report or next steps to completions presented by the ad hoc "editors"

14 Adoption of resolutions presented by various Resolution Committees

15 Adoption of press release

16 Closing remarks

20.00 Evening banquet at the Institute

Minutes of the 13th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Nuuk, Greenland 23–28 June 2001

Saturday 23 June

Opening and administrative issues

Introductory remarks

The 13th Working Meeting of the IUCN/SSC Polar Bear Specialist Group (PBSG) was called to order by the current Co-Chairs S. Belikov and S. Schliebe at 10.00 am at the Greenland Institute of Natural Resources, Nuuk, Greenland. They welcomed the delegates to Nuuk, which was followed by a series of introductory and administrative remarks. E. Born invited Alfred Jakobsen, Minister of Health Care and Environment, Home Rule Government of Greenland, to officially open the meeting.

A. Jakobsen welcomed the delegates to Nuuk and the Greenland Institute of Natural Resources and noted that Greenland has seen a fast development as a modern society over the first two decades of Home Rule government. Although Greenland has one of the most modern fishing fleets in the Arctic, there is a strong, traditional dependency on wildlife. He emphasized that, while most arctic species have had and still have both cultural and traditional importance to the people of Greenland, the polar bear is of special value.

He noted that Greenland recognized the importance of polar bear research and shares the visions of the Oslo Convention. The sharing of the scientific results from many years of research on polar bears between users and scientists was stressed because a broader understanding of polar bear science requires the inclusion of detailed, traditional knowledge of the environment and natural resources. Such a mutual dependency of knowledge is the best foundation on which to manage polar bears across the circumpolar Arctic. The challenge facing us is to find ways to build on the ideas of co-management of polar bears that are practiced elsewhere, such as between the Inuvialuit of Canada and the Inupiat of Alaska.

Through the contributions of the Polar Bear Specialist Group, it was hoped that we all learn more about the impacts of pollution and the consequences of climate change that are occurring in the Arctic. He also hoped that opportunities, such as this meeting, could be used to further promote and develop the effective co-management of polar bears between Greenland and Canada.

He concluded his address by wishing for a productive meeting in Nuuk and good luck with future research.

Introduction of participants

There was a brief introduction of each participant, a list of which is included in these Proceedings.

S. Schliebe noted that, since the Oslo meeting, the Polar Bear Specialist Group has lost two members: Gerald Garner and Malcolm Ramsay. A moment of silence was observed in recognition of their contributions to the conservation and management of polar bears.

Election of meeting chairman and selection of meeting secretary

S. Belikov was elected meeting Chair and N. Lunn appointed as meeting Secretary.

Additional topics and adoption of final agenda

No additional agenda items were provided prior to the meeting. The final agenda of the meeting was adopted with the understanding that it should remain flexible as issues and discussion arise.

Production, format and dedication of the proceedings of this meeting

The Group agreed that the proceedings would be dedicated to both Gerald Garner and Malcolm Ramsay and that these would appear as two facing pages, with photos. S. Schliebe agreed to write the dedication for Gerald; I. Stirling and M. Taylor agreed to do the same for Malcolm.

A. Derocher noted that the cost of publishing the 12th proceedings was approximately US$6,000. The cost is very much dependent on the amount of editorial work done by IUCN Publications Services Unit. Costs could be minimized if we are able to produce a camera-ready or near camera-ready document ourselves. The Group thought that this was not unrealistic given the power and features of current word-processing and publication software.

Canada, Greenland/Denmark, Norway and the USA all indicated that they would be able to make a financial contribution towards the costs of publication.

Election of editors for the compilation and publication of the proceedings of this meeting

N. Lunn, E. Born and S. Schliebe agreed to compile and publish the Proceedings.

Election of group to draft press release

S. Schliebe, I. Stirling and E. Born were elected to draft the press release.

There was a general discussion on subsequent distribution of the press release. World Wildlife Fund's *Arctic Bulletin* and the newsletters of the Marine Mammal Society and the International Bear Association were suggested as appropriate outlets for the press release. The Group decided to revisit the issue later in the meeting.

Presentation of draft resolutions

No draft resolutions had been provided prior to the meeting and none were presented. The Group thought that discussion over the course of the working meeting might result in the drafting and tabling of resolutions. It was agreed that such resolutions should be drafted and developed by the proponents.

Summary of research and status of populations by nation and future research priorities

Presentations of research and population status were presented by each nation. Because detailed reports from each nation are included in these Proceedings, only summaries are presented here.

Canada

N. Lunn reported that most research is conducted by federal, provincial and territorial governments with the support of user groups. Co-operative research is often undertaken because of the shared responsibilities of various governments and wildlife management boards and because of the high costs associated with polar bear research.

N. Lunn and I. Stirling summarized ongoing research by the Canadian Wildlife Service and provided information on long-term trends in the population ecology of polar bears in western Hudson Bay in relation to climatic change, the use of fatty acid signatures to gain insights into polar bear feeding ecology, the potential effects of forest fires on the availability of maternity dens, maternity den selection, and ringed seal research.

M. Taylor reported that most of the research in Nunavut was management-oriented. Population inventories have recently been completed for most of the eastern and central Canadian Arctic polar bear populations. Analysis is near completion, which will result in new information on population numbers and vital rates.

M. Obbard provided information on Ontario research involving aerial surveys, boundary delineation, and a planned genetic study.

N. Lunn summarized research on population delineation (Northwest Territories, Canadian Wildlife Service, U.S. Geological Survey Biological Resources Division), *Trichinella* (Québec), genetics (University of Alberta), development of body condition indices (Western College of Veterinary Medicine, University of Saskatchewan), and organochlorine dynamics, polar bear/sea ice dynamics, and effects of handling (Dept. of Biology, University of Saskatchewan). In the study of handling effects, François Messier found the risk of mortality from capture for population studies to be low (1 in 1000) and concluded that long-term effects were either negligible or not measurable.

Resolution Committee:
A. Jessen, I. Stirling and M. Taylor to draft resolution recommending the importance of continuing research on the effects of global climatic warming on polar bears in order to better understand how polar bears may be affected in the future and to develop management and conservation measures to respond to future change.

Greenland/Denmark

E. Born noted that research on polar bears in Greenland focused on population studies and pollution studies. M. Taylor summarized the joint Canadian-Greenland study delineating and enumerating polar bear populations in the eastern Canadian High Arctic and in western Greenland. Cluster analysis of movement data showed three separate populations (Baffin Bay, Davis Strait, and Kane Basin) whereas studies of genetics and concentrations of metals in bears suggested only two, Baffin Bay and Davis Strait. Neither of the latter studies was able to separate Kane Basin and Baffin Bay as distinct populations.

In 1999, the Danish National Environmental Research Institute and the Greenland Institute of Natural Resources initiated a study to assess the effects of persistent organic pollutants on internal and external organs of polar bears in East Greenland. Interviews of hunters resulted in information on 1110 polar bears taken between 1945 and 1999, most having been shot after 1980. Thirteen 'anomalous' polar bears were reported; the most striking being that of an adult female bear killed in June 1999 that had clear signs of pseudohermaphrodism.

A. Rosing-Asvid summarized a study of sea ice, ringed seals, polar bears and hunters. He has looked at almost 200 years of catch statistics for ringed seals and polar bears from East Greenland. The harvest shows that 200 ringed seals have been taken for every polar bear taken since 1954 in period where there was no trend in sea ice extent. However, trends in sea ice extent appear to favour one species over the other, depending on the direction of the trend. Less sea ice seems to favour polar bears whereas more sea ice favours seals. East Greenland catch statistics are likely to be more reliable than those from Canada because the Canadian seal hunt is tied to the price of seal hides. In Greenland the hunt is subsidized with hunters being paid a base price per pelt regardless of actual prices.

Norway

A. Derocher presented the Norwegian report and noted that their research has focused primarily on two main themes: effects of climate change and toxicology. Recent mapping of polar bear movement data on ice imagery has shown that bears move against the southerly flow of ice to maintain position. Trend analysis of den emergence has shown that females generally left maternity dens a month earlier during the 1990s than they did in the 1980s. The use of Hopen Island for maternity denning is correlated with the timing of ice arrival.

In a comparison of bears in the Svalbard area with those in western Hudson Bay, older females with cubs were largely absent from Svalbard. Only 11% of females were older than 15 years compared with 42% of females in western Hudson Bay. Svalbard is an area that is highly polluted whereas western Hudson Bay has comparatively low levels of pollutants. The high levels of pollutants in the Barents Sea are likely affecting polar bears. For example, the immune system is weakened in "polluted" bears. Furthermore, although polar bears are able to breakdown contaminants, the metabolites often have more serious effects than the parent compound. In general, pollutant levels were low in the 1960s but increased in the 70s and 80s.

The Specialist Group recognized the importance of the Norwegian research on pollutants and the effects on the immune response of polar bears.

Sunday 24 June

Summary of research (continued)

Ø. Wiig reported that funding to continue large-scale research on polar bears is unlikely and that a new approach for a coordinated Norwegian Arctic Research Program is being developed. A Norwegian Polar Bear Working Group was appointed in 1999 and asked to provide a short report identifying the most important research issues that required attention. The report was completed and identified population delineation, population size, population demographics, energetics, anthropogenic threats, ecosystem modeling, and monitoring as priority issues. Norway would like a critical opinion from the IUCN/SSC Polar Bear Specialist Group.

S. Amstrup noted that studies of population size would be the most expensive, most difficult, and will come at the expense of funding for other issues. I. Stirling suggested that Norway consider concentrating on strengths, such as research on pollutants and their effects. Following a brief discussion, the Group decided to revisit the issue later in the meeting.

Russia

A. Boltunov presented the Russian report and noted that funding for research continues to be an ongoing problem. As part of a joint Russian-American research program, satellite telemetry data on the movement of polar bears together with ice data from remote sensing are being used to study the distribution and mobility of bears in relation to sea ice dynamics. The All-Russian Research Institute for Nature Protection and the Norwegian Polar Institute initiated a joint research program on polar bears in the Barents and Kara seas. The primary objectives are to examine the basic population parameters, identify critical habitat, and to examine the influence of environmental pollution.

Areas of future research include diseases in marine mammals, development of a Russian satellite tracking system, undertaking an aerial survey along the ice edge in co-operation with American colleagues, and examining the possibility of using teeth to study aspects of polar bear life history (e.g., reproductive cycle).

M. Stishov provided an overview on a model that has been developed for the selection of maternity dens by polar bears on Wrangel Island. The model is based on landscape-level characteristics. Distance from coast, slope, and elevation all appear to be important variables. Timing of den emergence is quite variable between years; occurring anywhere from late February through late April.

United States

S. Amstrup presented the report and noted that the research focused on describing movement and distribution patterns of polar bears in the Beaufort Sea, estimation of population size, and on denning ecology. He reported that satellite transmitter implants in adult males worked reasonably well. Movement data suggest four populations in the Alaska area: West Chukchi, East Chukchi, Northern Beaufort, and Southern Beaufort. Using these data, a grid system was developed to estimate the probability of occurrence of bears from each population at any location in the Beaufort and Chukchi Seas in order to assess the risks of oil spills to bears and to allocate harvest. A new modeling approach has been developed that makes better use of existing data and that identifies shortcomings in the data and techniques of the past.

Substantial maternity denning occurs out on the sea ice and there appears to be a westward shift (west of the Arctic National Wildlife Refuge) in the location of dens when comparing the period 1981–91 with 1992–2001. Forward Looking Infrared (FLIR) was able to detect two-thirds of known dens. Fog, precipitation, and heat from the sun all affect the system's ability to distinguish dens.

Summary of polar bear management by nation

Presentations on polar bear management were made by each nation. Because detailed reports on management are included in these Proceedings, only summaries are presented here.

Canada

N. Lunn reported that polar bear management in Canada remained under the jurisdiction of the provinces and territories together with some user groups through the settlement of land claims. The Government of Canada is involved as a signatory to the Agreement, through CITES, and through other federal legislation. The most significant change that has occurred since the last meeting of the PBSG was the division of the former Northwest Territories into two new jurisdictions in April 1999. The western jurisdiction is still named the Northwest Territories whereas the eastern jurisdiction is named Nunavut. The Northwest Territories and Nunavut have revised management agreements and memoranda of understanding for those populations that they share. There have been no management changes in Manitoba, Newfoundland/Labrador, Québec or the Yukon Territory. Ontario has introduced new mandatory reporting requirements that are hoped will improve the tracking of the harvest of polar bears. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) reassessed the status of polar bears and listed them as a species of special concern in 1999. Endangered species legislation tabled by the Government of Canada in 1996 died with the dissolution of Parliament in 1997. However, similar legislation was introduced in February 2001 and is expected to be proclaimed by the end of the year.

M. Taylor raised the issue that it is currently unclear as to which jurisdiction has the management responsibility for polar bears in the offshore areas of Canada. N. Lunn reported that federal and territorial lawyers have undertaken reviews of the relevant legislation and that each believes that they have the management responsibility. Given this uncertainty, M. Taylor suggested that the PBSG consider a resolution to recommend that Canada clarify the issue.

Resolution Committee:
I. Stirling and S. Atkinson to draft resolution recommending Canada clarifies which jurisdictions have the legal authority to enforce laws governing the take of polar bears in Canadian waters.

Monday 25 June

Summary of polar bear management by nation (continued)

Norway

D. Vongraven reported that polar bears continue to have complete protection from harvest. In 2001, the Norwegian Parliament passed a new Environmental Act for Svalbard that is intended to provide a unified and stronger protection for Svalbard. Regulations are currently being developed for the Act and should be completed by the end of the year. However, the specifics of these regulations, as they pertain to polar bears, are not known at present. There has been a rapid increase in tourism to Svalbard, which has contributed to an increase in the numbers of polar bears killed in defense of life and property. Nine bears were killed in Svalbard in the period 1997–2000. Although there exist programs to monitor polar bears in Norwegian territories, limited funding is a significant problem.

Greenland/Denmark

A. Jessen noted that the Department of Industry is responsible for the protection of polar bears and management of hunting activities. Two types of licenses are issued, those to full-time hunters and those to part-time or free-time hunters. Only full-time hunters are allowed to take polar bears, free-time hunting of polar bears has been prohibited since 1994 but unfortunately it still continues. Sport or trophy hunters are not allowed to take polar bears. Polar bears are protected from 1 July through 31 August, although in Ammassalik the period of protection is 1 August through 30 September. Currently there is some regional variation in the age to which cubs are protected. However, the regulations will be revised to fully protect females accompanied by cubs. In addition, the Government of Greenland is going to introduce harvest quotas for polar bears. Meetings to discuss polar bears have been held between hunters from Grise Fiord, Pond Inlet, and Qaanaaq; additional meetings will be held next year in Nunavut. To date, no biologists have been invited to these meetings in order that hunters feel free to speak freely. While it is recognized that the current system of harvest reporting is not perfect, improvements are being made. For example, there are now wildlife officers in eight communities to help improve the reporting and a desire to expand to include an additional 10 communities.

Resolution Committee:
M. Taylor, Ø. Wiig, E. Born and A. Jessen to draft resolution complimenting the initiatives of the Greenland management authorities and the Greenland hunters in reporting harvest statistics while recommending the need to improve the existing harvest monitoring program in order that it will provide complete data with respect to the numbers, location, sex, and age of polar bears taken.

During the discussion of the drafting of the above resolution, it was thought that a parallel resolution should be developed for hunters from Québec.

Resolution Committee:
M. Taylor and M. Obbard to draft resolution for the development of a quota system for the harvest of polar bears in Québec.

Russia

S. Belikov noted that polar bears are listed in the 2[nd] edition (2001) of the Red Data Book of the Russian Federation, which is an official document that reflects state policy for the protection and restoration of rare and endangered species in Russia. The Ministry of Natural Resources is responsible for the management of those species listed in the Red Data Book. The hunting of polar bears continues to be prohibited. The only permitted take is the capture of cubs for public display (zoos and circuses). From 1996–2001, 6 cubs were caught in the Kara Sea for public display. Five defense kills were reported for the period 1997–2000 and 1 person was killed by a polar bear on Novaya Zemlya in 1998. Poaching appears to be increasing in Chukotka due to unemployment and food shortages. Elsewhere in the Russian Arctic, poaching is thought to be on the decline because of the closure of military bases, weather stations, and research facilities. In October 2000, the Governments of the Russian Federation and the United States signed an agreement on the conservation and management of the Chukotka polar bear population. It was expected that the agreement would be ratified and come into force by the end of 2001. The primary purpose of the bilateral agreement is to assure the long-term conservation of the Alaska-Chukotka population and its habitat through science-supported programs that can be carried out in both countries.

United States

S. Schliebe reported that the US Marine Mammal Protection Act guides the management of polar bears in the United States. A lot of effort is put into harvest management and reporting. Over the past decade, there has been a decline in the harvest in Alaska; in the period 1980– 1990, 130 bears/year were taken whereas this has declined to 85 bears/year for 1990–2000. In particular, the harvest in the Chukchi and Bering seas has declined by 50% in the past 10 years. There is continued co-operation with the Alaska Nanuuq Commission, the North Slope Borough, and the Inuvialuit Game Council for the co-management of polar bear populations. Amendments to the MMPA allowed for the issuance of permits to import sport-hunted polar bear trophies from Canada provided that specific legal biological findings were made. In 1995, five populations were approved and another two added in 1999. In January 2001, the M'Clintock Channel population was found to no longer meet the import requirements; polar bears taken from this population after 21 May 2000 will no longer be eligible for importation. The MMPA allows for the incidental, but not intentional, taking of polar bears by those engaged in specific activities in specific geographical areas. Letters of Authorization specify necessary monitoring conditions and reporting requirements under the incidental take regulations. Since 1997, three sets of incidental take regulations have been developed with respect to oil and gas industry exploration, development, and production activities.

Bi-/multilateral agreements

Canada-United States

A summary of the Inuvialuit-Inupiat Agreement had already been presented at previous meetings. A general discussion was held in which it was noted that the agreement has resulted in keeping the Southern Beaufort Sea population on a sustained yield basis. A manuscript summarizing the first 10 years of the agreement has been written. The Inuvialuit are happy with the agreement and the existing quotas will not be revisited until completion of the next population status study. Because the US-Russia bilateral agreement will result in a quota for Alaskan hunters, a query arose as to whether this might affect the Inuvialuit-Inupiat agreement, where the quotas are not legislated but voluntary.

Russia-United States

S. Schliebe summarized the "Agreement on the Conservation and Management of the Alaska-Chukotka Polar Bear Population", which was signed by the Governments of the United States and the Russian Federation on 16 October 2000. Under the terms of this agreement, a conservation program that can be regulated and enforced in both countries will be implemented. A US-Russia Polar Bear Commission will be formed to oversee the agreement that will consist of one federal and one native representative from each country. The Commission will be responsible for making decisions regarding polar bear management. A Scientific Advisory Group will provide biological and technical information and recommendations to the Commission. The Chukotka Union of Marine Mammal Hunters and the Alaska Nanuuq Commission are developing a native-to-native agreement to help implement the terms of the bilateral agreement.

Norway-Russia

M. Ekker reported that there have been bilateral environmental agreements between both countries since 1988. The emphases of these agreements are on cultural heritage and on marine and terrestrial environments. These agreements function through working groups of scientists and experts. These agreements aid in the acquisition of funding for polar bear research projects of mutual concern and interest to both countries.

Greenland-Canada

S. Atkinson noted that we had already heard about the coming progressive changes to the harvest of polar bears in Greenland. The Government of Nunavut is very interested in entering into an agreement with Greenland, although it will be very important to ensure that things move ahead without overtaking the speed of change in Greenland. A second hunter-to-hunter meeting is planned for February 2002. At this point in time, it is still uncertain as to the form of an eventual agreement (*e.g.*, government to government, hunter to hunter).

A general discussion followed about whether a quota needed to form part of an agreement because the take in Greenland is often opportunistic and associated with other activities. The need for a quota would depend on whether the total take of polar bears is sustainable. If the overall take is sustainable, then a quota may not be necessary; however, if the current take is not sustainable, then a quota will be required to ensure the sustainability of the population. Some consideration should also be given to include in an agreement a condition for the monitoring of the population because all estimates have errors associated with them. There is an overall process that needs to be followed in the development of an agreement: estimate the size of the population, determine the sustainable harvest, and divide that harvest between Canada and Greenland. It will be up to each country to decide how to divide its share of the harvest among communities.

Environmental issues

Toxic chemicals

A. Derocher indicated that a number of studies have been undertaken at the Norsk Polarinstitutt and that a second circumpolar survey of pollutants is overdue. It was suggested that all analyses should occur in one place and that Drs Derek Muir and Aaron Fisk (Environment Canada, National Water Research Institute, Burlington, Ontario) have indicated that they are prepared to do this. Derocher stated that he would be prepared to coordinate the survey although he does not have to if someone else has a strong desire to do so. Furthermore, he felt that a toxicologist should probably take the lead in the eventual write-up.

In the discussion that followed, it was noted that one 'hole' in the data from the last survey was from Eastern Russia. S. Belikov indicated that at the moment it would be problematic because it is illegal under Russian law to harvest polar bears and because no research is occurring, especially in the central Russian Arctic. He did say that there might be a Russian research cruise through the Russian Arctic in 2–3 years, which may provide an opportunity to get some samples from the central Russian Arctic. S. Schliebe noted that it might also be a problem in getting samples from Alaska, especially if restricted to adult males.

E. Born wondered about the timing and coordination of samples given that samples from the first survey were collected over a six-year period from 1988–1993. A. Derocher indicated that he, Ø. Wiig and S. Schliebe would coordinate and send protocols to everyone so that the samples to collect and the procedures are known. Collections should start in 2002 and 2003.

Alaska work

S. Amstrup reported that the Alaska Marine Mammal Tissue Archival Project (AMMTAP) was started in 1997/98 and that a storage facility has been set up in the eastern United States. Samples of marine mammals are taken from the subsistence harvest. Half of each sample is simply stored whereas the other half is made into powdered form and stored. Researchers can apply for access to the samples. At present, no analyses have been conducted.

A. Derocher asked whether any other nations have polar bear tissue in storage. I. Stirling replied that some samples collected by the Canadian Wildlife Service are archived in Ottawa and the rest are stored in Edmonton. L. Carpenter and F. Pokiak indicated that nothing has been set up in the Inuvialuit Settlement Area (Canada) but that there would probably be a willingness by local hunters to collect samples if required.

Other studies

E. Born reported that East Greenland hunters have noted that in the past five years that the sea ice has diminished and that there has been an increase in bears. This was provided as an example of ongoing local knowledge. M. Taylor indicated that traditional knowledge surveys were ongoing in Nunavut. C. Johnson also noted recent traditional knowledge surveys undertaken in Alaska and that a report should be released soon.

There was a general discussion on the incidence of abnormalities in polar bears. A. Derocher suggested that we should check with veterinarians and pathologists as to what abnormalities to collect in the field and how. S. Schliebe noted that a histological atlas for polar bears in Alaska was being coordinated and prepared by Todd O'Hara. Whether or not genetic abnormalities are more common now is unknown, however, E. Born remarked that the Inuit would be in the best position to indicate whether such abnormalities are more commonly seen now or not.

Issues pertaining to the Agreement

S. Belikov raised Russian concerns as to how to create laws to protect areas of the Russian Arctic. He noted a current shift from strict Nature Reserves to multi-use Protected Areas. One approach may be to enlarge the network of protected areas, taking an ecosystem approach rather than species-specific approach because there would likely be greater public support if presented as saving overall landscape (land and wildlife) not just polar bears.

C. Johnson noted that critical polar bear habitat in Chukotka is currently being identified and that a report is due later in the year.

M. Ekker added that the Arctic Council's Program for the Conservation of Arctic Flora and Fauna (CAFF) created the Circumpolar Protected Areas Network, which aims to maintain in perpetuity the diverse habitats and biodiversity of the circumpolar Arctic. Therefore, there may be a role for CAFF in polar bear habitat protection. S. Belikov wondered whether the Arctic Council would be in a better position than the PBSG to push governments to protect habitat.

M. Taylor indicated that one of the problems of trying to protect habitat is that it is not effective given mobility of polar bears unless very large amounts of continuous habitat are protected. Furthermore, in Canada, the responsibility for species management/conservation lies with the provincial and territorial jurisdictions whereas habitat in the north is mainly a federal responsibility.

S. Amstrup remarked that perhaps we should broaden perspectives and talk more about the wise management of natural resources rather than protection. S. Belikov responded that in some circumstances, the only option is for total protection. L. Carpenter added that the conservation of healthy habitat for use by all is a better approach.

A. Derocher stated that Norway has no plans, outside of Svalbard, for habitat protection measures.

S. Atkinson asked whether there has been a summary of habitat protection measures in previous proceedings. S. Schliebe responded that, in the 12th proceedings, there was a summary as to how each country was meeting obligations of the Agreement. Ø. Wiig added that the issue had been addressed previously, including at the Copenhagen meeting and perhaps also in the Polar Bear Action Plan.

S. Amstrup raised the point that it is important to separate habitat concerns into those that we can manage and those we cannot. For example, in building ice roads we can manage their placement but for oil spills it is an issue of risk management.

Tuesday 26 June

Population modeling workshop

In introducing the workshop, M. Taylor noted that this was not the venue for an in-depth modeling workshop. It was designed as more of a "show and tell" workshop to provide information on some of the tools and techniques available.

Overview of essentials

M. Taylor provided an overview of population modeling using the Viscount Melville Sound (VM) polar bear population as an example. The basic steps involve identifying population boundaries, applying a standard capture protocol over a uniform area over a specified period of time, analyzing the data to obtain estimates of various population parameters, and then using these values to estimate abundance. One of the problems encountered in the analysis of the VM data was that survival estimates either exceeded one or were too low, obviously numbers that did not make biological sense. Part of the problem was that small capture samples resulted in little data on individuals over time and, consequently, unrealistic estimates of survival. Because small capture samples limit subsequent analyses to simpler models using few parameters, sample size not only influences precision but also accuracy.

The population parameter values were then used in a risk analysis simulation that estimated the risks to a population over a range of harvest levels. For example, the analysis indicated that if the harvest reduced the VM population by about 6% then it would take about 1 year without any hunting for the population to recover. However, if the harvest reduced the population by 79% then it would take about 25 years of no hunting for the population to recover.

In the general discussion, it was suggested that 'leaky' population boundaries are one of the biggest problems with mark-recapture studies because not all individuals necessarily have an equal probability of capture. It was noted that mark-recapture is not a 'study area directed' method but rather a 'population directed' method and that small populations constrain the types of models that can be used because of small sample size. In addition, a good harvest-monitoring program is critical in population studies.

A. Derocher wondered whether it might be better to combine small populations with larger neighbouring populations in order to reduce capture heterogeneity. He also commented that small populations might almost always be over-harvested. S. Amstrup suggested that one approach might be to generate probabilities of population origin and apportion the harvest accordingly.

Population delineation models

A. Derocher noted that because both M. Taylor and S. Amstrup discussed population delineation models during the research summaries earlier in the meeting, there was not much more to add here. He noted that Norway used radio telemetry to delineate populations of polar bears in the Barents and Kara seas. However, the Norwegians now think that there is no evidence for separate populations based on recent cluster analysis that included a measure of home range. Like the earlier Norwegian work, the recent population delineation studies in North America used cluster analysis techniques that did not incorporate home range.

Enumeration: aerial surveys

M. Kingsley provided a brief summary of enumeration surveys and stressed that they are area-directed not population-directed. The key to precision is not the size of the area surveyed but rather the number of targets seen. Although difficult to determine how much effort is required, as a general rule "the error CV equals one over the square root of the number of sightings". Line and strip transects are common types of aerial survey. For line transects, all sightings with distances to the sightings are recorded. For strip transects, all sightings are recorded within a defined sample strip.

A general discussion of the problems associated with aerial surveys followed. Ways to address the problems with detection of all individuals on the transect line (i.e., G(0)=1) include double-observer trials, behavioural studies to see how long animals are out of sight, and having a dedicated observer looking straight ahead and recording animals on the transect line. For line transects, it is important to have unbiased estimates of the distance to the object sighted. Experience, particularly recent experience, is an important factor to minimize aspects of observer bias. Stratification is fine so long as previous data exists from which to identify appropriate strata. Finally, environmental factors need to be considered because these may affect counts. For example, temperature may affect animal behaviour.

Enumeration: mark-recapture

S. Amstrup noted that M. Taylor had already summarized the main problems of mark-recapture in his earlier overview. He re-emphasized that capture heterogeneity is one of the biggest problems and, therefore, it is important keep track of capture variability in order to account/ explain it in within the modeling process.

A general discussion followed in which it was reiterated that there is a real need to go outside of the 'polar bear world' in developing appropriate mark-recapture models. Survival estimates are less affected whereas abundance estimates are greatly affected by capture bias. One way to address issues of capture heterogeneity is to add a co-variate to models. It was noted that good survival estimates typically come from capture efforts over many years whereas good estimates of abundance come from large capture samples in each year. The duration of a mark-recapture study will depend, in part, on whether or not marks currently exist in the population in question. If marks already exist, then three years of capture would probably be sufficient. However, if no marks exist or the existing marks were put out many years ago, then the study would probably require three years of capture, a minimum of a two-year break, followed by another two years of capture. The break in capture effort would allow for a better estimate of survival.

Estimation of vital rates

M. Taylor made an overview presentation of VITAL RATES, which is a population analysis system that enables the calculation of the mean and standard error of various population parameters for species with three-year reproductive cycles, such as polar bears. It consists of two programs, INTERVAL and ANURSUS, the latter that was initially developed during a series of workshops co-sponsored by the Canadian Federal-Provincial Technical Committee, the University of Minnesota, and the University of British Columbia. VITAL RATES was developed by ESSA Technologies Ltd under contract with the Ontario Ministry of Natural Resources and the Northwest Territories Department of Resources, Wildlife, and Economic Development.

The resultant population parameters can then be used as input into population modeling tools, such as RISKMAN, which will be discussed later in the workshop.

Harvest monitoring

The need for a good harvest monitoring program to provide accurate information on the number, sex, age, and location of harvested animals had already been discussed.

Wednesday 27 June

Population modeling workshop (continued)

Sustainable yield and risk management

M. Taylor provided an overview and demonstration of the program RISKMAN that has been developed by the Ontario Ministry of Natural Resources and the Nunavut Department of Sustainable Development. Past and current perspectives on polar bear populations have relied on deterministic simulation models that used generalized and "expert-corrected" estimates of population number, recruitment rate, and survival rate. The uncertainty of the status evaluation was categorized qualitatively (*e.g.*, poor, fair, good). Recent developments in population viability analysis (PVA) simulation models and mark-recapture models provide a more quantitative approach to estimating the uncertainty of status determinations by allowing structured, statistical modeling of capture and survival probabilities and of co-variates.

RISKMAN allows for the correct simulation of the 3-year life cycle of polar bears and for the actual (estimated from data) selectivity/vulnerability of the harvest to be incorporated directly. Deterministic or stochastic models can be run. The program incorporates three types of variance: demographic, parameter, and environmental. Because it is an individual-based model, full demographic uncertainty is incorporated. The uncertainty associated with estimates of survival and recruitment pools both parameter and environmental uncertainty.

RISKMAN has two distinct uses. First, as a management tool, it can be used to design management strategies and regulations for specific populations of wildlife. Second, as a research tool, it can be used to investigate the behaviour of populations under various management practices and to investigate and understand the effects of uncertainty on population persistence.

During a general discussion of the model, it was noted that there is no difference between parameter and environmental variability; they are simply sampling variabilities of different types. Environmental uncertainty will be a confounding factor in any model, particularly that arising from potential effects of climate change and contaminants.

Thursday 28 June

Status report

The population status table was updated and reviewed. Much of the discussion focused on the layout of the status table and the need to make the information clear because most readers are likely to only focus on the table and not read the individual population summaries.

In the status table in the 12th proceedings, poaching had been identified in the 'Mean Annual Kill' column for the Chukchi Sea, Laptev Sea, and Franz Josef Land/ Novaya Zemlya populations. In the updated status table, S. Belikov and A. Boltunov suggested its removal because military personnel were thought to be the ones responsible for poaching. Because military activity in the Russian arctic had essentially stopped, it was felt that poaching was no longer a problem. D. Vongraven raised concerns that by removing the identification of poaching from the table, without providing supporting evidence, would result in the issue being forgotten. In the discussion that followed, it was thought that it was important to raise concern about the poaching of polar bears but that the Group should not lend credence to unsubstantiated reports of poaching.

C. Brower noted that, for the Chukchi Sea population, there is good reporting of the Alaskan harvest. Consequently, he thought if only a single value for the population harvest was reported that it would reflect poorly on Alaskans, especially given that poaching is of concern.

The Group discussed a number of suggested improvements to the population status table, which led to an overall reorganization of the status table. Each jurisdiction also agreed to update the individual population summaries and to provide these to the editors for inclusion in the status report that will appear in these proceedings.

PBSG website

D. Vongraven has been working on a website for the Polar Bear Specialist Group. Probably the greatest benefit of the site would be in raising the profile of the Group and the work it does. For example, information such as the circumpolar distribution map, individual population summaries, and a general publications list could be made available to the public. It was noted that there would be a disclaimer on the site that the views/opinions did not necessarily represent the views of the Group or the IUCN.

Issues handled by the Chairmen

S. Schliebe noted that he had had frequent interaction with IUCN over a number of items including SSC Specialist Group membership, review of the IUCN/SSC Red List criteria with respect to polar bears, questionnaires, and submitting articles for publication in *Species* on behalf of the PBSG. In addition, he has written articles on the Group's activities for the World Wildlife Fund's *Arctic Bulletin*.

Future status of the PBSG

S. Schliebe summarized the PBSG members' meeting that was held in conjunction with the working meeting. Five main issues were discussed and agreed upon by the members.

Membership

In order to maintain the functionality of the Group, the current membership guidelines (see 11th Proceedings) should be retained. In brief, each nation is entitled to designate up to 3 members and the Chair can appoint up to 5 members, thereby limiting the size of the Group to 20. It was noted that there is no requirement for each country to designate 3 members or for the Chair to appoint anyone. In addition, a country that designates less than 3 members retains the unfilled spot within the Group. An unlimited number of specialists can be invited by the Chair to participate in the working meeting.

Mechanics of membership and participation

Each government has sole discretion of appointing their members. At least four months in advance of a working meeting, each nation should provide a ranked list of specialists to the Chair to facilitate the sending of invitations.

NGO participation

The Group reaffirmed that it is a technical group that meets to discuss technical matters that relate to the *Agreement on the Conservation of Polar Bears and Their Habitat*. It is not an open forum for public participation and, therefore, there should be no observer status for NGOs or others at the working meetings.

Length of meeting

The Group thought that it was reasonable to extend a meeting by a day or two, especially given the costs associated with member participation. However, it was not appropriate to extend the meeting for a major undertaking outside of the normal agenda, such as in-depth workshops.

Release of information from the meeting

The Group agreed that it was appropriate to distribute both the press release and the resolutions following the meeting. However, it was up to each country to decide on whether to release their research or management reports in advance of the publication of the Proceedings. Both the status report and the minutes could be released once the Group has reviewed and approved them.

Next meeting

Alaska was suggested as a possible site. It was noted that, because travel costs would likely be high, another alternative would be to meet somewhere else in the United States, such as Seattle, where the Group might be able to use facilities at the National Marine Mammal Laboratory. No firm date or location were set for the next meeting; these will be determined later.

Election of a new chair of the PBSG

Scott Schliebe was elected as the new chair of the IUCN/SSC Polar Bear Specialist Group.

Adoption of status report

Although the status table had been updated during the meeting, the status report was not adopted at the meeting because the accompanying narratives for each population had not been revised to include the most recent information. Each jurisdiction agreed to provide these narratives to N. Lunn in order that an updated status report could be included in these Proceedings.

Adoption of resolutions

Four resolutions were drafted and revised following discussion among the Group. All were unanimously adopted and are included in these Proceedings.

Adjournment

The 13th Working Meeting of the IUCN/SSC Polar Bear Specialist Group was adjourned at 17.00.

Status of the polar bear

IUCN/SSC Polar Bear Specialist Group

Status and distribution

Polar bears are not evenly distributed throughout the Arctic, nor do they comprise a single nomadic cosmopolitan population, but rather occur in 20 relatively discrete populations. The total number of polar bears worldwide is estimated to be 21,500–25,000. The following population summaries and Table 1 which summarises the current population estimates, harvest data, and provides a qualified status determination, are the result of discussions of the IUCN/SSC Polar Bear Specialist Group that were held in Nuuk, Greenland in June 2001 and based on the status reports and revisions given by each nation.

East Greenland

No inventories have been conducted in recent years to determine the size of the polar bear population in eastern Greenland. Although polar bears range widely along the entire coast of eastern Greenland, various studies have indicated that more or less resident groups of bears may occur within this range (Born 1995, Sandell *et al.* 2001). Although there is little evidence of a genetic difference between populations in the eastern Greenland and Svalbard-Franz Josef Land regions (Paetkau *et al.* 1999), satellite telemetry and movement of marked animals indicate that the exchange between these populations is minimal (Wiig 1995, Born *et al.* 1997).

From 1979–1998, the annual catch in eastern Greenland averaged 69 bears (range, 26–129 bears per year). However, an additional annual catch of about 8 bears (i.e., 77 bears) taken in southwestern Greenland, south of 62º N, must be added to the catch statistics because polar bears arrive in SW Greenland with the drift ice that comes around the southern tip from eastern Greenland (Sandell *et al.* 2001).

Despite an increasing practice by hunters from Scoresby Sound in Central East Greenland to go further north to take polar bears during spring, there is no information to indicate an overall increase in hunting by East Greenlanders (Sandell *et al.* 2001). Based on harvest sampling in Scoresby Sound (A. Rosing-Asvid, unpubl. data) and an interview survey in Scoresby Sound and Ammassalik municipalities (Sandell *et al.* 2001), the proportion of adult (=independent) female polar bears in the catch in eastern Greenland is estimated at 0.38.

Given the estimates of the proportion of adult females in the catch and an annual catch of about 80 bears (i.e., East and SW Greenland combined), a minimum population of 2000 individuals would be needed to sustain this take. However, the actual number of animals in the exploited population is unknown.

During the last decades, the ice in the East Greenland area has diminished both in extent and thickness (e.g., Parkinson 2000). Furthermore, polar bears in East Greenland have high body burdens of organic pollutants (Norstrom *et al*. 1998). In 1999, an instance of a pseudohermaphroditic female polar bear was found in East Greenland (Dietz *et al.* 2001), which may be related to the high levels of persistent organic pollutants (Wiig *et al.* 1998).

The effects of global warming and persistent organic pollutants on East Greenland polar bears have not been documented. However, with reference to what has been found in other parts of the Arctic (*e.g.*, Hudson Bay and Svalbard), these environmental changes cause concern about how polar bears in East Greenland may be negatively affected.

Barents Sea

The size of the Barents Sea population is unknown. The only population estimate was based on ship surveys and den counts in the early 1980s (Larsen 1972, 1986) and is too outdated to be of use. Denning in this population occurs in both Svalbard and Franz Josef Land (Belikov and Matveev 1983, Larsen 1985). Both movement and population studies using telemetry and mark-recapture have been conducted in the western parts of the population at intervals beginning in the 1970s (Larsen 1972, 1986, Wiig 1995). Studies of movements using telemetry indicate that some polar bears associated with Svalbard are very restricted in their movements but bears from the Barents Sea move widely between Svalbard and Franz Josef Land (Wiig 1995, Mauritzen *et al.* 2001). Population boundaries are based on satellite telemetry data (Mauritzen *et al*. 2002) and the current boundaries represent a change from earlier reports. Extent of overlap between the Barents Sea and East Greenland populations is unknown but may be limited (Born *et al.* 1997). Gene flow from East Greenland to Franz Josef Land is high (Paetkau *et al.* 1999). It is possible that over-harvest in NE Greenland has reduced the population density in the Greenland Sea but lack of research in this area precludes assessment.

Table 1. Summary of polar bear population status as determined by both historical harvest (1995–96 to 1999–00) levels and current management practices. Abundance estimates are based on the best available data for each population, which ranges from little or no information to detailed inventory studies. The percent females statistic excludes bears of unknown sex, and natural deaths are not included.

Population	*Abundance Estimate*	*Certainty of Estimate*	*Monitoring of Harvest and Other Removals*	*% Females in Kill*	*Sustainable Kill*[1]	*Mean Annual Kill*	*Environmental Concerns*[2]	*Status*[3]
East Greenland	2000	poor (1997)	fair	38	unknown	80	P, W	?
Barents Sea	2000–5000	poor (1982)	Norway – good Russia – poor		na	Norway – 2 Russia – ?	P, W	?
Kara Sea	unknown	unknown	poor		na	unknown	P, I	?
Laptev Sea	800–1200	poor (1993)	poor		na	unknown	P	?
Chukchi Sea	2000+	poor (1997)	US – good Russia – poor	US – 35 Russia – ?	86+	US – 76 Russia – ?	W, I	S?
Southern Beaufort Sea	1800	good (2001)	good	33	81	50	W, I	I
Northern Beaufort Sea	1200	good (1987)	good	33	54	32	W	I
Queen Elizabeth	200	poor (1995)			9?	0	P	S?
Viscount Melville Sound	230	fair (1992)	good	25	4	4		S
Norwegian Bay	100	fair (1979)	good	32	4	4	W	S[a]
Lancaster Sound	1700	fair (1996)	good	25	77	76	W	S[a]
M'Clintock Channel	350	fair (2001)	good	26	11	24	W	S?
Gulf of Boothia	900	poor (1986)	good	40	34	37		S[a]
Foxe Basin	2300	good (1996)	good	36	97	90	W	S[a]
Western Hudson Bay	1200	good (1997)	good	35	52	49	W	S[a]
Southern Hudson Bay	1000	fair (1986)	good	36	41	45		S
Kane Basin	200	fair (1996)	fair	32	9	10		S
Baffin Bay	2200	fair (1996)	fair	36	93	139		D
Davis Strait	1400	fair (1996)	fair	38	56	63	W	D?
Arctic Basin	unknown	unknown	none		na			?
Total estimate of world abundance: 21,500–25,000								

[1] Except for Viscount Melville Sound, sustainable harvest is based on population estimate (N), estimated rates of birth and death, and harvest sex ratio (Taylor *et al.* 1987):

$$\text{Sustainable harvest} = \frac{N \quad 0.015}{\text{Proportion of harvest that was female}}$$

Proportion of harvest that was female is the greater of the actual value or 0.33. Unpublished modeling indicates a sex ratio of 2 males:1 female is sustainable, although mean age and abundance of males will be reduced at maximum sustainable yield. Harvest data (Lee and Taylor, 1994) indicate that selection of males can be achieved

[2] I – industrial development current or proposed; P – evidence of pollutants in bear tissues; W – evidence of global warming effects on sea ice or populations

[3] D – decreasing; I – increasing; S – stationary; S[a] – stationary, population managed with a flexible quota system in which any over-harvest in one year results in a fully compensatory reduction to the following year's quota; ? – indicated trend uncertain

Fig. 1. Distribution of polar bear populations throughout the circumpolar basin.

The Barents Sea population is currently unharvested with the exception of bears killed in defense of life and property (Gjertz and Persen 1987, Gjertz *et al.* 1993, 1995). The population associated was depleted by over-harvest but a total ban on hunting in 1973 in Norway and in 1956 in Russia allowed the population to increase (Larsen 1986, Prestrud and Stirling 1994). Trend information after the mid-1980s is lacking. High levels of PCBs have been detected in a sample of polar bears from this area, which raises the concern that industrial activity, and contaminants may cause environmental degradation (Skåre *et al.* 1994, Bernhoft *et al.* 1997, Norstrom *et al.* 1998) but recent studies suggest a decline and levelling of some pollutants (Henriksen *et al*. 2001). Heavy metal levels have been assessed but do not appear to present a threat (Norheim *et al.* 1992). Oil exploration in polar bear habitat may increase in the near future (Hansson *et al.* 1990). The natural history of this population is reasonably well known (Lønø 1970).

Kara Sea

This population includes the Kara Sea and overlaps in the west with the Barents Sea population in the area of Franz Josef Land and Novaya Zemlya archipelagos.

The information for the Kara and Barents Seas, in the vicinity of Franz Josef Land and Novaya Zemlya, is mainly based on aerial surveys and den counts (Parovshikov 1965, Belikov and Maeteev 1983, Uspenski 1989, Belikov *et al.* 1991, Belikov and Gorbunov 1991, Belikov 1993). Studies of movements, using telemetry, have been done throughout the area but data to define the eastern boundary are incomplete (Belikov *et al*. 1998, Mauritzen *et al*. 2002). The population estimate should be regarded as preliminary. Reported harvest activities have been limited to defense kills and an unknown number of illegal kills; these are not thought to be having an impact on the size of the population. However, contaminant levels in rivers flowing into this area and recent information on nuclear and industrial waste disposal raise concerns about the possibility of environmental damage. Recent studies clearly show that polar bears from the Kara Sea have the highest organochlorine pollution levels in the Arctic (Andersen *et al*. 2001, Lie *et al*. in press).

Laptev Sea

The Laptev population area includes the western half of the East Siberian Sea, the entire Laptev Sea, including the Novosibirsk and Severnaya Zemlya islands. Telemetry data from the East Siberian and the Chukchi seas support the eastern boundary (Garner *et al.* 1990, 1994, 1995). Recent telemetry data from the Kara and Laptev seas indicate the western boundary is probably Severnaya Zemlya (Belikov *et al.* 1998, Mauritzen *et al.* 2002) but data are incomplete. The estimate of population size for the Laptev Sea is based on aerial surveys and den counts (Kischinski 1969, Belikov and Randala 1987, Uspenski 1989, Belikov *et al.* 1991, Belikov and Gorbunov 1991, Belikov 1993) and should be regarded as preliminary. Reported harvest activities here are limited to defense kills and a small but unknown number of illegal kills. The current levels of harvest are not thought to be having a detrimental impact on the population.

Chukchi Sea

This population occupies the Chukchi Sea adjacent to Alaska and Russia. Co-operative studies between USA and Russia, using telemetry to study movements, have confirmed that polar bears in the area are widely distributed on the pack ice of the northern Bering, Chukchi, and eastern portions of the East Siberian seas (Garner *et al*. 1990, 1994, 1995). Based upon those telemetry data, the accepted western boundary of the population is near Chaunskaya Bay in northeastern Russia. The eastern boundary is Icy Cape, Alaska, which is also the accepted western boundary of the Southern Beaufort Sea population (Amstrup *et al*. 1986, Amstrup and DeMaster 1988, Garner *et al*. 1990, Amstrup *et al*. 1995). Estimates of the size of the population have been derived from observations of dens, and aerial surveys (Chelintsev 1977, Stishov 1991a,b, Stishov *et al*. 1991). Those estimates, however, are considered unreliable. Similarly, reliable estimates of population size based upon mark and recapture have not been available for this region. McDonald *et al*. (1999) reported on a test of aerial survey methods, which may have application to the Chukchi Sea area. In August 2000, an aerial survey in the eastern Chukchi Sea and western portions of the southern Beaufort Sea provided relatively high-density estimates for this survey area (Evans *et al*. in prep.). The Chukchi population is believed to have increased after the level of harvest was reduced in 1972. However, the degree of increase and absolute numbers of animals remains unknown.

Hunting polar bears throughout the Russian Arctic was banned in 1956. Legal harvesting activities are currently restricted to Inuit in western Alaska and appear to be sustainable at current levels. However, recent reports of illegal harvest in Russia are cause for concern, particularly because the magnitude of this illegal kill is not known. In the Alaska Chukchi Sea a 50% reduction in harvest between the 1980s and 1990s has been detected (Schliebe *et al*. 1998). Exact causes for the decline in the Alaska harvest have not been determined. Despite fluctuations in harvest levels in Alaska, polar bears appear to be abundant in the Chukchi Sea; the unknown rate of illegal take in Chukotka, however, makes the stationary designation uncertain and tentative.

Southern Beaufort Sea (SB)

The southern Beaufort Sea polar bear population is shared between Canada and Alaska. During the early 1980s, radio-collared polar bears were followed from the Canadian Beaufort Sea into the eastern Chukchi Sea of Alaska (Amstrup *et al*. 1986, Amstrup and DeMaster 1988). Telemetry data combined with earlier returns of tagged individuals suggested that bears of the Southern Beaufort Sea comprised a single population with an eastern boundary between Paulatuk and Ballie Island, NWT, Canada, and a western boundary near Icy Cape, Alaska (Amstrup *et al*. 1986, Amstrup and DeMaster 1988, Stirling *et al*. 1988). Recognition that these animals are shared by Canada and Alaska prompted development of the "Polar Bear Management Agreement for the Southern Beaufort Sea" (Agreement). The Agreement, between the Inupiat hunters of Alaska and the Inuvialuit hunters of Canada, was ratified by both parties in 1988. The text of the Agreement included provisions to protect bears in dens and females with cubs, and stated that the annual sustainable harvest from the SB polar bear population would be shared between the two jurisdictions. Harvest levels also were to be reviewed annually in light of the best scientific information available (Treseder and Carpenter 1989, Nageak *et al*. 1991).

A principal assumption of the Agreement was that polar bears harvested within the region identified came from one population. Early estimates suggested the size of this population was approximately 1800, although uneven sampling was known to compromise the precision of that estimate (Amstrup 1985, Amstrup *et al.* 1986, Amstrup and DeMaster 1988).

Research incorporating mark and recapture and radio-telemetry has continued on a nearly annual basis through to the present time. Recent analyses using new spatial modeling techniques have altered our view of the bounds and size of this population. These analyses suggest that the polar bears occurring in the SB area, as currently defined, should be divided into two groups. These are the eastern portion of the previously described Chukchi sea population (hereafter called Eastern Chukchi [EC]) and the SB population. The SB and the EC populations comprise most of the bears from this region. The boundary between these groups occurs near Lonely, which is approximately 140km east of Barrow Alaska on the Beaufort Sea coast. This is a soft boundary, however. Proportional representation of EC bears increases while representation of SB bears decreases on a cline from east to west.

Concurrent with recognition of possible new boundaries are new population estimating techniques suggesting the total numbers of bears in this region are higher than previously thought (Amstrup *et al*. 2001, McDonald and Amstrup 2001). Although the new population sizes have been published, the new methods for estimating population bounds have not yet been reviewed. Therefore, the region to which the new estimate applies is still under investigation. The revised population descriptions and estimates, therefore, are not incorporated into this status report. If completed analyses and subsequent reviews substantiate the above population definitions, they will be incorporated into subsequent status reports. For purposes of this report, however, we will continue to use the previously published bounds and size estimates for the SB population.

Northern Beaufort Sea (NB)

Studies of movements and population estimates of polar bears in the eastern Beaufort Sea have been conducted using telemetry and mark-recapture at intervals since the early 1970s (Stirling *et al.* 1975, 1988, DeMaster *et al.* 1980, Lunn *et al.* 1995). As a result, it was realized that there were separate populations in the North and South Beaufort Sea areas and not a single population as was suspected initially (Stirling *et al.* 1988, Taylor and Lee 1995, Amstrup 1995, Bethke *et al.* 1996). The density of polar bears using the multi-year ice of the northernmost area was lower than it was further south. The population estimate of 1200 (Stirling *et al.* 1988) is believed to be unbiased and the current harvest appears to be within sustainable limits.

Queen Elizabeth (QE)

The Queen Elizabeth population is a geographic catch-all population to account for the remainder of northern Canada. Polar bears occur at low densities here, but systematic inventory studies have not been done. This area is characterized by heavy multi-year ice, except for a recurring lead system that runs along the Queen Elizabeth Islands from the northeastern Beaufort Sea to northern Greenland. Perhaps 200 polar bears are resident in this area, and others are known to move through the area or use it for a portion of the year (Durner and Amstrup 1995, Lunn *et al*. 1995). This population is unharvested except for an occasional defense kill. Given the low numbers and low rate of reproduction that is likely, even a small amount of incidental take could cause population depletion if visitation to this remote area becomes more common.

Viscount Melville Sound (VM)

A five-year study of movements and population size, using telemetry and mark-recapture, was completed in 1992 (Messier *et al.* 1992, 1994). Population boundaries were based on the observed movements of female polar bears with satellite radio collars and movements of bears tagged in and out of the study area (Bethke *et al.* 1996, Taylor *et al.* 2001). The population estimate of 230 is accurate with a 14% CV (M.K. Taylor, unpubl. data). Because this population occupies such a large geographic area, it was thought to be more abundant and productive at the time the original quotas were allocated in the mid-1970s. However, this area is characterized by heavy multi-year ice and low densities of ringed seals (Kingsley *et al.* 1985) and the productivity and density of polar bears was lower than was initially expected. Consequently, quotas were reduced and a five-year moratorium on hunting began in 1994/95. Hunting resumed in 1999/2000 with a quota of 4. While it is expected that only males will be taken, a kill of one female per year will be allowed.

Norwegian Bay (NW)

The Norwegian Bay population is bounded by heavy multi-year ice to the west, islands to the north, east, and west and polynyas to the south (Stirling 1980, 1997, Taylor *et al.* 2001). From data collected during mark-recapture studies, and from satellite tracking of adult female polar bears, it appears that most of the polar bears in this population are concentrated along the coastal tide cracks and ridges along the north, east, and southern boundaries (Taylor *et al.* 2001). The preponderance of heavy multi-year ice through most of the central and western areas has resulted in low densities of ringed seals (Kingsley *et al.* 1985) and, consequently, low densities of polar bears. Based on preliminary data, the current estimate for this population is 100 (M.K. Taylor, unpubl. data). The estimate of population size is currently under revision based on the analysis of mark-recapture data collected during an inventory of Canadian High Arctic populations (1993–97).

The harvest quota for this population was reduced to four (three males and one female) in 1996 and appears to be sustainable.

Lancaster Sound (LS)

The central and western portion of the area occupied by the Lancaster Sound population of polar bears is characterized by high biological productivity and high densities of ringed seals and polar bears (Schweinsburg *et al.* 1982, Stirling *et al.* 1984, Kingsley *et al.* 1985, Welch *et al.* 1992). The western third of this region (eastern Viscount Melville Sound) is dominated by heavy multi-year ice and apparently low biological productivity, as evidenced by low densities of ringed seals (Kingsley *et al.* 1985). In the spring and summer, densities of polar bears in the western third of the area occupied by the Lancaster Sound population are low but, as break-up occurs, polar bears move west to summer on the multi-year pack ice. Recent information on the movements of adult female polar bears monitored by satellite radio collars, and mark-recapture data from past years, has shown that this population is distinct from the adjoining Viscount Melville Sound, M'Clintock Channel, Gulf of Boothia, Baffin Bay and Norwegian Bay populations (Taylor *et al.* 2001). The current estimate of 1700 is based on a preliminary analysis of both historical and current mark-recapture data, which compares favourably with a previous estimate of 1675 that included Norwegian Bay (Stirling *et al.* 1984), and was considered to be conservative. The estimate of population size is currently under revision based on the analysis of mark-recapture data collected during an inventory of Canadian High Arctic populations (1993–97).

M'Clintock Channel (MC)

The current population boundaries are based on recovery of tagged bears and movements of adult females with satellite radio-collars in adjacent areas (Taylor and Lee 1995, Taylor *et al.* 2001). These boundaries appear to be a consequence of large islands to the east and west, the mainland to the south, and the heavy multi-year ice in Viscount Melville Sound to the north. A six-year mark-recapture population study covered most of this area in the mid-1970s (Furnell and Schweinsburg 1984). Subsequently, a population estimate of 900 was derived from the data collected within the boundaries proposed for the M'Clintock Channel population, as part of a study conducted over a larger area of the Central Arctic (Furnell and Schweinsburg 1984). More recently, local hunters suggested 900 might be too high so the Canadian Polar Bear Technical Committee accepted a recommendation to reduce the estimate to 700.

Following the completion of a mark-recapture inventory in spring 2000, preliminary population estimates were calculated that varied from 238 to 399, depending on whether or not estimates of natural mortality were included and on whether capture data from different years were pooled or treated separately. In February 2001, the Canadian Polar Bear Technical Committee reviewed these estimates and recommended the most conservative estimate of 240, pending a more detailed analysis of the capture data. This analysis has been completed (J. Laake and M.K. Taylor, unpubl. data); the best current estimate is 350 (367, SE=191, 95% asymmetrical CI=141-958).

The Government of Nunavut has recommended the implementation of a moratorium on hunting for the 2001/2002 hunting season.

Gulf of Boothia (GB)

The population boundaries are based on movements of tagged bears, movements of adult females with satellite radio-collars in adjacent areas, and interpretations by local Inuit hunters of how local conditions influence the movements of polar bears in the area (Stirling *et al.* 1978, Taylor and Lee 1995, Taylor *et al.* 2001). An initial population estimate of 333 was derived from the data collected within the boundaries proposed for the Gulf of Boothia population, as part of a study conducted over a larger area of the Central Arctic (Furnell and Schweinsburg 1984). Although population data from this area are limited, local hunters report that numbers have remained constant or increased. The Canadian Polar Bear Technical Committee agreed to an increase in the population estimate from 333 to 900, on an interim basis, pending completion of satellite tracking and mark-recapture studies, based on recognition that the central and eastern portions of the area were not sampled in the earlier study and the beliefs of local Inuit hunters about polar bear abundance in the area. The status was listed as stationary (Table 1), but this designation should be regarded as uncertain and tentative. A satellite telemetry study of movements and a mark-recapture population inventory began in 1998.

Foxe Basin (FB)

Based on 12 years of mark-recapture studies, a limited amount of tracking of female bears with conventional radios, and satellite tracking of adult females in western Hudson Bay, the Foxe Basin population appears to occur in Foxe Basin, northern Hudson Bay, and the western end of Hudson Strait (Taylor and Lee 1995). The current estimate of 2300 (SE=350) was developed in 1996 (M.K. Taylor, unpubl. data) from a mark-recapture program based on tetracycline biomarkers (Taylor and Lee 1994). During the ice-free season, polar bears were concentrated on Southampton Island and along the Wager Bay coast. However, significant numbers of bears were also encountered on the islands and coastal regions throughout the Foxe Basin area. The marking effort was conducted during the ice-free season, and distributed throughout the entire area. The population estimate is believed to be accurate. The previous harvest quotas are believed to have reduced the population from about 3000 in the early 1970s to about 2300 (15% CV) in 1996. The Nunavut harvest quota for this population has been revised to levels that will permit slow recovery of this population, provided that the kill in Québec does not increase. Co-management discussions with Québec are ongoing.

Western Hudson Bay (WH)

The distribution, abundance, and population boundaries of this population have been the subject of research programs since the late 1960s (Stirling *et al.* 1977, Derocher and Stirling 1995, Lunn *et al.* 1997, Taylor and Lee 1995). Over 80% of the adult population is marked and there are extensive records from mark-recapture studies and the return of tags from bears killed by Inuit hunters. This population appears to be geographically segregated during the open-water season, although it mixes with those of Southern Hudson Bay and Foxe Basin on the Hudson Bay sea ice during the winter and spring (Stirling *et al.* 1977, Derocher and Stirling 1990, Stirling and Derocher 1993, Taylor and Lee 1995). The size of this population was estimated to be 1200 in autumn 1995 (Lunn *et al.* 1997), and the current harvest is believed to be sustainable. The harvest sex ratio of 2 males per female has resulted in a population composition that is 58% female and 42% male (Derocher *et al.* 1997).

Over the past two decades, the condition of adult male and female bears and the proportion of independent yearling bears caught during the open water season have declined significantly (Derocher and Stirling 1992, Stirling and Lunn 1997, Stirling *et al.* 1999). Over the same period of time, the date of break-up of the sea-ice in western Hudson Bay has advanced by two weeks (Stirling *et al.* 1999), which is probably due to spring air temperatures in the region warming at a rate of 0.2–0.3º C per decade since 1950 (Skinner *et al.* 1998). Stirling *et al.* (1999) documented that the timing of break-up was positively correlated with the condition of adult females (*i.e.*, the earlier the break-up the poorer the condition of the bears) and suggested that the declines in the various parameters measured in the polar bears have resulted from the trend toward earlier break-up, which in turn appears to be due to the long-term warming trend in spring temperatures.

Southern Hudson Bay (SH)

The population boundaries are based on the observed movements of marked bears, and telemetry studies (Jonkel *et al.* 1976, Kolenosky *et al.* 1992, Kolenosky and Prevett 1983, Stirling and Derocher 1993, Taylor and Lee 1995). Ongoing research using satellite-collared bears is aimed at refining the boundaries of this population (M. Obbard, M.K. Taylor and F. Messier, unpubl. data). The estimate of population numbers comes from a three-year (1984–1986) mark-recapture study, conducted mainly along the Ontario coastline (Kolenosky *et al.* 1992). This study and the more recent telemetry data have documented seasonal fidelity to the Ontario coast during the ice-free season, and intermixing with the Western Hudson Bay and Foxe Basin populations during the months when the bay is frozen over. In 1988, a population-modeling workshop resulted in the Canadian Polar Bear Technical Committee increasing the calculated population estimate from 763 to 1000 because portions of the eastern and western coastal areas were not included in the area sampled. Additionally, the area away from the coast may have been under-sampled due to the difficulty of locating polar bears inland in the boreal forest. Thus some classes of bears, especially pregnant females and females with cubs, may have been under-sampled. The estimate of 1000 is considered conservative, and the total harvest by Nunavut, Ontario, and Québec appears to be sustainable. Discussions between these jurisdictions on co-management and co-operative research are ongoing.

Kane Basin (KB)

Based on the movements of adult females with satellite radios and recaptures of tagged animals, the boundaries of the Kane Basin population are the North Water Polynya to the south, and Greenland and Ellesmere Island to the west, north, and east (Taylor *et al.* 2001). Polar bears in Kane Basin do not differ genetically from those in Baffin Bay (Paetkau *et al.* 1999). Prior to 1997, this population was essentially unharvested in Canadian territory because of its distance from Grise Fiord, the closest Canadian community and because conditions for travel there are typically difficult. However, this population has occasionally been harvested by hunters from Grise Fiord since 1997 and continues to be harvested on the Greenland side of Kane Basin. In some years, Greenland hunters have also harvested polar bears in western Kane Basin and Smith Sound (Rosing-Asvid and Born 1990, 1995).

Few polar bears were encountered by researchers along the Greenland coast 1994 through 1997, possibly because of intense harvest pressure there. Based on preliminary data from ongoing research (see Lancaster Sound summary), the population estimate of 200 would support a total cumulative harvest of eight per year at two males per female (M.K. Taylor, unpubl. data). The current best estimate of the Greenland kill is 10 per year (Born 2001), which is not sustainable. However, the actual number being taken by Greenland hunters is uncertain (Born 2001) and must be validated. The Canadian quota for this population is 5 and if Canadian Inuit continue to harvest from this area, over-harvest and population depletion could occur. Although the habitat appears suitable for polar bears on both the Greenland and Canadian sides of Kane Basin, the densities of polar bears on the Greenland (harvested) side were much lower than on the Canadian (unharvested) side; suggesting that this population may have been larger in past years, and could be managed for increase. Co-management discussions between Greenland and Canada are continuing, and Greenland has indicated its intention to move to a quota system.

Baffin Bay (BB)

Based on the movements of adult females with satellite radios and recaptures of tagged animals, the Baffin Bay population is bounded by the North Water Polynya to the north, Greenland to the east, and Baffin Island to the west (Taylor and Lee 1995, Taylor *et al.* 2001). A distinct southern boundary at Cape Dyer, Baffin Island is evident from the movements of tagged bears (Stirling *et al.* 1980) and recent movement data from polar bears monitored by satellite telemetry (Taylor *et al.* 2001). A study of micro-satellite variation did not reveal any genetic differences between polar bears in Baffin Bay and Kane Basin, although Baffin Bay bears differed significantly from Davis Strait and Lancaster Sound bears (Paetkau *et al.* 1999). An initial population estimate of 300–600 bears was based on mark-recapture data collected in spring (1984–1989) in which the capture effort was restricted to shore-fast ice and the floe edge off northeast Baffin Island (R.E. Schweinsburg and L.J. Lee, unpubl. data). However, recent work has shown that an unknown proportion of the population is typically offshore during the spring and, therefore, unavailable for capture. A second study (1993–1997) was done in September and October, when all polar bears were ashore in summer retreat areas on Bylot and Baffin islands. The mark-recapture sampling in 1995 was compromised by an unexpected autumn outflow of multi-year ice from Lancaster Sound, Jones Sound, and the polar basin. This resulted in an unknown fraction of the polar bears from Baffin Bay remaining on the offshore pack ice where they were unavailable. A preliminary estimate of 2200 is based only on the 1993–1995 data and believed to be conservative (M.K. Taylor, unpubl. data). The estimate of population size is currently under revision based on the analysis of mark- recapture data collected during an inventory of Canadian High Arctic populations (1993–97).

This population is shared with Greenland, which does not limit the number of polar bears harvested. Based on the preliminary population estimate and the most recent harvest information (Born 2001), it appears the population may be over-harvested. Better information on population numbers and validation of the Greenland harvest data are required to clarify the status of this population. Co-management discussions between Greenland and Canada are ongoing, and Greenland has indicated its intention to move to a quota system.

Davis Strait (DS)

Based on the movements made by tagged animals and, more recently, of adult females with satellite radios, this population has been determined to occur in the Labrador Sea, eastern Hudson Strait, Davis Strait south of Cape Dyer, and an as yet undetermined portion of south-west Greenland (Stirling and Kiliaan 1980, Stirling *et al.* 1980, Taylor and Lee 1995, Taylor *et al.* 2001). A genetic study (Paetkau *et al.* 1999) showed significant differences between bears from Davis Strait and both Baffin Bay and Foxe Basin. The initial population estimate of 900 (Stirling *et al.* 1980) was based on a subjective correction from the original mark-recapture calculation of 726, which was felt to be too low because of possible bias in the sampling. In 1993, this estimate was increased to 1400 by the Canadian Polar Bear Technical Committee to account for the realisation that the bias in sampling caused by the inability of researchers to survey the extensive area of offshore pack ice was greater than had previously been thought and to account for additional scientific information (I. Stirling and M.K. Taylor, unpubl. data) and traditional knowledge, which suggest that the population has increased over the last 20 years. The principal justification for this adjustment is the observation that the annual harvest has been sustained for the last 20 years, non-quantitative observations continue to suggest the population has increased, and there are no data to suggest the population has been detrimentally impacted by the ongoing harvest. The population estimate of 1400 was selected because that is the minimum number of animals required to sustain the observed harvest.

Clarification of the status of this population will require a population inventory conducted during the open water season, and more reliable (*i.e.*, systematically validated) harvest information from Greenland. Within Canada, this population is harvested by Inuit from Nunavut, Québec, and Labrador. Co-management discussions between Greenland and Canada are continuing, and Greenland has indicated its intention to move to a quota system.

Arctic Basin

The Arctic Basin population is a geographic catch-all to account for polar bears that may be resident in areas of the circumpolar arctic that occur outside of the territorial jurisdictions of the polar nations. Polar bears probably occur at very low densities here, although no systematic surveys have been conducted. Twelve polar bears were seen during a joint US-Canada scientific oceanographic voyage across the Arctic Basin in 1994 (Ramsay and Farley 1996); seven of these bears were handled. It is probable that bears from neighbouring populations move through the Arctic Basin or use it for a portion of the year (*e.g.*, Durner and Amstrup 1995, Lunn *et al*. 1995).

Management uncertainties

Anthropogenic and natural changes in arctic environments as well as new recognition of the shortcomings of our knowledge are increasing the uncertainties of polar bear management. Higher temperatures and erratic weather fluctuations, apparent symptoms of global climate change, are increasing across the range of polar bears. Following the predictions of climate modelers, such changes have been most prevalent in Arctic regions (Stirling and Derocher 1993, Stirling and Lunn 1997), and already have altered local and global sea-ice conditions (Gloersen and Campbell 1991, Vinnikov *et al*. 1999). Because changes in sea-ice are known to alter polar bear numbers and productivity (Stirling and Lunn 1997, Stirling *et al*. 1999), effects of global climate changes can only increase future uncertainty and may increase risks to the welfare of polar bear populations. Uncertainty about effects on polar bears of climate change must be included in future management and conservation plans.

Persistent organic pollutants, which reach Arctic regions via long-range transportation, also increase uncertainty for the welfare of polar bears. The effects of pollutants on polar bears are only partially understood. Levels of such pollutants in some polar bear populations, however, are already sufficiently high that they may interfere with hormone regulation, immune system function, and possibly reproduction (Wiig *et al*. 1998, Bernhoft *et al*. 2000, Skaare *et al*. 2000, Henriksen *et al*. 2001, Skaare *et al*. 2001). Population level impacts on polar bears are unknown, at present, but reproductive and survival rates may be affected, and management uncertainty is sure to increase.

Further, although our understanding of polar bear population dynamics constantly improves, new analysis methods (Lebreton *et al*. 1992, Amstrup *et al*. 2001, McDonald and Amstrup 2001) suggest estimates of population parameters and numbers are more uncertain than (and in some cases different from) those used to generate this status report (Taylor *et al*. 1987). Additionally, computer simulations (*e.g.*, Taylor *et al*. 2000, 2001) suggest harvesting polar bear populations at or near maximum sustained yield is accompanied by greater risks than previously believed.

Some new information is not yet reviewed. Other results are too recent to have withstood the tests of time or to be fully understood. Hence, possible ramifications were not included in the current status report. Nonetheless, we recognize that the suggested uncertainties in the balance between current harvest opportunities and risks to future population security must be incorporated into future status reports. More importantly, even in advance of future reports, managers must consider the entire range of cumulative but uncertain threats to polar bears including the many uncertainties and shortcomings of knowledge regarding population dynamics. Management models must become more proactive and adaptive, and cumulative uncertainty may require more conservative management regimes.

The International Polar Bear Agreement

In the early 1960s, great concern was expressed about the increasing harvest of polar bears. In 1965, representatives from the five “polar bear countries” met in Fairbanks, Alaska to discuss protection of polar bears. At the time that this first international meeting was convened, there was little management in effect except for the USSR, where polar bear hunting was prohibited in 1956 (Prestrud and Stirling 1994). At this meeting the following points were agreed upon:

1. The polar bear is an international circumpolar resource.

2. Each country should take whatever steps are necessary to conserve the polar bear until the results of more precise research findings can be applied.
3. Cubs, and females accompanied by cubs, should be protected throughout the year.
4. Each nation should, to the best of their ability, conduct research programs on polar bears within its territory.
5. Each nation should exchange information freely, and the IUCN should function to facilitate such exchange.
6. Further international meetings should be called when urgent problems or new scientific information warrants international consideration.
7. The results of the First International Scientific Meeting on the Polar Bear should be published.

Following the first international meeting on polar bear conservation, the IUCN Polar Bear Specialist Group (PBSG) was formed to coordinate research and management of polar bears on an international basis. In addition, this group took on the role of developing and negotiating the *Agreement on the Conservation of Polar Bears and Their Habitat* (the Agreement). That Agreement (Appendix 1) was signed in Oslo, Norway in May 1973 and came into effect for a five-year trial period in May 1976. The Agreement was unanimously confirmed for an indefinite period in January 1981.

Article VII of the Agreement stipulates that: “The Contracting parties shall conduct national research programs on polar bears, particularly research relating to the conservation and management of the species. They shall as appropriate coordinate such research with the research carried out by other Parties, consult with other Parties on management of migrating polar bear populations, and exchange information on research and management programs, research results, and data on bears taken.” To meet the conditions of Article VII of the Agreement, the IUCN PBSG meets every 3–5 years.

The Agreement did not provide for protection of female polar bears accompanied by cubs or for the cubs themselves. Annex E to the Agreement drew attention to the need for this protection (Appendix 2). In 1997, the PBSG reviewed Annex E and reaffirmed the need for special protection measures for adult females (Appendix 2), but noted that the occasional take of cubs for cultural and nutritional purposes by subsistence users did not present a conservation concern.

The Importance of the Agreement

A primary goal of the Agreement was to limit the hunting of polar bears to sustainable levels. Because so many management changes had already been put in place during the period when the Agreement was being negotiated, there was little detectable impact immediately following it being signed and ratified (Prestrud and Stirling 1994). However, there is no doubt that the knowledge that the Agreement was being negotiated, and was likely to be successful, was a significant stimulus (Fikkan *et al.* 1993). The Alaskan harvest rate was reduced by 50% following the MMPA in 1972.

To date, the Agreement has been the most important single influence on the development of internationally coordinated management and research programs, which have ensured the survival of polar bears (Prestrud and Stirling 1994). The Agreement is not enforceable by law in any of the countries that have signed it, a weakness that has been identified in previous reviews of international wildlife law. It has been successful in bringing the harvest of polar bears within sustainable limits for most populations, while still facilitating harvest by local people. Most of the original habitat of polar bears is still intact (although not protected) and uninhabited. The polar bear is the only bear, and probably one of the only large carnivores that still occurs throughout most of its original range.

The IUCN Polar Bear Specialist Group

The work of the PBSG has always been important to the Agreement. Initially, membership was limited to government biologists working on polar bears because one of the principal tasks was negotiation of the Agreement. After the Agreement was signed, “Invited Specialists” were included to facilitate the input of experts in fields like population dynamics and physiology. One of the reasons the PBSG has been so successful is that members have been appointed by government agencies and have usually been polar bear specialists as well. Because governments have been more directly involved in the work of this Specialist Group, they have also had a vested interest in its success. Consequently, the people going to meetings have had a fair amount of authority to make decisions and commitments.

The PBSG has no regulatory function and the main function is to promote cooperation between jurisdictions that share polar bear populations, facilitate communication on current research and management, and monitor compliance with the agreement. The PBSG is not an open forum for public participation; it is a technical group that meets to discuss technical matters that relate to the Agreement. The deliberations and resolutions adopted by the PBSG are available to the public as are the published proceedings of the meetings. They have been published in the IUCN Occasional Papers Series of the IUCN Species Survival Commission (SSC).

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

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

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

These guidelines are intended to maintain the integrity of the PBSG as a small working group of technical specialists on polar bears while still ensuring that it is responsible to the governments signatory to the Agreement, IUCN, and the international conservation community.

Conservation Action Plan for Polar Bears

The PBSG considers the Agreement to be an action plan for the conservation of polar bears. In 1999, the PBSG published a review of the Agreement and how it has worked for the conservation of polar bears (IUCN Polar Bear Specialist Group 1999).

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Resolutions, 13th Meeting of the IUCN Polar Bear Specialist Group

1. Effects of global warming on polar bears

The IUCN Polar Bear Specialist Group

Recognizing that sea ice is critical to the continued survival of polar bears; and

Recognizing that the earth's climate has warmed significantly over the past century and this trend is continuing; and

Recognizing that, as a result of climatic warming, the maximum ice cover of the Arctic Ocean has declined significantly over the past 20 years; and

Recognizing that documented changes in the pattern and timing of breakup and fluctuations in the seasonal distribution of sea ice significantly influence the condition and reproduction success of polar bears and their prey; and

Recognizing the need to manage polar bears and the ecosystem of which they are a part (Article II); therefore

Recommends that research on the effects of global climatic warming on polar bears be increased in order to understand how these changes will continue to affect polar bears in the future and develop management and conservation measures to respond to future changes.

2. Improvement of harvest monitoring program in Greenland

The IUCN Polar Bear Specialist Group

Recognizing that the right of local hunters to harvest polar bears is identified in the Agreement for the Conservation of Polar Bears (Article I and III) provided that this harvest is managed in accordance with sound conservation practices; and

Recognizing that Greenland and Canadian management authorities have initiated polar bear co-management discussions for the shared Kane Basin, Baffin Bay and Davis Strait polar bear populations; and

Recognizing the need for a mechanism to regulate regulating the harvest of shared populations of polar bears in Canada and Greenland; and

Recognizing that the Greenland management authorities have accepted the need for quota regulation of the take of polar bears in Greenland; and

Noting that sound conservation practices for sustainable harvest of polar bears requires accurate information on the number, sex, age and location of harvested animals; and

Complimenting Greenland management authorities for their effort during recent years to establish a monitoring program to provide information about the catch of polar bears in Greenland; and

Complimenting the Greenland hunters for their effort to report data on their catches; and

Noting the need to validate this information; therefore

Recommends that Greenland improve its harvest monitoring program so that it provides accurate data about numbers of polar bears caught by season and area, as well as the sex and age of the individual kill.

3. Offshore jurisdiction for enforcement of polar bear regulations in Canadian waters

The IUCN Polar Bear Specialist Group

Recognizing that the management of polar bear populations that are shared between populations needs to be coordinated; and

Recognizing that each Contracting Party to the Agreement for the Conservation of Polar Bears requires appropriate legislation to regulate polar bear harvest activities within their jurisdiction (Article VI); and

Noting that within Canada there is uncertainty about whether jurisdiction for enforcement of laws controlling the harvest of polar bears on the sea ice offshore from the low tide mark lies with the Federal or the Provincial and Territorial governments; therefore

Recommends that relevant legislation be reviewed by all jurisdictions with a view to confirming which jurisdiction has the legal authority for enforcement; and

Recommends that, if required, legislation be developed as needed to ensure the ability to enforce laws governing the take of polar bears.

4. Development of a quota system for polar bear harvest in Québec

The IUCN Polar Bear Specialist Group

Recognizing that the right of local people to harvest polar bears is identified in the Agreement for the Conservation of Polar Bears (Article I and III) provided that this harvest is managed in accordance with sound conservation practice; and

Recognizing that Greenland and Canadian management authorities have initiated co-management discussions for the shared Kane Basin, Baffin Bay, and Davis Strait polar bear populations; and

Recognizing the need for a mechanism to regulate the harvest of polar bears in Canada and Greenland; and

Recognizing that all management authorities in Greenland and Canada (except Québec/Makivik) have accepted the need for quota regulation for the take of polar bears; and

Noting that sound conservation practices for sustainable harvest of polar bears requires accurate information on the number, sex, and age of harvested animals; and

Complimenting Quebéc/Makivik management authorities for their comprehensive and accurate harvest monitoring program; and

Complimenting Nunavik hunters for their participation in, and cooperation with, the harvest monitoring program; therefore

Recommends that Quebéc/Makivik institute a polar bear quota system that effectively regulates the take of polar bears.

Press Release
13th Meeting of the IUCN Polar Bear Specialist Group

The 13th meeting of the IUCN Polar Bear Specialist Group was held in Nuuk, Greenland, during 23–28 June 2001, under the Chairmanship of Dr Stanislav Belikov and Scott Schliebe. Delegates representing each of the five circumpolar nations signatory to the Agreement for the Conservation of Polar Bears (Canada, Denmark, Norway, Russia, USA), were in attendance. Also attending, as invited specialists, were representatives from the Greenland Home Rule Government, the Alaska Nanuuq Commission (Alaska), the Inuvialuit Game Council and the Nunavut Tuungavik Incorporated (Canada), and the Inuit Circumpolar Conference. The PBSG meets on a 3–5 year rotation and reviews and exchanges information on progress in the research and management of polar bears throughout the arctic.

Harvesting of polar bears remains of great importance to the culture and economy of aboriginal groups through much of the Arctic. Therefore, monitoring harvests and population trends remains a priority. Greenland in particular announced new progressive and positive management changes. The Group recognized the importance of co-management agreements, including the active participation of user groups, which have been established between the Inuvialuit of Canada and the Inupiat of Alaska and between the United States and Russia. The Group further noted and fully supported the initiative to establish co-management of populations of polar bears shared between Greenland and Canada.

The status of all populations was evaluated within the limits of the data available. The current minimum estimate of the total number of polar bears occupying the 20 distinct populations in the circumpolar Arctic is 22,000. New approaches were demonstrated for modeling polar bear populations. Such models offer the ability to assess the relative risks of a range of management alternatives. The Group also recognized the need for more proactive management to address both knowledge limitations regarding polar bear population dynamics, and increasing environmental uncertainty resulting from climate change and pollution in the Arctic.

The group reviewed overall progress in research and management of polar bears throughout its circumpolar range and identified priorities for future studies. In particular, new information indicates the greatest future challenges to conservation of polar bears may be ecological change in the Arctic as a result of climate change and pollution. For example, in western Hudson Bay, the ice now breaks up about two weeks earlier than it did 20 years ago so that polar bears have less time to feed and store fat needed while on shore for four months before the ice re-freezes. Furthermore, particularly high levels of persistent organic pollutants have been found in polar bears from northeast Greenland, Svalbard, and the western Russian arctic. A comparative study of the relationship between the levels of these contaminants and the immune system of polar bears in Svalbard and western Hudson Bay confirmed that high levels of contaminants have a negative effect on the ability to combat disease. Pollutants are also affecting hormonal systems with uncertain consequences. In response, the group is now planning a collaborative circumpolar study to determine current contaminant levels in bears, to compare to one it completed 10 years ago. This study will provide definitive information on trends in pollutants previously identified in the Arctic, as well as detection and quantification of new contaminants.

Aboriginal people resident throughout the Arctic are uniquely positioned to observe changes in the environment so integration of their traditional knowledge with western science to aid polar bear conservation was confirmed as a priority. For example, ongoing efforts to collect traditional knowledge of polar bear habitat use in Chukotka, Alaska, Canada, and Greenland are being encouraged and the results will be incorporated into future research and management.

Future challenges for conserving polar bears and their Arctic habitat will be greater than at any time in the past because of the rapid rate at which environmental change appears to be occurring. The complexity and global nature of the issues will require a great degree of international cooperation and development of diverse and new approaches to address these issues.

Polar bear management in Canada 1997–2000

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Since the Twelfth Working Meeting of the IUCN/SSC Polar Bear Specialist Group in 1997, several changes in the management of polar bears in Canada have occurred. The most significant of these was the division of the former Northwest Territories into two new jurisdictions on 1 April 1999. The western jurisdiction is still named the Northwest Territories whereas the eastern jurisdiction is named Nunavut. A summary of the regulations covering polar bear management in Canada, as of 31 December 2000, is presented in Table 2. Changes made prior to 1997 are outlined in the management reports included in the proceedings of previous working meetings of the IUCN/SSC 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, three territories (Northwest Territories, Nunavut and the Yukon Territory), and four provinces (Manitoba, Newfoundland and Labrador, Ontario and Québec), continued to meet annually to discuss research results and to make management recommendations. In recent years, representatives of the Inuvialuit Game Council (IGC), Nunavut Wildlife Management Board (NWMB), Makivik Corporation and the Labrador Inuit Association (LIA) have been invited to participate as members on both the PBTC and PBAC.

Status report on polar bear populations within and shared by Canada

The status of Canada's 14 polar bear populations (Fig. 2, Table 3) is determined by the number of individuals in the population, the rates of birth and death, and the rate at which animals are harvested. Population boundaries were initially proposed based on barriers to movements, reconnaissance surveys, traditional knowledge, and partly on management considerations (Taylor and Lee 1995). Past revisions to the initial boundaries have occurred following reviews of the movements of individuals determined from mark-recapture studies, mark-kill data, and VHF and satellite telemetry. The current boundaries were established by the PBTC in 1996 (Lunn *et al*. 1998).

Polar bear kills by jurisdiction

The quota of polar bears taken by each jurisdiction is based on recommendations by the Federal-Provincial Committees. Table 4 summarises the annual quotas and numbers of polar bears killed each season from 1996–97 through 1999–00 and the recommended quotas for 2000–01.

Table 2. Summary of regulations covering polar bear management in Canada as of 31 December 2000.

	JURISDICTION						
CATEGORY	**Manitoba**	**Newfoundland**	**Northwest Territories**	**Nunavut**	**Ontario**	**Québec**	**Yukon**
Hunting	Closed	Reviewed annually: hunting permitted Feb-Jun in portion of Labrador north of Cape Harrison	Season varies between Polar Bear Management Areas: longest 1 Oct–31 May; shortest 1 Jan– 31 May	Season varies between Polar Bear Management Areas: longest 1 Aug–31 May; shortest 1 Jan–31 May	Closed	No sport hunting	1 Oct–31 May in GMZ1 only
Who can hunt	A person who possesses a Ministerial permit	Licences distributed by Labrador Inuit Association	A person who possesses a tag. Tags are distributed by the HTCs	A person who possesses a tag. Tags are distributed by the HTOs	Permissible kill by Treaty Indians	Inuit and Indians	Inuit only who are issued polar bear tags
Quota	27 (19 on loan to Nunavut; 8 retained for the Polar Bear Alert Program)	6	By settlement: 2000-01 quota is 103 (97 + 6 administered on behalf of the Yukon)	By settlement: 2000–01 quota is 395	Permissible kill of 30 (by restricting sales over 30)	None	6 (all of which are administered by the NWT)
Females and cubs protected by law	Yes	Females accompanied by cubs-of-the-year may not be taken	Yes, cub defined by hide length	Yes	No	Yes	Yes
Bears in dens protected by law	Yes	Yes	Yes, also protects bears constructing dens	Yes, also includes bears constructing dens	No	Yes	Yes
Proof of origin of untanned bear	Documented proof	Documented proof (no seal on hide implemented to date)	Tag on hide and export permit	Tag on hide and export permit	Seal on hide, proof of origin required on imported hides	Seal on hide	Seal on hide, kill monitored by export permit
Export permit required and cost (out of province or territory of origin)	Required: no cost	Required No cost	Required: no cost. There is a $750.00 Trophy Fee for non-residents and non-resident aliens	Required: no cost. There is a $750.00 Trophy Fee for non-residents and non-resident aliens	Required: no cost	Required: no cost	Required: no cost
Export permit out of Canada	Required by CITES for all polar bears or parts thereof exported out of Canada; obtained in Province or Territory exporting from						
Scientific Licences	Discretion of Minister	Discretion of Minister	Discretion of Director, Wildlife and Fisheries	Discretion of Superintendent of Wildlife	Discretion of District Manager	Discretion of Minister	Discretion of Director, Field Services Branch

Table 2. Summary of regulations covering polar bear management in Canada as of 31 December 2000 (continued).

	JURISDICTION						
CATEGORY	**Manitoba**	**Newfoundland**	**Northwest Territories**	**Nunavut**	**Ontario**	**Québec**	**Yukon**
Selling of hide by hunter	Subject to conditions of Ministerial permit	Yes, must be taken legally	Yes, must have tag attached	Yes, must have tag attached	Must be sealed by Ministry staff	Must be sealed; fee 5% of average value of last 2 years	Permit required from Conservation Officer
Basis of Regulation	The Wildlife Act; reclassified as protected species in 1991	Wildlife Act, Chapter W-8 of The Revised Statutes of Newfoundland, 1990; classified as big game	Wildlife Act and Regulations; 1960 Order in Council (Endangered Species)	Wildlife Act and Regulations	Fish and Wildlife Conservation Act, 1997 (Statutes of Ontario, 1997 Chapter 41)	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	$25.00 general $25.00 travelling	Fur Dealer's Licence: no cost	$200.00 Fur Dealer's Licence for first year, $100.00 each year after	$200.00 Fur Dealer's Licence for first year, $100.00 each year after	$28.00 licence	$335.00 licence	$25.00 Resident $300.00 Non- resident $5.00 Agent $25.00 Non-resident restricted
Taxidermy	$30.00 licence	Yes, must be taken legally; legislation under review	$100.00 Taxidermist Licence for first year, $50 for each year after	$100.00 Taxidermist Licence for first year, $50 for each year after	See Tanner's Authority	See Tanner's Authority	$25.00 Resident Licence $30.00 Non-resident Licence
Tanner's Authority	$30.00 licence	No legislation at present	$100.00 Tanner's Licence for first year, $50.00 each year after	$100.00 Tanner's Licence for first year, $50.00 each year after	Fish and Wildlife Conservation Act, 1997 ($28.00 licence)	$256.00 Tanner's Licence	$2.00 Resident $10.00 Non-resident
Live Animal Capture	Ministerial permit	Ministerial permit required	$5.00 licence to capture live wildlife	$5.00 licence to capture live wildlife	District Manager	Ministerial permit	Free Wildlife Research Permit, $5.00 fee for capture of live wildlife
Live Animal Export	Ministerial permit	Ministerial permit required	Licence to Export Live Wildlife, $3000.00/polar bear	Licence to Export Live Wildlife, $3000.00/polar bear	District Manager	Ministerial permit	Special permit

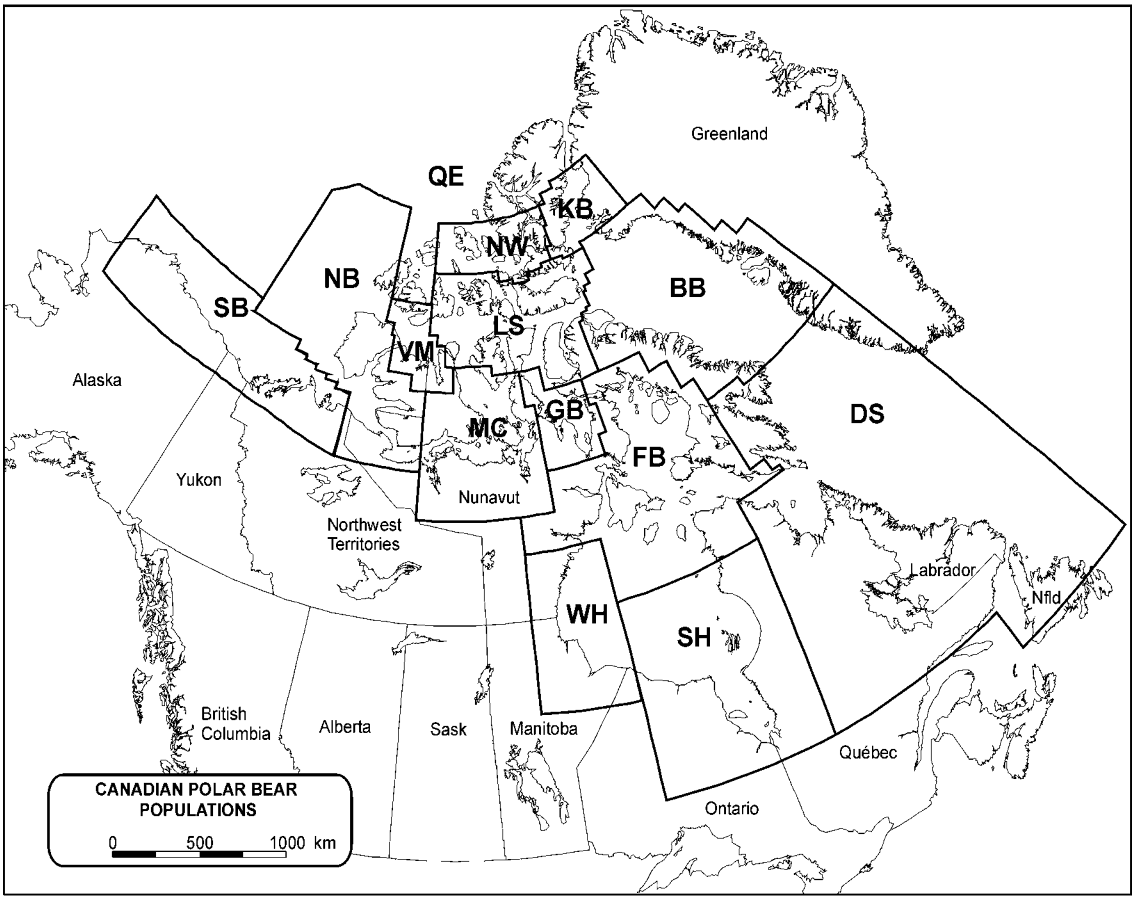

Fig. 2. Canadian polar bear populations as of 31 December 2000. BB: Baffin Bay; DS: Davis Strait; FB: Foxe Basin; GB: Gulf of Boothia; KB: Kane Basin; LS: Lancaster Sound; MC: M'Clintock Channel; NB: Northern Beaufort Sea; NW: Norwegian Bay; QE: Queen Elizabeth Islands; SB: Southern Beaufort Sea; SH: Southern Hudson Bay; VM: Viscount Melville Sound; WH: Western Hudson Bay.

Management changes and reports

Provincial and Territorial Jurisdictions

Manitoba

Polar Bear Quota

The current sustainable harvest of the Western Hudson Bay population is estimated to be 55 bears, which is divided between Nunavut (28) and Manitoba (27). To comply with the goals of the International Agreement on the Conservation of Polar Bears, Manitoba has legislated that the polar bear is a protected species. The Manitoba quota is to be used for polar bear control in and around the Churchill townsite. Based on the average number of bears removed annually, including all bears killed by Manitoba Conservation staff, sent to zoos, and accidental deaths while immobilized, Manitoba commits eight tags to the Polar Bear Alert Program. The balance of Manitoba's quota (19) is loaned to and administered by the Government of Nunavut on the understanding that all or part of the quota will be returned to Manitoba at their request.

In June 1999, a draft Memorandum of Understanding (MOU) was developed between the Governments of Canada (for Parks Canada), Manitoba, and Nunavut, in consultation with the NWMB, Keewatin Wildlife Federation, and local Hunters' and Trappers' Organizations (HTOs). The primary objective of this inter-jurisdictional MOU is to formalize the allocation of the quota at a government-to-government level. One of the issues currently being discusPsed, as part of the agreement, is the application of a restricted hunting zone for sport hunPters in Nunavut. The intent of this initiative is to avoid the presence of sport hunters in the 'Marine Area east of Manitoba' as described under the Nunavut Land Claim. Any mortalities occurring within Wapusk National Park, including defense kills and research related, would be included in the Manitoba quota. Further consultation is continuing in Nunavut communities. Once completed, the MOU will be brought forward for approval and implementation.

Table 3. Current status of Canadian polar bear populations incorporating harvest statistics from 1995–96 to 1999–00, including kills reported in Alaska and Greenland. The % female statistic excludes bears of unknown sex.

			5-year average (95–96 to 99–00)			3-year average (97–98 to 99–00)			Current year (99–00)			
Population	Estimate	Reliability[1]	Kill	% female	Sustainable harvest[2]	Kill	% female	Sustainable harvest	Kill	% female	Sustainable harvest	Status[3] (5yr/3yr/1yr)
BB[4]	2200	fair	138.8	35.6	92.6	146.7	36.7	90.0	135	39.3	84.1	(-/-/-)
DS[4]	1400	fair	66.8	37.6	55.8	73.3	39.8	52.7	81	41.3	50.9	(-/-/-)
FB	2300	good	89.8	35.7	96.6	84.3	36.5	94.4	95	36.8	93.6	(+/+/0)
GB[5]	900	poor	36.6	39.9	33.8	36.0	37.0	36.5	33	39.4	34.3	(-/0/0)
KB[4]	200	good	10.0	32.0	9.0	9.7	27.6	9.0	10	30.0	9.0	(-/-/-)
LS[5]	1700	good	76.2	24.5	76.6	75.0	24.4	76.6	75	25.3	76.6	(0/0/0)
MC[6]	240	good	24.4	26.2	10.8	22.7	26.5	10.8	22	27.3	10.8	(-/-/-)
NB	1200	good	31.8	32.7	54.1	34.3	35.0	51.5	43	25.6	54.1	(+/+/+)
NW[5]	100	fair	3.8	31.6	4.5	3.7	27.3	4.5	4	25.0	4.5	(+/+/+)
QE	200	none	0.0		0.0	0.0		0.0	0		0.0	
SB	1800	good	50.4	32.9	81.1	44.3	31.1	81.1	46	27.9	81.1	(+/+/+)
SH	1000	fair	45.4	36.2	41.4	45.0	37.9	39.6	46	43.5	34.5	(-/-/-)
VM	230	good							4	25.0	4.0	(/ /0)
WH	1200	good	49.2	34.7	51.9	51.7	33.8	53.3	53	35.8	50.2	(+/0/-)
Total	**14670**		**623.2**		**608.2**	**626.7**		**599.5**	**647**		**587.6**	

[1] Good: minimum capture bias, acceptable precision; fair: capture bias, precision uncertain; poor: considerable uncertainty, bias and/or few data; none: no information available

[2] Except for the VM population, sustainable harvest is based on the population estimate (N) for the area, estimated rates of birth and death, and the harvest sex ratio (Taylor *et al*. 1987):

$$\textit{Sustainable harvest} = \frac{(N \times 0.015)}{\textit{Proportion of harvest that was female}}$$

The proportion of the harvest that was female is the greater of the actual value or 0.33. Unpublished modeling indicates a sex ratio of two males to one female is sustainable, although the mean age and abundance of males will be reduced at maximum sustainable yield. Harvest data (Lee and Taylor, 1994) indicate that selection of males can be achieved

A 5-year voluntary moratorium on harvesting bears in VM ended with the 1998–99 season. The rate of sustained yield of this population is lower than other populations because of lower cub and yearling survival and lower recruitment. In 1999–2000, an allowable quota of four bears began, with the expectation that only males would be killed. However, a kill of one female per year is allowed

[3] Population status designation is conditional on the harvest continuing at the same level with the same sex ratio: + under harvest; - over harvest; 0 no change (kill within 5% of the sustainable harvest)

[4] Greenland harvest information for 1999–2000 is based on 1994–1998 average measured during full calendar years; data for 1999–2000 are incomplete

[5] Populations harvested with a flexible quota system (see Appendix 1 in Lunn *et al*. 1998)

[6] Harvests in MC from 1995–96 through 1999–2000 were within quota limits, but the population estimate was retroactively reduced from 700 to 240 after the 1999–2000 season, based on new information

Table 4. Quotas[1] and known numbers of polar bears killed[2] in Canada, 1996–97 through 1999–00.

	Man.[3]	Nfld.	NWT[3]	Nunavut[4]	Ont.[5]	Qué.[6]	Yukon[7]	Total
1996–97 Quota	8	4	525	–	30	62	6	635
Killed	7	5	467	–	2	47	1	529
Captured/zoos	2	0	0	–	0	0	0	2
1997–98 Quota	8	4	503	–	30	62	6	613
Killed	8	6	416	–	8	33	0	471
Captured/zoos	0	0	0	–	0	0	0	0
1998–99 Quota	8	6	93	404	30	62	6	609
Killed	1	5	61	376	3	36	0	482
Captured/zoos	0	0	0	0	0	0	0	0
1999–00 Quota	8	6	93	419	30	62	6	624
Killed	5	7	57	405	3	53	0	530
Captured/zoos	0	0	0	0	0	0	0	0
2000–01 Quota	8	6	97	395	30	62	6	604

[1] Management year extends from 1 July to 30 June the following year. Numbers may change as more information is received from the communities
[2] All known kills, including quota and sport-hunt kills, problem kills, illegal kills, and bears that die while being handled by scientists
[3] Through the end of the 1997/98 season, 19 of the Manitoba quota of 27 for the Western Hudson Bay population were administered by the NWT and all kills under this loaned quota included in the NWT total. Nunavut began reporting this loaned quota in their summaries in 1998/99
[4] On 1 April 1999, two independent jurisdictions were created from the former Northwest Territories: Nunavut and the Northwest Territories. Nunavut began reporting quotas and harvest statistics in 1998/99
[5] Permissible kill
[6] The total allowable kill in Québec is controlled through agreements with Natives; length of hunting season is adjusted and only certain sex- and age-categories can be taken
[7] Yukon quota is administered by the NWT but kills are included in the Yukon total

Polar Bear Alert Program

The annual Polar Bear Alert Program for the Churchill townsite and surrounding area continues each autumn. The objectives of this program are to (1) ensure the safety of people and the protection of property from damage by polar bears and (2) ensure that bears are not unnecessarily harassed or killed. Program highlights are summarised in Table 5.

Protection of Denning Habitat

With the establishment of Wapusk National Park in 1996 and the transfer of land from the provincial crown to the federal crown completed in March 1998, the majority of the maternity denning habitat in Manitoba is now protected by Parks Canada. Maternity denning habitat outside of Wapusk National Park remains under Manitoba jurisdiction and occurs in the Cape Tatnam and Cape Churchill Wildlife Management Areas. Both of these WMAs have management plans under development that will control access to maternity denning areas.

Newfoundland

No changes in the management of polar bears have occurred since the last meeting of the Specialist Group.

Northwest Territories

Polar Bear Quotas

With the division of the former NWT into two jurisdictions, the "new" NWT now harvests from three populations; Northern Beaufort Sea (NB), Southern Beaufort Sea (SB), and Viscount Melville Sound (VM). All three are shared, with either Alaska or Nunavut. All polar bear harvest in the NWT occurs within the Inuvialuit Settlement Region. Successful hunters are required to provide information about the hunt and submit proof of sex, the lower jaw or a premolar, and tags\tattoos when present to the Department of Resources, Wildlife, and Economic Development (DRWED). At the end of each quota year, DRWED produces posters that show the

Table 5. Manitoba Polar Bear Control Program 1997–2000.

	1997	1998	1999	2000
Occurrences[1]	159	170	197	147
Bears captured	103	105	87	59
Bears killed by Department personnel	2	0	1	0
Bears killed by public	3	1	2	2
Handling deaths	3	0	2	1
Natural deaths	3	0	0	1
Bears sent to zoos	0	0	0	0

[1] All bears reported to or observed by Manitoba Conservation staff in the Churchill control zone and peripheral area

distribution of the harvest, the total number and sex of bears taken annually by each community, and the total number and sex of bears taken annually from each population during the previous five years. These posters are sent to the local Hunters' and Trappers' Committees and presented to IGC and the Wildlife Management Advisory Council (WMAC (NWT)). A report, "Summary of Harvest Data for Species Under Quota in the Inuvialuit Settlement Region", is produced annually by DRWED for WMAC (NWT). The information in this document is reviewed by WMAC (NWT) to ensure that the annual polar bear harvest was sustainable. After consultations with IGC, WMAC (NWT) makes recommendations for any management changes, including quotas, to the Minister of DRWED.

Status of Management Agreements

In June 1999, a workshop was held in Inuvik to update the polar bear management agreements for the SB, NB, and VM populations. Representatives from the Hunters and Trappers Committees/Organizations/ Associations, WMAC (NWT), NWMB, DRWED, Nunavut Department of Sustainable Development (DSD), Canadian Wildlife Service, and Parks Canada attended the workshop. The objectives were to revise the text of the agreements, review and agree on quotas and boundaries, agree on the system for setting quotas, and draft new agreements.

After the workshop, new agreements for all three populations were drafted and distributed for comment. Another workshop is planned for 2001 to finalize the agreements.

Human-Polar Bear Conflicts and Bear Safety Program

The current management agreements require that all bears killed as a result of human activity be accounted for in the annual quota. The number of problem bear kills each year is small and has generally been by local residents (three kills between 1 July 1995 and 30 June 2000). However, with the increase in oil and gas exploration in the area, the DRWED is developing a bear safety awareness program to be delivered upon request.

A preliminary analysis of recorded problem bear kills between 1972 to 1999 showed that 82% of bears killed (where age was determined, n=44) were younger than five years old. The database records problem bears that were killed during encounters. Encounters that did not result in the death of a bear were not always reported or recorded. DRWED now enters all reported encounters into a database but more public education is required to ensure that everyone reports bear encounters to DRWED.

Nunavut

Status of Management Agreements

Memoranda of Understanding (MOU) between communities and the Government of Nunavut are in effect for all polar bear populations. These documents specify quotas and other aspects of harvest management. Except for those communities that harvest from the Davis Strait population, all others have signed MOUs that are based on a flexible quota system (see Appendix 1 in Lunn *et al*. 1998). The Davis Strait communities continue with a single-tag, either sex system because they regarded both the population estimate and harvest as conservative, and felt the sex ratio of the pooled harvest has not been a problem. Therefore, they did not feel that a flexible quota system was currently needed.

Human-Polar Bear Conflicts

Polar bears continue to cause difficulties for some communities by destroying food caches and outpost camps. Because the MOUs require that all bears killed by human activity be included in the annual quota, these encounters have subsequently affected some community quotas and decreased the opportunity for a regular harvest. The need for a Nunavut bear safety program has been recognized; program options are being considered.

Ontario

On 1 January 1999, Ontario's new Fish and Wildlife Conservation Act (FWCA) [Statutes of Ontario, 1997 Chapter 41] replaced the Game and Fish Act. Under the FWCA, polar bears are prescribed as furbearing mammals by regulation (Ont. Reg. 669/98). There is no open season for polar bears, however, authorization is given to some native trappers, in possession of a valid trapping license, to harvest limited numbers of polar bears. No person may sell the pelt of any furbearing mammal killed during the closed season unless the person has a license to sell a pelt of any furbearing mammal killed during the closed season. In the case of polar bear, a native trapper in possession of a polar bear must be the holder of a seal authorizing the sale. This seal is obtainable from the Ontario Ministry of Natural Resources (OMNR). As the season is always closed, a native trapper requires authorization from OMNR to sell any polar bear pelt.

Under the FWCA, hides of other fur-bearers are no longer required to be sealed, although mandatory season and harvest reports are required for all harvested furbearers. Any person buying or selling a furbearing mammal must be licenced, must record the transaction and must report acquisition and disposition of all furbearing mammals. The Nishnawbe-Aski Nation (NAN) and Grand Council Treaty #3 are authorized to issue and sell their own trapping licences. NAN and Grand Council Treaty #3's policy follows OMNR's in that trappers who are issued NAN or Grand Council Treaty #3 trapping licenses must submit mandatory season and harvest reports. The native organizations will then pass on this information to OMNR for collation. Tracking of the harvest of polar bears may be improved under the new mandatory reporting requirement.

In January 1999, the Committee on the Status of Species at Risk in Ontario (COSSARO) listed the polar bear as 'Vulnerable'.

Québec

In accordance with the law on hunting and fishing rights in the James Bay and Northern Québec Agreement, the polar bear harvest is restricted to native people to protect their traditional rights as recognized by the Governments of Québec and Canada. The law makes provision for guaranteed harvest levels that can be taken as long as the principle of conservation is respected. Guaranteed harvest levels were established based on observed polar bear harvest between 1976–1980 and have been agreed to by both Inuit and Cree. The current harvest levels appear to be sustainable and, thus, agree with the principle of conservation.

Following discussions on the 'Polar Bear Tactical Plan' with native organizations, it was agreed that the Provincial Government would not impose additional hunting regulations to those already accepted by native organizations after the negotiation of an agreement on implementing a hunting season (September–May), on the protection of females with cubs, and on the prohibition of the hunting of polar bears in their summer refuge.

A good harvest-monitoring program is in place and the harvest statistics for all the Québec communities over the past seven years have been recently summarized.

Yukon Territory

No changes in the management of polar bears have occurred since the last meeting of the Specialist Group. The quota of six continues to be administered by the NWT.

Management Boards and User Groups

Inuvialuit Game Council

In March 2000, an updated "Inuvialuit-Inupiat Polar Bear Management Agreement in the Southern Beaufort Sea" was signed in Inuvik, NWT, replacing the first agreement signed in January 1988. Two committees were set up under the agreements to ensure annual review of harvest data, research results, and management recommendations: (1) the Joint Commissioners, consisting of two representatives designated by each of the IGC and North Slope Borough Fish and Game Management Committee, and (2) a Technical Advisory Committee, appointed by the Joint Commission. Each year, the Technical Committee has been responsible for providing an annual report, on behalf of the Inupiat and Inuvialuit, to account for the way in which the quota was taken and other matters of concern or interest.

At the Inuvialuit-Inupiat meeting in April 1997, it was agreed that the total quota for the Southern Beaufort Sea population could be raised from 77 to 80 and divided equally between Alaska and Canada. The decision was based on the calculation of a sustainable harvest of 81 for a population of 1800 bears, providing the harvest of females does not exceed one-third of the quota. In July 1997, it was agreed to allocate the 40th Inuvialuit tag to Inuvik. Significant changes to the new agreement were this quota increase, an increase of the season length in Canada, and a commitment to review the agreement at least every 10 years. The agreement continues to protect females with cubs or yearlings and bears in or constructing dens.

Although the Polar Bear Management Agreement for the Southern Beaufort Sea (NWT) has not been amended, the WMAC (NWT) has advised that it wishes to continue using the Polar Bear Management Agreements as a vehicle for polar bear management. Amendments to the NWT SB, NB, and VM polar bear management agreements are underway (see NWT Status of Management Agreement section).

Nunavik (northern Québec)

Under the James Bay and northern Québec Agreement (JBNQA) of 1975, the taking of polar bears is restricted to aboriginals, to protect the traditional subsistence harvesting rights of northern Québec natives. In law, provisions have been made to ensure the Inuit of Nunavik have exclusive access to an agreed minimum level of harvest (Guaranteed Harvest Level – GHL) subject to the principles of conservation. Set at 62 polar bears per year for the entire region, this level of harvest is based on the recorded subsistence take between 1976–80. While the GHL is not linked to a specific management zone, the greatest numbers of bears are killed in Management Zone SH on the Hudson Bay coast. Although the Government of Québec retains the right to institute conservation measures, this has not been considered necessary to date.

Nunavik harvests polar bears from the Davis Strait, Foxe Basin, and Southern Hudson Bay populations. The Société de la Faune et des Parcs du Québec (Government of Québec) is responsible for the monitoring and collecting of harvest data and requires that native hunters planning to sell polar bear hides obtain a tag from them. Although some hides are retained for personal use, this is rare because most bears are hunted for meat and the cash gained from the sale of the hide. Therefore, the number of tags requested is considered a good estimate of harvest numbers. Hunters are also requested to provide data on the location, date, sex, and age class of kills, and to collect the head, for which they are reimbursed. A tooth is sent to the Nunavut Department of Sustainable Development for age determination.

Management resolutions protecting females with cubs and bears in dens were passed in 1984 by the native hunters' organization, Anguvigak. These resolutions were subsequently ratified by the Nunavik Hunting Fishing and Trapping Association (HFTA), which replaced Anguvigak, and reaffirmed in 1997. Although resolutions passed by the HFTA on management issues are not legally binding, hunters are expected to abide by them through general consensus.

The Inuit of Nunavik continue to express a willingness to consider establishing harvest quotas for polar bears in northern Québec, similar to what has been suggested by the PBTC and previous inter-jurisdictional co-management agreements. They also support population studies to ensure that the eventual harvest quota is established within sustainable limits.

Nunavut Wildlife Management Board

The Nunavut Wildlife Management Board (NWMB) is a co-management board established under the Nunavut Land Claim Agreement. The NWMB is a co-management board and an Institution of Public Government, with members appointed by both Inuit organizations and Government. The NWMB is the main instrument of wildlife management, including polar bears, within the Nunavut Settlement Area (NSA) and has the responsibility for setting quotas and non-quota limitations (e.g., hunting seasons, methods of harvest), approving management plans, and approving designation of endangered species. Ultimate approval of NWMB decisions relating to polar bears rests with the Nunavut Minister of Sustainable Development. However, the Minister may only reject or modify an NWMB decision on the basis that the decision (1) interfered with Inuit harvesting rights, (2) creates a concern with respect to species conservation, or (3) results in a public health or safety concern.

Agencies and Committees

Parks Canada

Parks Canada was established as an agency of the federal government (from the Department of Canadian Heritage) by the *Parks Canada Agency Act* (1998) on 1 April 1999. The Agency is responsible for the management of Canada's system of protected heritage areas, including national park and national historic sites. Parks Canada's mandate to maintain or restore the ecological integrity of the parks is based on the existing policy document, *Parks Canada Guiding Principles and Operational Procedures* (1993), and was strengthened in the *Canada National Parks Act (2000)*. There are currently six existing and three proposed National Parks that contain polar bears: Ivvavik in the Yukon; Aulavik in the NWT; Auyuittuq, Quttinirpaaq and Sirmilik (established in 2000) in Nunavut; and, Wapusk in Manitoba. Negotiations are underway to establish new national parks around Wager Bay and on North Bathurst Island in Nunavut. A feasibility study for the proposed national park in the Torngat Mountains in Labrador has been completed and accepted by the federal government, the government of Newfoundland and Labrador and the Labrador Inuit Association.

Polar bear management plans have been prepared for both Auyuittuq and Quttinirpaaq National Parks; both are currently awaiting approval. There are no major management initiatives for polar bears in Aulavik, Auyuittuq, Ivvavik, Quttinirpaaq or Sirmilik National Parks. Wapusk National Park is currently finalizing the first park management plan and in 1998 commissioned a contract report assessing the risk of polar bears to different categories of park visitors.

Parks Canada's interest in conservation of polar bears and their habitat comes from the mandate of ecological integrity, but the agency also has a duty to visitors to reasonably minimize the exposure to risk from polar bears. Since most visitors to national parks in the Arctic are experienced and self-sufficient, this is generally met by providing them with information on polar bears and ways to minimize potential conflicts. All visitors to these parks are required to register with park staff. In most of the arctic National Parks, the probability of interactions between polar bears and people is very low because of generally low bear density in those areas, and most use by visitors is at times of the year when polar bears are absent. On 5 September 2000, a hiker in Auyuittuq National Park was slightly injured by a polar bear biting through his tent. To date, this is the only injury by a polar bear in a national park and no polar bears have been killed in defense of life or property. However, polar bear and visitor use overlap in Wapusk and Sirmilik National Parks, which may necessitate appropriate management measures in order to avoid conflicts there. The issue of the possession of a firearm by a visitor, for personal protection, remains unresolved. A new set of regulations to accompany the *National Parks Act* is being drafted, and will address who may carry a firearm and under what circumstances. A regulatory impact assessment of these regulations is required, and this process should ensure that these decisions reflect adequate stakeholder input.

Polar bear viewing by helicopter or large-tired tundra vehicles is popular in and around Wapusk National Park. While most of this activity is concentrated at Cape Churchill, access to the maternity denning area is an emerging issue. Currently, one guiding company is permitted by the *Federal-Provincial Agreement for Wapusk National Park* (1996) to operate in this area. This company uses tracked vehicles and snowmachines to bring tourists and photographers into the denning area to view family groups emerging from their dens and returning to the sea ice. Although this activity is not regulated or monitored, the subjective impressions of park staff, pilots and biologists are that the number of parties and the distance travelled into the denning area have increased since 1997. The effects of this on the behaviour, condition or survival of bears is not known.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC)

COSEWIC assigns national status to species at risk in Canada. It is a committee of representatives from federal, provincial, territorial, and private agencies, as well as independent experts. COSEWIC designated the polar bear as "Not At Risk" in 1986, which was upgraded to "Vulnerable" in 1991. No change in status was recommended in an updated status report for polar bears submitted to the COSEWIC Mammal Subcommittee in summer 1998 (Stirling and Taylor 1999). In April 1999, COSEWIC again listed the polar bear as "Vulnerable".

Species designations were recently changed, with the former category "Vulnerable" being replaced by the category "Special Concern". Consequently, COSEWIC currently lists the polar bear as a species of "Special Concern".

Federal Government

CITES

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 to avoid utilisation incompatible with their survival').

Since July 1975, a permanent record of all polar bears, hides, or any other products legally exported from or imported to Canada has been maintained by the Federal Government through the issue of permits. Data for 1975–1995 were included in the management reports prepared for the previous four IUCN Working Meetings. The 1996–1998 data are summarised in Table 6.

Canada Endangered Species Protection Act (CESPA)

At the last meeting of the IUCN Polar Bear Specialist Group it was reported that the Minister of the Environment had recently introduced (31 October 1996) the *Canada Endangered Species Protection Act, Bill C-65* in the House of Commons of Canada. The Act was to be the federal cornerstone of a National Accord between the federal, provincial and territorial governments, and was intended to prevent Canadian wildlife species from becoming extirpated or extinct and to provide for the recovery of those that are extirpated, endangered or threatened as a result of human activity.

Table 6. Number of permits issued and number of live polar bears and polar bear parts legally exported from Canada, 1 January 1996 to 31 December 1998 (Canadian Wildlife Service CITES unpublished data)[1].

	1996		1997		1998		Total	
	Permits	Parts	Permits	Parts	Permits	Parts	Permits	Parts
Live polar bears[2]	1	2	1	2	2	2	4	6
Polar bear hides[3]	139	339	254	467	189	323	582	1129
Skulls/jaws/teeth	10	13	106	111	67	71	183	195
Claws	0	0	1	4	1	1	2	5
Bones	3	3	9	10	8	8	20	21
Biological specimens	8	631	5	845	0	0	13	1476

[1] Data for 1999 and 2000 not available
[2] Sent to zoos
[3] Includes some hides as head mounts and some as whole mounts

CESPA never became law because *Bill C-65* died on the Order Paper upon the dissolution of the 35th Parliament in April 1997.

Species at Risk Act (SARA)

On 11 April 2000, the *Species at Risk Act, Bill C-33* was introduced and given First Reading in the House of Commons but died on the Order Paper upon dissolution of the 36th Parliament in October 2000. This bill was to be the first federal piece of legislation dealing with the listing, protection and recovery of endangered species and other species at risk within federal jurisdiction.

SARA was one part of a three-pronged federal strategy to protect species at risk, the other two components being stewardship and incentive programs, and the federal/provincial/territorial *Accord for the Protection of Species at Risk*. The bill would create a legislative base for the scientific body that assesses the status of species at risk in Canada. It would prohibit the killing of extirpated, endangered or threatened species and the destruction of their residences, and it would provide authority to prohibit the destruction of the critical habitat of a listed wildlife species anywhere in Canada. The listing of a species at risk would lead to automatic recovery planning and action plans. The bill would provide emergency authority to protect species in imminent danger, including emergency authority to prohibit the destruction of the critical habitat of such species. Funding and incentives for stewardship and conservation action would be available, and the bill would enable the payment of compensation where it was determined to be necessary. SARA was similar in many respects to its predecessor, *Bill C-65* (CESPA), but with a number of significant differences. The bills varied in their scope and in their approach to the exercise of federal jurisdiction in the area of species protection.

The re-elected government re-introduced the *Species at Risk Act, Bill C-5* on 2 February 2001. Proclamation is expected by the end of 2001.

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Research on polar bears in Canada 1997–2000

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Most polar bear research in Canada is conducted by federal, territorial, and provincial governments. Primarily because of the cost involved, but also because of the management responsibilities of the various governments, co-operative research is often undertaken where the project is of interest to several jurisdictions. In addition, international co-operation for specific projects or shared populations is also undertaken with scientists in Alaska, Denmark, Greenland, and Norway. Some research projects conducted by university researchers are co-ordinated with government researchers through bilateral agreements and through the Federal-Provincial Polar Bear Technical Committee (PBTC). Other projects are supported with funds from wildlife management boards established by the land claims process, by independent foundations, and through grants to students co-supervised by government and university researchers. This report summarizes the research conducted in Canada between 1997 and 2000, organized by jurisdiction or agency, and lists publications and reports completed or in press.

Canadian Department of Environment – Canadian Wildlife Service

Priorities for research in the Federal Department of Environment are aimed at increased understanding and conservation of ecosystems. This is due, in part, to Canadian commitments under the Biodiversity Convention and Canada's broad commitment to the protection of polar bear habitat under the international Agreement on the Conservation of Polar Bears. To this end, the Canadian Wildlife Service (CWS) Marine Science project takes an ecosystem approach to their research of polar bears.

Long-term ecological studies of polar bears in Western Hudson Bay

From 1981 through 1998, the condition of adult male and female polar bears has declined significantly in western Hudson Bay, as have natality and the proportion of independent yearling cubs caught during the open water period. Over this same period, the breakup of the sea ice on western Hudson Bay has been occurring earlier. There was a significant positive relationship between the time of breakup and the condition of adult females (i.e., the earlier the breakup, the poorer the condition of the bears). The ultimate factor responsible for the earlier breakup in western Hudson Bay appears to be a long-term warming trend in atmospheric temperatures from April through June between 1950 and 1990. In southeastern Hudson Bay, there has been a cooling trend over the same 40-year period when temperatures have been warming in western Hudson Bay. As a result, the ice breaks up later than it does in western Hudson Bay and the bears are significantly heavier in SH than they are along the Manitoba coast (unpublished data collected in 1997 and 1998 from Obbard and Taylor).

Continuing to monitor the long-term trends discussed above is a high priority for CWS because climatic warming is predicted to continue in northern areas with a potential significant impact on polar bears and other components of the marine ecosystem. The long-term study in western Hudson Bay is the only one in the Arctic from which the effects on polar bears of ecological variation in general and climatic warming in particular may be assessed. Bears are sampled in the spring and autumn to take standard morphometric measurements and to assess body condition. Conventional radio collars are put out on adult females to aid in the determination of cub survival and to facilitate the collection of longitudinal data on individual reproductive histories. Satellite collars have been used to determine winter and spring movements on the sea ice, determine habitat use by females on shore during the summer, and to examine maternity den selection. In addition, other specimens (e.g., blood and tissue) have been collected for collaborative projects.

Ringed seal research in Western Hudson Bay

Over the past 20–25 years, a decline in the reproductive rate and cub survival of polar bears in western Hudson Bay has been documented. Because polar bears are dependent upon ringed seals for food, one hypothesis was that these declines might reflect changes in the abundance of seals. From 1994–1997, 1999, and 2000, medium-altitude, strip-transect surveys were flown over western Hudson Bay during the peak of the annual moult (late May to early June) to estimate the distribution and abundance of seals and to document the degree of annual variation in ringed seal abundance.

Multiple regression analysis of the 1995–1997 data showed that ringed seals preferred high ice cover habitat ($p<0.001$) and had a greater tendency to haul out on clearer days ($p<0.001$). Significant annual variation in density occurred ($p<0.001$), with estimates of 2.06, 1.34 and 1.25 seals/km^2 of sea ice being recorded in 1995, 1996, and 1997 respectively. Post hoc pair-wise comparisons showed significantly higher densities in 1995 than in 1996 ($p<0.01$) or 1997 ($p<0.001$) but no statistical difference between 1996 and 1997 ($p>0.05$). Although reasons for these differences are unknown, the magnitude of the variation in density underscores the importance of continuing these surveys, especially if a more reliable interpretation of future changes in the marine ecosystem of Hudson Bay is desired.

A study of food habits, age composition, and reproductive rates of ringed seals was initiated to determine if the seals are being affected by long-term ecological or climatic fluctuations. Hunters from the village of Arviat, Nunavut, collected lower jaws, stomachs, and reproductive tracts from ringed seals in autumn 1998, 1999 and 2000. Analyses of these specimens are ongoing.

Prey species of polar bears (with Dalhousie University)

In most parts of their range, polar bears prey predominantly on ringed seals. However, in some areas, they also prey to variable degrees on other species of seals, walruses, belugas, and narwhals. It is not well understood how important alternate prey species are in different parts of polar bear range but this is important to know because it affects the size of polar bear populations. Furthermore, the numbers, distribution, and availability of alternate prey species may change significantly if the climate continues to warm as predicted. To date, understanding of the foraging ecology of polar bears has come from collecting specimens from seals killed by bears and from direct observations at Radstock Bay on Devon Island. CWS have been working with Dr Sara Iverson at Dalhousie University for several years to apply her techniques of analyzing quantitative fatty acid (FA) signatures to polar bear fat to obtain different insights into their feeding ecology. Preliminary results were presented at the 1999 Marine Mammal Conference in Maui; the abstract follows:

"We analyzed 276 blubber and 22 milk samples from 259 bears in the Beaufort Sea, Labrador Sea (Lab), and Western Hudson Bay (WH) in early spring and late summer 1994–1996 and 210 blubber specimens from ringed, bearded, harp and hooded seals. FA patterns in bears revealed distinct differences by location, sex, season, and year. Seal species were 100% correctly classified by their FA signature, although geographic variation was apparent. We used a mathematical model under development to quantitatively predict proportions of seal species eaten. In WH, polar bears were estimated to have fed primarily on ringed and bearded seals (averaging 96% of diet), while those in Lab. (spring) fed primarily on harp and hooded seals (69%), followed by bearded seals (30%). In WH, diets up to early spring contained more bearded seals. But by late summer substantially more ringed seals were evident in diets, consistent with increased availability of weaned pups in late spring to early summer. Adult males had higher bearded and lower ringed seal proportions in their diets than females. In repeat-sampled bears, diets of an individual in the same season of consecutive years were nearly identical (suggesting specialization), while diets in the spring and autumn of the same year differed (consistent with changing prey availability). In twin yearlings or cubs associated with their mother (seven sets), the diets of the two offspring were always the same, consistent with feeding together on both milk and prey. Finally, terrestrial plant FAs were apparent in several late summer milks collected from females exhibiting berry stains on teeth."

Maternity den selection by polar bears in Western Hudson Bay

In September 1996, a four-year project was initiated to increase understanding of the selection and use of earth dens, because of their importance to the conservation of polar bears in western Hudson Bay. Satellite radio collars were used to track pregnant females while selecting denning habitat during late summer and autumn, and to determine whether they remained throughout the winter in the same dens they used in the summer. To minimize the effect of handling on subsequent den selection by pregnant females, collars were deployed on adult females accompanied by yearlings before they returned to the sea ice in the autumn, weaned their cubs and mated the following spring, then were pregnant when they came ashore the following autumn. Therefore, one year would have passed between handling of a bear and its selection of a den site, and handling by researchers should not influence the behaviour of the bears. All other researchers working in the area were provided with the locations of these females, once ashore, and were requested not to disturb the bears.

An additional benefit of not disturbing these animals was that information could be obtained on whether or not handling pregnant females in the summer or autumn immediately prior to parturition had a detectable influence on den selection. A total of 19 satellite collars were deployed in the autumns of 1996 and 1997. The tracking data indicated that pregnant females moved inland and selected an area to den shortly after coming ashore in the summer and, if not disturbed, did not move later in the autumn. For pregnant females that moved after being disturbed in the autumn, the size of the subsequent litter was not significantly different from the litter size of females that were not disturbed. The disturbance caused by handling occurred in August and September, several months prior to parturition. It is not known whether disturbance of pregnant females in late October or early November, closer to the time when cubs are born, might have detrimental effects.

Because much of the study area is now part of Wapusk National Park, and the remainder lies within provincial Wildlife Management Areas, results of this research will be important to park planning activities to ensure adequate protection of denning polar bears and the continued stability of this population. These results probably also have relevance to the behaviour of denning polar bears elsewhere in their range.

Effects of toxic chemicals on the immune system of polar bears

(with Norwegian Polar Institute, Norwegian School of Veterinary Medicine, CWS Ottawa, University of British Columbia, Carleton University)

Persistent toxic chemicals, such as PCBs and DDTs, tend to accumulate in fat. Because polar bears are at the top of the Arctic food chain and have a diet high in fat, they are considered to be at high risk from the potential effects of persistent toxic chemicals. In addition to the direct effects of the original chemicals, some of the metabolites produced during the breakdown of the chemicals may also accumulate in seals and polar bears, further contributing to potential toxic effects.

A recent Norwegian study suggested that polar bears from the European Arctic, which are more contaminated than bears in Canada, might have suppressed immune systems, possibly due to the effects of PCBs. As part of a larger-scale collaborative project, to determine whether PCBs do affect the polar bear immune system, CWS repeated the Norwegian study at Churchill, an area where exposure to PCBs is lower. A more detailed summary of the research can be found in the Norwegian research report to the IUCN Polar Bear Specialist Group.

Research on bears and seals in the High Arctic North Water Polynya

Although the North Water polynya has long been assumed to be important to large numbers of marine mammals for feeding, migration, and over-wintering, the relative significance of different factors to each species or taxonomic group is not clear. As part of a multi-national, multi-disciplinary research expedition in the area of the North Water polynya, CWS had an opportunity to collect data on the pelagic distribution of seals for one month in autumn 1997, March through July 1998, and for 2 months in autumn 1999, working from a Canadian Coast Guard icebreaker.

While the icebreaker was in transit, continuous observations of marine mammals were made from the bridge whenever there was sufficient light. All seals sighted were identified to species, and distance and direction from the ship were recorded. All observations of whales and bears were also recorded. Specimens of plankton, seabirds, and fish were collected whenever the ship was not in transit. These observations were correlated with oceanographic data collected by other investigators.

During all shipboard surveys during the months of April through September, all years combined, 735 ringed seals were seen. Most (70%) were seen on the ice during the moult in June. Preliminary analyses showed that there were no significant differences in ringed seal densities between the east and west sides of the polynya, although densities tended to be slightly greater on the east side. This suggested that although differences in productivity may exist between the two sides of the polynya, they are not reflected in the distribution or density of ringed seals in the pack ice of the North Water.

Behaviour of polar bears and interrelationships with seals

The purpose of this long-term study, conducted at various times since 1973, is to document the behaviour of undisturbed polar bears. Specific activities are recorded: hunting success of bears of different age and sex classes, participation of cubs in hunting activities, proportion of time bears spend in each activity, and use of habitats by bears of different age and sex classes.

Undisturbed polar bears were observed from a clifftop camp at Cape Liddon, at the mouth of Radstock Bay, Devon Island in spring and summer 1997 and in spring 1999. In 1997, a total of 921 hours of detailed observations were recorded on bears in the spring and 961 hours during the summer. Bears of all age- and sex-classes were seen, but the most numerous were adult females with yearling cubs.

Thirteen seals were killed during the summer observations, for an average of one seal killed each 3.1 bear-days. Only one seal kill was seen in the spring. Most of the kills were made after the bear waited quietly at a breathing hole or beside a haul-out lair under drifted snow in the rough ice. One kill was observed after an aquatic stalk (swimming in the water) along a lead and one kill was made after a bear slowly stalked a seal basking on the ice.

Counts were kept of the number of seals hauled out every day between 15.00 and 16.00 – the time of day when the greatest numbers of seals were hauled out. The number of seals observed on a single day ranged from 2 to 111. The number seen each day increased from the spring through the early summer, reaching a maximum in the first week of July, then decreasing as the ice became covered with surface water and the seals had finished their moult.

In 1999, a total of about 250 hours of detailed observations on bears were recorded, but in general, fewer bears were seen than expected in the spring. Part of the reason was probably that the ice edge was much further east in Lancaster Sound than usual at that time of year, so the bears were more spread out. Again, because the bears were not individually marked, some bears were probably seen several times. Bears of all age- and sex-classes were seen, but the most numerous were adult females with yearling cubs. Only one large adult male was seen – a frequency that was unusual compared to past years, when they were much more abundant.

Canadian National Parks

A report "*Conserving Ecological Integrity in Canada's National Parks*" by the Panel on the Ecological Integrity of Canada's National Parks to the Minister of Canadian Heritage was released in 1999. The Panel notes, "Our national parks are under threat, from stresses originating both inside and outside the parks." It recommends that the Parks Canada Agency needs to do more and better science. The Minister has committed to addressing the issues identified in the Panel's report.

Thus, although Parks Canada employees have not themselves conducted studies on polar bears during 1997–2000, they have supported studies by several agencies, including CWS and University of Saskatchewan. One of the primary objectives for Parks Canada in Wapusk National Park, Manitoba is to support long-term research and monitoring activities on the Western Hudson Bay polar bear population.

Wapusk staff and Manitoba Department of Conservation personnel conducted a preliminary test of the resistance of commercial bear-proof food containers in November 1999. Preventing polar bears from gaining access to human food and garbage is fundamental to minimizing the risk of conflicts between bears and people. Seal fat was put inside two ABS plastic containers built by Garcia Machine, Inc. for use by hikers. The containers were closed and each placed in a different cell with polar bears in the polar bear holding facility at Churchill. Three different bears had access to containers for a total of seven nights. The bears showed little interest in the containers: they smelled them when they were initially introduced to them, but were never observed to try to actively break in. Neither container showed evidence of break-in attempts at the end of the tests. The outside of one container was smeared with seal fat to increase its attractiveness, but the bear simply licked the fat off. This provides no conclusive answer to how resistant these containers are to polar bears, but the relative lack of interest shown by bears to containers with highly odorous, preferred food inside suggests that they may provide some security simply by not appearing edible. Whether or not a motivated or curious bear might be able to obtain food from one is unclear. One container that was run over with a truck shattered easily at -26°C. The probability of the containers breaking would be lower in a typical summer field situation when hikers or paddlers would be using them.

Manitoba

The Manitoba Department of Conservation has not flown denning surveys since 1990. They continue to support and assist researchers on approved studies in the western Hudson Bay area.

Churchill Polar Bear Alert Program

Although mostly a management program, the Churchill Polar Bear Alert (PBA) Program is an important source of data on polar bears near Churchill, Manitoba. Each year in the autumn, bears that approach too closely to the town area are held until the ice forms, or are airlifted away from the townsite. Every bear is marked and measured as part of the overall mark and recapture program in western Hudson Bay, and the data are logged with the National Polar Bear Database. In the past 12 years, most handled bears have been sub-adults, with more male than female bears in both adult and sub-adult age classes.

One of the best measures of the success of the PBA program is the reduction in problem bear kills. During the 10-year period from 1970 to 1979, there was an average of 17.2 bears killed per year (109 by the public and 63 by the department). In contrast, the 10 years from 1990 to 1999 had an average of 4.4 bears killed per year (18 defense kills and 26 bears killed by the department). This reduction in bear deaths occurred even though numbers of bears handled under the PBA program during 5 of those years were the highest recorded (range = 79 to 113), and seven years had higher than average numbers of bear occurrences in the control zone around Churchill. It appears that the combination of public education in bear awareness and prevention of food conditioning of polar bears are the main factors contributing to fewer problem bears.

Northwest Territories

(formerly the western Northwest Territories)

Beaufort Sea Boundary Delineation

(Northwest Territories (NWT) Department of Resources, Wildlife, and Economic Development (DRWED) with Wildlife Management Advisory Committee (WMAC)(NWT), CWS, and the US Geological Service (USGS) Biological Resources Division)

The polar bears of the Beaufort Sea were originally thought to constitute a single population. Mark-recapture studies by CWS in the 1980s and movement studies by the US Fish and Wildlife Service using VHF radios showed that there were two populations – one shared with Alaska along the mainland coast from about the Cape Bathurst Polynya west (the Southern Beaufort population), and one off the western and southern shores of Victoria and Banks islands (the Northern Beaufort population). The Joint Commission of the Inuvialuit-Inupiat Management Agreement for Polar Bears of the Southern Beaufort Sea have asked to have the border between the Northern and Southern Beaufort polar bear populations more accurately defined than was possible from previous mark-recapture data.

This is a two-year collaborative study between WMAC(NWT), DRWED, CWS, and the USGS Biological Resources Division. Twenty satellite radio collars were deployed on female polar bears in early April 2000. The results of this study will be used in designing subsequent mark-recapture studies to determine the sizes of the two Beaufort Sea polar bear populations.

Nunavut

(formerly the eastern Northwest Territories)

Population inventory of Baffin Bay, Lancaster Sound, Norwegian Bay, and Kane Basin

(Department of Sustainable Development (DSD) with Greenland Home Rule, Parks Canada, University of Saskatchewan)

Baffin Bay (BB) and Kane Basin (KB) include Greenland waters. This research was co-operative, with the Nunavut Department of Sustainable Development, Nunavut Wildlife Management Board, Greenland, Parks Canada, the University of Saskatchewan, and local Hunters' and Trappers' Organizations (HTOs) all participating. The first phase of this project was to delineate population boundaries using satellite telemetry (1990–1995). The second phase was to estimate population numbers using mark-recapture methods (1990–1997). The field portion of both phases was completed in 1997.

Radio collars were deployed over the Lancaster Sound (LS), Norwegian Bay (NW), KB, and BB areas as approximately uniform coverage. Radio collars were also deployed in the neighbouring Viscount Melville Sound (VM), Davis Strait (DS), Gulf of Boothia (GB) and M'Clintock Channel (MC) populations. The radio collars demonstrated that all Baffin Bay polar bears spent the open-water season on Baffin and Bylot islands, but were widely distributed in the active pack ice of Baffin Bay in the spring, where they were unavailable for capture. Therefore, the mark-recapture sample was collected in autumn for the onshore BB population and in spring for the LS, NW, and KB populations.

The population estimate for Lancaster Sound from the initial 1978–1979 study was 1031. That estimate had been increased to 2000 based on extrapolations to areas that had not been surveyed. A preliminary estimate of 1700 was calculated based on the data collected from 1993–1995. Males were pooled with females and the adult natural (no harvest mortality) survival rate for pooled adults was 0.96. However, the 1995 capture sample was the first year of the mark-recapture program, and most of the recaptures were from the earlier study. Relatively few recaptures were obtained, and the estimate of 1700 was tentative.

The Norwegian Bay population was estimated as 100 based on limited data collected up to 1995. The previous estimate of 200 was based on two years of sampling north of Bathurst Island only, and may have been biased if animals marked in the first year shifted their distribution. The low number of polar bears in this area makes it difficult to capture enough individuals to get a precise estimate.

There was no previous estimate of population numbers for the Kane Basin population. The estimate of 200 was based on few data collected in 1995. Although the 1995 estimate was suspect, it was clear from the capture work that Kane Basin did not contain a large population.

The population estimate for Baffin Bay from the initial 1979–1985 study was 300–600. A preliminary estimate of 2400 was calculated based on the data collected from 1993 to 1995. However, the survival estimates from the Jolly Seber model B were impossibly low, suggesting strong capture heterogeneity effects. The increased population estimate was tempered with new information that Greenland was also harvesting from this population. Although the population estimate was increased, the inclusion of the Greenland kill increased the estimated total kill to a level slightly higher than the maximum sustained yield. In addition, the offshore pack ice raised questions about the accuracy of the final estimates of survival and population number. There was extensive pack ice in autumn 1996, and no capture work was done. There was pack ice around Bylot Island and northern Baffin Island in 1997. However, the remainder of the Baffin Bay western coast was ice-free.

The telemetry data were analysed for delineation of population boundaries. The paper "Delineation of Canadian and Greenland polar bear (*Ursus maritimus*) populations using cluster analysis of movements" has been published (Taylor *et al*. 2001).

The mark-recapture data have been re-analyzed recently to estimate survival rates and population sizes.

Davis Strait

(DSD with governments of Newfoundland and Labrador, Québec, the Labrador Inuit Association, Makivik Corporation, University of Saskatchewan, CWS)

Although there are currently no apparent conservation concerns for the Davis Strait population, the uncertain nature of the population estimate is an obstacle to the development of inter-jurisdictional co-management agreements between Nunavut, Labrador, Québec, and Greenland, all of whom harvest from this population. The various jurisdictions and Inuit organizations have been working together for the past five years to identify the boundaries of this population.

Inter-jurisdictional discussions began in 1997. Financial and logistical commitments were agreed upon and a draft research agreement was prepared. This agreement will form the basis for the mark-recapture population estimate phase of the inventory. As mentioned above, the telemetry study to delineate this population has been completed. The mark-recapture sampling was planned to begin in summer 2001.

Central Canadian Arctic (Gulf of Boothia and M'Clintock Channel)

(DSD)

The initial mark-recapture work done from 1973–1978 did not identify Gulf of Boothia (GB) and M'Clintock Channel (MC) as distinct populations. The population estimate for the two areas combined was 1081. This estimate was biased low by non-representative sampling, and so was increased to 900 for GB and 900 for MC, based on the belief that the current harvests were sustainable. In the mid-1990s, the MC estimate was revised down to 700 based on hunters' reports of reduced densities.

Mark-recapture sampling for a new inventory of the two populations was conducted during each spring 1998–2000. Several preliminary population estimates have been generated for MC, based on the 1998–2000 data; the one with the lowest standard error was 243 (SE=49). The preliminary population estimate for GB of 1087 (SE=186) is based on only 1998–1999 data. Further work is planned.

Population modelling – RISKMAN, Vital Rates, and flexible-quota software

(DSD with OMNR, U. of Saskatchewan)

A new version of the modeling software for harvest risk management and population viability analysis (RISKMAN) is available for distribution on CD. It runs on Windows operating systems. There are plans to have it also available on the Nunavut and Ontario Ministry of Natural Resources websites. The Vital Rates program (population parameter analysis program for species with three-year reproductive cycles) has also been improved and on-line help files have been augmented.

These analyses and simulation models were also used to conduct a preliminary risk analysis of barren-ground grizzly bear populations.

Taylor has developed a program, named Flexible Quota, to aid in determining quotas for a community harvesting under the flexible-quota system. The next year's quota is calculated when given the base allocation, current allocation, current year's kill, and credits from previous years, by sex.

Ontario

Late-summer aerial surveys

(Ontario Ministry of Natural Resources (OMNR))

The last annual late-summer aerial survey to monitor the number and distribution of bears along the Ontario coast and offshore islands was conducted in 1996. Subsequently, funding available for monitoring Ontario's polar bear population was diverted to a co-operative study of polar bear movements, described below. Obbard has summarized Ontario's annual late-summer aerial survey to monitor the number and distribution of bears along the Ontario coast and offshore islands.

The number of bears counted during the annual late-summer survey was generally considered to be an unknown proportion of the total population. However, during a 3-year mark-recapture study from 1984–86, the sighting frequency of bears marked with paint marks was about 20% during each year's aerial survey. If about 20% of the bears of the Southern Hudson Bay (SH) population that summer in Ontario are sighted along the coast each year, then the current population estimate of 1000 for the SH population is supported by the recent aerial survey results (1990–96 mean observations 192.9, yields population estimate of 965).

Additional bears from the SH population summer on the islands in James Bay and along the coast south of Hook Point. The sightability of bears on the smaller islands in James Bay must be close to 100% because of the small size of the islands and their flat relief, but for the area south of Hook Point and on Akimiski Island, sightability must be lower. There is no estimate from the mark-recapture study of the mid-1980s of the proportion of bears that are sighted in these latter two areas. However, if sightability in these areas was also about 20%, then an additional 130 bears should be added to the 965 estimate, giving a total population estimate of 1095 based on Ontario's recent aerial survey results.

Polar bear movements in SH

(Nunavut DSD, University of Saskatchewan, Ontario Parks, Government of Québec, and CWS)

The objective of this study is to examine movement patterns and population boundaries for the SH population, including bears in James Bay, and to describe maternity denning habitat requirements. Live-capture and tagging have been conducted each year 1997–2000, and satellite collars have been deployed on adult females.

To date, information on maternity denning habitat requirements is limited. Of the four bears collared in 1997, two females were located at denning sites in September 1998, and a third had apparently been digging a den, though her final den site was not located. Neither of the bears collared in 1998 that returned to the ice carried her collar beyond March 1999. Four of the bears collared in 1999 retained their collars until autumn 2000 and then moved inland to presumed maternity denning areas.

Québec

Trichinella and other disease factors

(Makivik Corporation)

Since most hunting of polar bears occurs in Nunavut, and polar bears are not considered by provincial authorities to be of management concern, scientific research in northern Quebec (Nunavik) is limited. The number and sex of bears taken by the communities are reported annually to the provincial Department of Wildlife and Parks (FPQ). Hunters are paid for sending skulls (with teeth for determining age) to the provincial agency. Samples of muscle from the tongue and masseter from these bears are used for a contaminant study and to screen for the presence of *Trichinella* cysts. The samples are also used at the Kuujjuaq Research Centre as positive controls in the diagnosis of *Trichinella* in walrus meat.

T. nativa, the species of *Trichinella* endemic to the Canadian Arctic, is a moderate to severe pathogen in humans. Freezing does not kill it, only thorough cooking. Because of the high occurrence of *Trichinella* in polar bears, the Regional Board of Health recommends that polar bear meat always be well cooked. However, there is a tradition of eating raw or aged walrus meat (igunaq) in the Nunavik communities, and also of distributing walrus meat to other communities. This has resulted in almost 100 people in Nunavik developing trichinosis between 1983 and 1999.

Daniel Leclair, working at the Nunavik Research Centre in Kuujjuaq, has been studying *Trichinella* in polar bears and their prey. Up to 60% of polar bears and between 1–10% of walruses are infected with *T. nativa*. *Trichinella* has also been detected in seals and whales, but at rates below 2%. There are some differences in incidence of *Trichinella* in walruses among the Nunavik communities, with walruses harvested on the Hudson Bay shore (especially within SH) having the highest infection rate.

University of Alberta

DNA Studies Using Microsatellites

(Department of Biological Sciences, with all member jurisdictions of the IUCN/SSC PBSG)

Following on the results of a study of the genetic relationships among four polar bear populations in the Canadian Arctic, using microsatellite loci, a larger study was begun using DNA samples from all the circumpolar populations of polar bears. Samples were provided from 16 suspected populations, and David Paetkau, a student co-supervised by Stirling, did the analyses at the University of Alberta.

The results published in 1999 (Paetkau *et al.*) showed that the genetic data generally supported the existing population (management unit) designations, although there were two cases (Kane Basin–Baffin Bay, and Svalbard—Franz-Josef/Novaya-Zemlya) where genetic data failed to differentiate between pairs of populations previously resolved by movement data. A sharp contrast was found between the minimal genetic structure observed among populations surrounding the polar basin and the presence of several marked genetic discontinuities in the Canadian Arctic.

University of Saskatchewan

Work at the University of Saskatchewan has been conducted by Messier and Ramsay and their students in the Department of Biology and by Cattet, at the Western College of Veterinary Medicine. Their papers from studies completed during the last four years are listed in the publications section. Several that may not be widely available are summarized below.

Department of Biology

Risk assessment of polar bear encounters in the national parks of Nunavut

Ferguson and Messier prepared this report for Parks Canada. The following is abstracted from their conclusions:

Polar bears used land in late summer and autumn only in areas where considerable melt occurs (Auyuittuq, Wager Bay, and Sirmilik). Visitors to all parks should exercise caution while on land during these times, particularly along the coasts of Baffin Bay and Hudson Bay, where males and females congregate on land. During spring, polar bears concentrated their greatest movement around major leads located offshore. Greater activity occurred from April to June for all regions, with continued high activity in July for Bathurst and Ellesmere regions where melt occurred later. Decreased activity was observed in autumn for Baffin Bay bears (Auyuittuq and Sirmilik), whereas polar bears in the Arctic Archipelago (Bathurst and Ellesmere) showed decreased activity during winter, particularly in January and February. Females with cubs-of-the-year (COYs) leaving maternity dens in March were located close to the coastline as they moved offshore. Visitors using sea ice in early spring along the coastline of Baffin Bay should be aware of the dangers associated with these bears, especially when travelling on fiords.

Study of the effects of handling of polar bears

Messier has completed a report for the Government of Nunavut on the effects of handling and radio-collaring polar bears for research purposes. The following is abstracted from the summary and recommendations in the report:

The capture, tagging, and radio-collaring of polar bears are important steps to collecting the scientific data needed to manage polar bears in Nunavut and the Northwest Territories. However, Inuit communities and Hunters' and Trappers' Organizations have often expressed concerns about the effects of capturing polar bears for research and management purposes. Their concerns focus on risks of injuries, displacement of the animals, and the long-term effects of tagging and radio-collaring bears.

The primary objectives of this report are to describe the handling protocol for polar bears, to assess the short- and long-term effects of chemical immobilization and tagging on polar bears, and to assess the long-term effects of radio-collaring on polar bears. Information on injuries and risk of mortality due to handling are summarized, and the impacts of handling and collaring on reproduction parameters, cub growth, and body weights of sub-adult and adult bears are evaluated. Long-term effects were assessed by comparing attributes of bears captured for the first time with those of bears recaptured after one year.

The capture data (3237 bear handlings) of the Government of the Northwest Territories for the period 1989–97 were used to evaluate the effects of capturing, tagging, and radio-collaring on polar bears. All captures were part of the population inventory program, and the handling protocol remained largely unchanged for the study period. Risk of mortality was also summarized for two other population studies (Beaufort Sea and Churchill), one physiology study (Churchill), and one bear deterrent program (Churchill).

Some short-term effects of handling are unavoidable. They include i) the stress associated with pursuing the animals before darting, ii) the bruises caused by the darts, and iii) the minor wounds due to removing a premolar tooth (for age determination), applying ear tags, and tattooing the animals. During darting and handling, bears are occasionally injured, at a rate of one case per 100 bears captured. The cohesion of family groups appears unaffected by captures.

Risk of mortality due to capturing polar bears for management and population studies is extremely low (one death per 1000 bears captured). Risk of mortality did not differ between spring and autumn capture operations. Risk of mortality was higher for complex handling protocols associated with physiology studies, and highest (28 deaths per 1000 bears captured) for bears handled as part of deterrent work.

For the long-term effects of tagging, Messier performed 25 independent analyses, of which 24 led to no measurable effects, and one led to a positive effect. For the long-term effects of radio-collaring, 27 independent analyses suggest no effects, one suggests a positive effect, and one suggests a negative effect. In particular, tagging and radio-collaring did not seem to affect the ability of females to feed their young, nor the ability of adults to rebuild their fat reserves in spring. Data on breeding success, litter size, and cub survival show a tendency for radio-collared females (but not tagged females) to experience lower reproduction.

Overall, Messier concluded that long-term effects on polar bears of tagging and radio-collaring are largely not measurable or are negligible. He judged that these effects, if present, are acceptable considering the conservation value of data secured through the tagging and radio-collaring of polar bears. The following recommendations were submitted to continue improving the capture protocols for polar bears:

1. Capture protocols used by government agencies should be reviewed periodically (5–10 years) by experts in veterinary medicine and wildlife ecology to ensure that the methodology remains up- to-date.
2. Capture protocols should include a contingency plan in cases of "overheating" for bears handled in warm weather.
3. The potential to use drug antagonists to allow a prompt return to an awakened state should continue to be developed and tested; these would be especially useful in summer.
4. Darting should be done by trained people to reduce risk of injury and mortality during capture operations. The training program should include aspects of anaesthesiology, ecology, and practicums.
5. Size and velocity of darts should be kept to a minimum, as long as the ballistics of the dart are not compromised.

Physiological Ecology Studies

Polischuk completed her Ph.D studies and analyses in 2000. Following is a summary of her research on organochlorine dynamics in free-ranging polar bears and their cubs:

Polar bears are top predators of the Arctic marine ecosystem, and as a consequence, accumulate relatively high burdens of organochlorine (OC) contaminants in their fat tissue. Depending on their nutritional and reproductive status, polar bears also undergo extreme annual fluctuations in their adipose tissue depots. I determined the dynamics of OCs in adipose tissue, milk, and plasma of polar bears during seasonal fasting and feeding, pregnancy, and the first two months of lactation. I collected tissue samples from free-ranging polar bears both before and after a period of fasting and feeding and analyzed them for concentrations and total body burdens of chlorobenzenes (S-ClBzs), hexachlorocyclohexanes (S-HCHs), chlordanes (S-CHLORs), S-DDTs and polychlorinated biphenyls (S-PCBs). Logistical constraints necessitated sampling to be conducted at two regions with the Canadian Arctic. Pregnant females, females with natal cubs in spring, and bears in summer and autumn fast were handled in the vicinity of Churchill, Manitoba. All of these bears were fasting at the time of handling. Bears during a period of feeding were handled on the sea ice in the vicinity of Resolute Bay, Northwest Territories.

During seasonal fasts, mean body burdens of S-DDTs declined while burdens of S-ClBzs, S-CHLORs, and S-PCBs remained the same for most bears. Generally, the OC concentrations in adipose tissue increased for S-ClBzs, S-CHLORs, and S-PCBs while the plasma concentrations remained relatively constant. Females with high OC concentrations in their adipose tissue also had high concentrations in their milk, suggesting that females with higher milk concentrations were transferring greater OC burdens to their cubs. The body burdens of OCs for females with COYs were related positively to those of their cubs.

The adipose tissue concentrations of some individual OC isomers decreased during fasting whereas other isomers were not mobilized and, instead, became concentrated. By contrast, the isomeric signature in the adipose tissue of feeding polar bears remained relatively constant, with little variation between captures. Bears that were feeding also had a greater transfer of compounds between tissue compartments (adipose-plasma-milk) compared to bears that were fasting. The relationship of OC isomers between mother and cub generally remained the same during fasting; some congeners were always higher in the cubs than mother and others the opposite.

Pregnant female polar bears maintain themselves on stored fat for eight months during gestation and the first few months of lactation. The fate of stored lipophilic OCs during pregnancy and lactation in an animal that is fasting and the consequent OC dynamics in their young cubs is unknown. I determined total body burden and concentration changes of OCs in female polar bears during pregnancy and the first 2–3 months of lactation. I also determined OC concentrations in adipose tissue and plasma from cubs in spring at the time of den emergence. Organochlorine body burdens in seven female polar bears declined during gestation and the initial lactation period, although the amount and percent decrease varied with OC compound. In descending order, the mean percent decreases were S-DDTs (81%) > S-HCHs (64%) > S-ClBzs (43%) > S-CHLORs (32%) > S-PCBs (23%), while the mean total body burden declines were S-CHLORs (71mg) > S-PCBs (56mg) > S-DDTs (21mg) > S-HCHs (14mg) > S-ClBzs (6mg). Lactation was estimated to account for over 95% of the decrease in S-CHLOR and S-PCB burdens, 40–60% of the decrease for S-HCH and S-ClBz burdens, and 6% of the decrease for S-DDT burdens. Total body burdens of OCs for cubs in spring were calculated to be 1–4% of the burden of pregnant females and 3–7% of the burden of females in spring. When body burdens were corrected for total body mass, mothers and cubs had similar relative burdens for all OCs except for S-PCBs, where cubs had a lower burden/mass in spring than did their mothers. Because cubs are smaller and have a lower percentage of body fat than their mothers, they had higher concentrations of S-ClBzs, S-HCHs, S-CHLORs, and S-PCBs in adipose tissue (3.1x, 3.0x, 2.3x, 1.3x higher, respectively). Cubs and females in spring had similar concentrations of S-DDTs in their adipose tissue and plasma. Concentrations of all OCs in the adipose tissue of adult females in spring were correlated positively with their milk levels. Cubs receive a large influx of contaminants during the initial lactation period; therefore various developmental processes could be impacted. Females who lost their COYs had significantly higher mean OC concentrations in their milk in spring by the following percentages, S-PCBs 70%, S-CHLORs 60%, S-HCHs 58%, S-ClBzs 58%, and S-DDTs 49%, than females whose COYs survived from spring to autumn.

A relatively high burden of OC contaminants can be transferred from mother to cub during the first year of the cub's life. In addition to receiving OC burdens from their mother's milk, the cubs also mobilized their adipose tissue and associated OCs during the seasonal fast from summer to autumn. This first year for the cub is a period of rapid growth and development that may be impaired with the presence of high OC loads.

Western College of Veterinary Medicine

Cattet has published his studies of body condition in polar bears, reversible immobilization, and cardiopulmonary response to suspension. He is currently expanding the body condition index calculations for use on other species of bears, studying the use of transponder implants for long-term identification of polar and grizzly bears, and is expanding the trials of immobilizing drugs.

Body condition index

This investigation had three objectives. The first was to develop a body condition index (BCI) for polar bears that could be measured easily and used to compare individual animals regardless of sex, age, reproductive class, geographical population, or date-of-capture. The second was to evaluate the use of the BCI by comparing it with two other indices used in recent years to measure body condition in polar bears. The third was to determine if the application of the BCI could be extended to assess body condition in black bears (*Ursus americanus*) and grizzly bears (*U. arctos*).

The BCI was developed from the total body mass (TBM) and straight-line body length (SLBL) recorded for 1072 captured polar bears. It is the standardised residual determined from the regression of TBM on SLBL, and it ranges as a continuous value from –3.0 to +3.0. BCI values of the sample population were distributed normally, independent of body size, and sensitive to differences in the mass of potential energy tissue (fat + skeletal muscle). The BCI and the Quetelet Index ($TBM \div SLBL^2$ in kg/m^2) were used to estimate the body condition of 420 adult bears captured during different months (i.e., cross-sectional comparison). Values from the two indices were associated significantly among bears, but the Quetelet Index was affected strongly by body size. The BCI and the Fatness Index (the proportion of fat to lean body mass in kg/kg based on an isotope dilution model) were used to estimate the change in body condition of 20 polar bears captured at two different times (i.e., longitudinal comparison). Values from the two indices were not associated among bears, raising concern regarding the validity of the isotope dilution model used to estimate body lipid content in polar bears.

Regression relationships between TBM and SLBL were determined for 595 black bears and 103 grizzly bears and compared against the relationship calculated for 1072 polar bears. The slopes and intercepts were similar among species. Thus, the data were pooled to determine the relationship between TBM and SLBL for the three species combined ($n = 1770$). BCI values were then re-calculated and nomograms were constructed allowing the BCI to be estimated at the point of intersection between paired values of SLBL and TBM. The use of nomograms will allow rapid estimation of BCI values without complex calculations.

Anaesthetic drugs for polar bears

Comparative research was conducted in 1999 and 2000 into the efficacy, and behavioral and physiological effects, of Telazol® and a combination of xylazine, zolazepam, and tiletamine (XZT) in free-ranging grizzly bears. XZT may prove to be a safe, effective drug combination for use in free-ranging polar bears too, and tentative plans have been made to test this drug combination on polar bears captured in association with Manitoba's Polar Bear Alert Program at Churchill.

Of the two drugs, XZT was the more potent drug combination, as it immobilized grizzly bears at significantly lower doses, and consequently lower volumes. The behaviour of grizzly bears following administration of XZT was quite distinct from the behaviour of grizzly (and polar) bears following the administration of Telazol®. During induction, grizzly bears injected with XZT appeared to maintain full co-ordination until the drug effect increased to a point where they would slowly sink into recumbence. The induction times (time duration from injection to fully immobilized) tended to be shorter with XZT than Telazol® (XZT vs Telazol®: 5.8±1.7 min vs 7.3±2.1 min). Bears anesthetized with XZT remained well relaxed throughout handling (approximately 1 hour duration) and showed no response to noxious stimuli (e.g., premolar tooth extraction, application of lip tattoo and ear radio transmitter). There were no sudden recoveries with either drug. Differences among bears in their physiological response to the drugs indicated XZT produced a greater degree of cardiopulmonary depression than occurred with Telazol®. Nevertheless, both drugs appeared to be safely tolerated by grizzly bears as there was no evidence of adverse response. Finally, administering the reversal drug, yohimbine, safely and reliably terminated the effects of XZT.

A note on the management of polar bears in Greenland

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Regulations for the management and protection of polar bears in Greenland were introduced in 1994. Since then various amendments to the regulations have been made. Some important protective measures of the present polar bear hunting regulations are highlighted:

- only Greenland residents who hunt as a full-time occupation are allowed to hunt polar bears,
- trophy hunting of polar bears is not allowed,
- polar bears are fully protected in July–August, except for single, adult male bears, which can be taken all year round,
- cubs younger than 12 months and their mothers are fully protected in the municipalities of Qaanaaq/Thule and Upernavik of NW Greenland and Ittoqqortormiit and Tasiilaq/Ammassalik of E Greenland. In the remainder of Greenland, cubs younger than 24 months and their mothers are completely protected,
- it is mandatory to report to the Greenland management authorities all catches including struck-and-lost polar bears,
- aircraft, helicopters, motorized vehicles (*e.g.*, ski-doos) and boats larger than 40 GRT are not allowed in the hunt or for transportation to and from the hunting grounds,
- poison, traps, foot snares or self-shooting guns are not allowed, and
- rim-fire rifles, shotguns or semi- or fully automatic weapons are not allowed.

Specific regulations apply to the traditional take of polar bears within the National Park of North and East Greenland and the Melville Bay Nature Reserve.

In recent years, the Ministry of Fishery, Hunting and Settlements has put effort into improving the hunting statistics, which still suffer from problems such as under-reporting from some areas and "multiple reporting" of some kills. "Multiple reporting" (*i.e.*, one kill is reported by more than one hunter) occurs when several hunters, who have participated in the same hunt and are proud that a bear was taken, have each reported the kill regardless of whether they shot the bear.

During the fall of 2000, the Greenland Home Rule Government signed a Memorandum of Understanding (MOU) with the Government of Nunavut (Canada). An appendix to this MOU contains a prioritized list of items, including that there should be cooperation between the two regarding shared polar bear populations. It is the intention of the Greenland Home Rule Government to continue the dialogue with the management authorities of the Government of Nunavut for the possible establishment of a Memorandum of Understanding regarding co-management of polar bear populations that are shared between Canada and Greenland. Potentially, this could be an extension of the MOU between Canada and Greenland regarding co-management of beluga and narwhal.

On 20 November 2000, the Greenland Home Rule Government decided, in principle, to work forward towards the introduction of quotas in the Greenland catch of polar bears and to introduce other catch-regulating mechanisms in this hunt.

During the spring of 2001, the Ministry of Fishery, Hunting and Settlements arranged a meeting in the town of Qaanaaq between residents of the Qaanaaq municipality (NW Greenland) and Grise Fiord (Ellesmere Island, Canada). The topic of this meeting was the hunt of polar bears from groups of polar bears that are shared between Qaanaaq and Grise Fiord. During the meeting information was exchanged about polar bear hunting regulations, catch statistics and, in particular, different hunting methods and use of polar bear meat and hides in the two jurisdictions. The Inuit of the Qaanaaq municipality emphasized their use of traditional hunting methods (in particular the use of dog sleds) during the polar bear hunt and that the vast majority of the hides were not traded but were used for traditional clothing. The next meeting of users and local management authorities will be in 2002 and hosted by Nunavut (Canada).

Research on polar bears in Greenland 1997–2001

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This report summarizes polar bear research in Greenland since the 12th meeting of the IUCN Polar Bear Specialist Group in February 1997, and presents information on the Greenland polar bear catch.

Population studies

The analyses of the movement data of the Canadian-Greenland joint study to delineate and enumerate polar bear sub-populations in western Greenland and the Canadian High Arctic were finalized and reported in Taylor *et al*. (2001). Based on satellite- tracking of 152 adult female polar bears (1989–1998) and mark-recapture information on movement of 484 polar bears (567 movements) of both gender and all age classes (1973–1997), it can be concluded that Greenland and Canada share three sub-populations of polar bears confined to Kane Basin (KB), Baffin Bay (BB) and Davis Strait (DS), respectively. The identification of BB and DS as separate demographic units is in accordance with the genetic study by Paetkau *et al*. (1999). However, the genetic study did not detect any genetic difference between KB and BB, and neither did a study that compared concentrations of various elements (zinc, cadmium, mercury, selenium) in bears from KB versus BB (Dietz *et al*. 2000a).

The finding that Canada and Greenland share polar bear sub-populations that are exploited at relatively high levels within both jurisdictions, and with different management schemes and exploitation strategies, calls for the establishment of a co-management regime for these shared populations.

The Canadian-Greenland joint study also provided new information about various aspects of polar bear ecology and life-history strategies. This information encompassed: the relationships between sea-ice and landscape and spatial patterns of polar bears (Ferguson *et al*. 1998); home range sizes in polar bears (Ferguson *et al*. 1999); relationships between denning of polar bears and conditions of sea ice (Ferguson *et al*. 2000); and movement patterns of polar bears inhabiting consolidated versus active pack ice (Ferguson *et al*. 2001).

Pollution studies

Tissue samples of 100 polar bears that had been caught (1983–1990) by the subsistence hunters living in northwestern and eastern Greenland were analyzed for contents of various heavy metals (zinc, cadmium, mercury and selenium) (Dietz *et al*. 2000a,b). In Central East Greenland (c. 69 N to c. 74 N), element concentrations in bears from the southern area (i.e., south of Illoqqortoormiut/Scoresby Sound at c. 70 N) were higher than in polar bears from the northern areas. This indicates the existence of two different ecological regions within this polar bear range (i.e., a coastal southern area dominated by drift ice and a northern area with sheltered fjords with fast-ice) and consequently some population sub-structuring. As stated earlier, differences in element concentrations were not detected when comparing bears from KB and northeastern BB (Dietz *et al*. 2000a).

A circumpolar study of POPs (persistent organic pollutants; *e.g.* PCB and DDT) in polar bears found high levels of POPs in polar bears from eastern Greenland and Svalbard (Norstrom *et al*. 1998). For example, concentrations of PCB averaged 22,419 g/kg wt. in females and 18,232 g/kg wt. in male polar bears from East Greenland (ibid.).

In 1999, the Danish National Environmental Research Institute and the Greenland Institute of Natural Resources initiated a study to assess the effects of POPs on internal and external organs of polar bears in East Greenland. The study involves: (1) obtaining information from the polar bear hunters concerning their observations of bears with aberrant organs or behavior, (2) analyzing bone and organ samples from 100 polar bears killed in 2000 and 2001 by subsistence hunters in East Greenland, and (3) comparing frequencies of morphological anomalies in historic and recent samples of polar bear skulls from East Greenland (Sonne-Hansen *et al*. in press).

To meet the first of these objectives, 52 hunters living in East Greenland were interviewed in 1999. Information was obtained concerning a total of 1110 polar bears shot between 1945 and 1999. The majority had been shot after 1980.

Thirteen anomalous polar bears were reported. The most striking record was from 10 June 1999 when an adult female bear, with clear signs of *pseudohermaphroditism* was killed at Scoresby Sound. This female had an enlarged clitoris, while the internal sexual organs apparently were normal.

The other 12 cases of aberrant bears included: cases of supernumary nipples or claws, a collapsed lung, abnormal claws after a healed fracture, partial melanism, missing limbs, and a malformed newborn. All these abnormalities might have been caused by naturally induced trauma. However, nine (*i.e.*, *pseudohermaphroditism*, malformed cub, supernumary nipples and claws, missing claws on hind paw, aberrant fur) *could* have been congenital abnormalities suggesting a prevalence of abnormalities of about 0.8% or less (Dietz *et al*. 2001).

The catch of polar bears in Greenland

Recent information about the catch of polar bears in Greenland was presented to the Canadian Polar Bear Technical Committee (Born 1999, 2001). In the present report the Greenland catch of polar bears is described on the basis of the official catch records, and in the case of eastern Greenland, also on an interview survey conducted in eastern Greenland in 1999 (Sandell *et al*. 2001).

An introduction to the official system of collecting information about the catch

In Greenland there are no quotas for the catch of polar bears and no administrative allocation of the catch to management areas or putative sub-populations. Since 1 January 1993, information about the catch has been obtained when the hunters on a voluntary basis report their catch via the *"Piniarneq"* system. The system is linked to the issuing of hunting licenses, of which two categories exist: one for full-time hunters and another for part-time hunters. Hunters in both categories have to pay a small fee for renewal of the license, at which time they are obliged to report their catches during the previous 12 months (*i.e.*, from September to September). Only full-time hunters are allowed to hunt polar bears. In the summaries, the catch is reported by municipality, meaning that in *"Piniarneq"* there are no records of the exact site of kill.

In *"Piniarneq"* each hunter must report his own catch. However, some hunters are not used to paper work, and they may not see the point of keeping exact notes on the dates and numbers of animals taken. Whether this leads to under-reporting, over-reporting, or just arbitrary reporting in order to have something to report when renewing the license, is not clear (Kapel and Rosing-Asvid 1996). In a study of the Greenland catch of ringed seals, Teilmann and Kapel (1998) identified examples of under-reporting and over-reporting. In 1993 about 4100 full-time licenses were issued and 3403 reports were received (*ibid.*), which indicates a potential 20% under-reporting.

In the case of the polar bear often two or more hunters participate in the hunt, and therefore there may be instances where they all have reported a particular kill in the *"Piniarneq"* which would result in "over-reporting" or multiple reporting of the same bear kill.

Generally, the numbers reported in *"Piniarneq"* are higher than those reported in the previous system of recording catches (i.e., The Hunters Lists of Game, *cf.* Teilmann and Kapel 1998). This apparent difference may be caused by several factors: (1) previous information was incomplete and the estimates of non-reported catches too low, (2) the recent system overestimates the catch due to over-reporting, (3) a real increase in the catch, or (4) a combination of all these factors.

As far as I am aware, a validation of the polar bear catches reported in *"Piniarneq"* has not been attempted so far. Therefore one has to be cautious when using and interpreting the data in *"Piniarneq"*.

The catch by region

The polar bear catch reported via *"Piniarneq"*, and summarized by municipality by the Department of Fisheries, Hunting, Commerce and Agriculture (Nuuk) (*in litt.* 2001) for the period 1993 to 1998, are presented in Table 7, which also presents provisional data for 1999.

During 1993–1998, the Greenland catch of polar bears averaged 145 bears per year (sd=27.3, range: 121–198 bears per year, n=6). The data in *"Piniarneq"* suggest that the catch of bears in Greenland has increased during this period (r=0.806, z=1.93, p=0.053).

However, information was not available (*i.e.*, for example total number of hunters reporting per year) for an evaluation of whether this was a real increase in the number of bears being killed or alternatively was due to the fact that the system had become more effective, meaning that more hunters reported their catch.

In the following the catch of polar bears is described by region from NW Greenland around the southern tip of Greenland to NE Greenland.

Northwest and Central West Greenland (i.e., the catch from the KB, BB and DS sub-populations): The catch taken in West Greenland in the municipalities from Qaanaaq south to Nuuk may arbitrarily be allocated to the three sub-populations (KB, BB and DS) that are shared with Canada. Bears taken between Qaanaaq and Sisimiut are taken from the KB and BB sub-populations, whereas those taken in Maniitsoq and Nuuk likely are extracted from the DS group (Table 7, last column).

Table 7. The Greenland catch[1] of polar bears (1993-1999) reported in the "Piniarneq" (see text). Locations of municipalities and borders of regions are shown in Fig. 3.

					Year				
Region	**Municipality**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**Comments**
NW and Central	Qaanaaq (Avanersuaq/Thule area)	24	33	23	30	41	22	17	Likely taken from the Baffin Bay
West Greenland	Upernavik	43	25	27	40	38	48	47	management unit. However, c. 10 of those
	Pituffik	0	0	0	0	0	0	0	reported for Qaanaaq may have been taken
	Uummannaq	3	0	4	5	2	9	9	from the Kane Basin management unit
	Qeqertarsuaq/Disko	6	1	1	0	0	5	2	
	Ilulissat	1	1	2	0	0	1	5	
	Aasiaat	4	3	1	0	3	3	8	
	Qasigiannguit	0	0	2	0	2	5	3	
	Kangaatsiaq	1	6	10	1	2	0	6	Some reported for Kangaatsiaq, Kanglussuaq
	Kangerlussuaq/Sdr. Strom.	0	0	0	0	0	1	0	and Sisimiut may have been taken from the
	Sisimiut	0	1	4	1	1	12	4	Davis Strait management unit
	Maniitsoq	4	0	5	1	4	22	0	Likely taken from the Davis Strait
	Nuuk	0	0	1	4	0	0	2	management unit
SW Greenland	Ivittuut	0	0	0	0	0	0	0	Likely taken from the East Greenland
	Paamiut	1	2	1	1	5	1	0	population
	Narsaq	1	0	0	0	2	0	0	
	Qaqortoq	0	0	2	0	0	4	1	
	Nanortalik	1	0	6	3	6	9	11	
East Greenland	Ammassalik	15	14	22	23	9	13	14	
	Illoqqortoormiut/Scoresbysund	28	35	26	26	34	43	52	
Greenland total		**132**	**121**	**137**	**135**	**149**	**198**	**181**	

[1] 1999 catch figures are provisional as they only include data for the period January-September

Source: Dept.of Fisheries, Hunting, Commerce and Agriculture (Nuuk; in litt. January 2001).

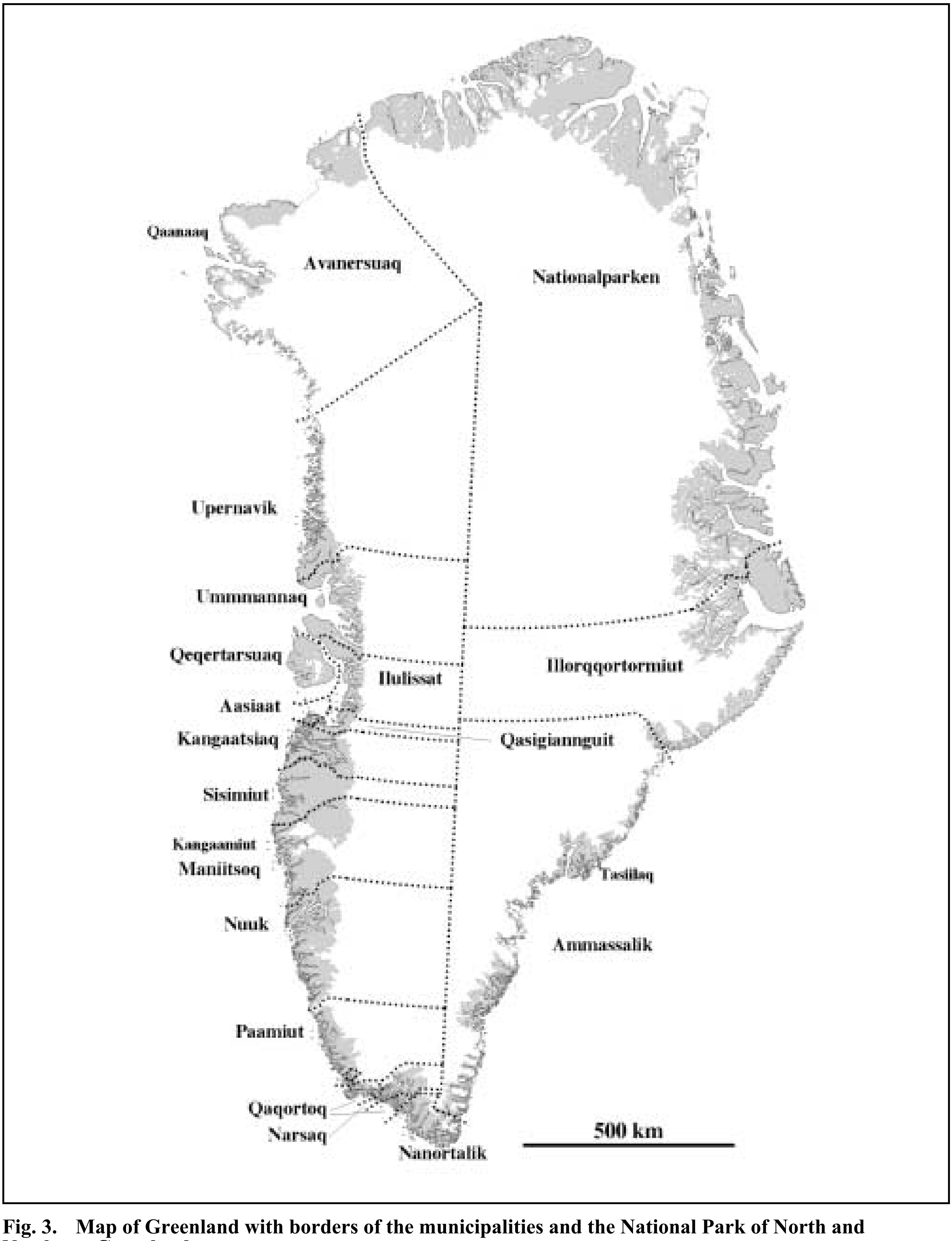

Fig. 3. Map of Greenland with borders of the municipalities and the National Park of North and Northeast Greenland.

In western Greenland, the occurrence of polar bears in the northernmost municipalities (i.e., Upernavik and Qaanaaq) is more regular than in the areas farther south. Hunters from the municipality of Qaanaaq (the Thule or Avanersuaq area) hunt polar bears in three areas: (1) in the northern Smith Sound and Kane Basin region (i.e., between approximately 78 30′ N and 80 N), (2) the central parts of the municipality (i.e., between approximately 76 N and approximately 78 N), and (3) Melville Bay. The hunters from northern Upernavik also hunt bears in the Melville Bay. In this area, and in KB, the bears are taken during hunting trips specifically for polar bears whereas the take of a polar bear is a more occasional event in the other parts of these two municipalities.

In the areas between Uummannaq (about 72 30′ N) and Sisimiut (67 N) – covering eight municipalities – (Table 7; Fig. 3), polar bears are hunted either on the shore-fast ice or at the eastern edge of the BB pack ice. North of Kangaatsiaq (c. 68 30′ N) the ice conditions are more stable than further south.

In the period 1993–1998 the catch reported in *"Piniarneq"* for the Qaanaaq-Sisimiut region averaged 83.0 bears per year (sd=13.1; range: 70–106 bears; Table 7). An increase in the annual catch in this region during 1993–98 was not statistically significant (r=0.74, p=0.10). A certain number must be subtracted from the total number of bears reported for this region to account for bears that were taken from the KB group. An average of 28.8 bears/year (sd=7.4; range: 22–41 bears) were reported from the Qaanaaq municipality during 1993–1998. However, hunters from Siorapaluk (the northernmost settlement in this municipality) usually go north to hunt polar bears in Kane Basin, whereas the hunters from the town of Qaanaaq sometimes go north and sometimes go south to the Melville Bay (Rosing-Asvid and Born 1990). Due to lack of information about the exact sites of kill, it is suggested that the Greenland catch from the KB group has averaged 10 per year during the period 1993–98 (this includes bears from KB that are shot in other parts of the municipality than Kane Basin proper).

Therefore, the estimates of the Greenland catch of polar bears from the KB and BB sub-populations during 1993–98 are 10 and 73 animals, respectively.

The polar bear catch north of Paamiut (c. 62 N; Fig. 3) can more or less arbitrarily be divided into a portion that may have been taken from the KB+BB management units, and a portion that may have been taken from the DS unit. Usually, the Davis Strait-Baffin Bay pack ice lies close to the Greenland coast north of about 67 N (Sisimiut) from fall to early summer. The northern boundary of the Canadian DS management zone crosses the coast of Greenland at 66 30′N (Fig. 3). Therefore the catch of bears reported from the municipalities of Nuuk and Maniitsoq (i.e., between 62 N and 65 30′ N at Maniitsoq) may represent the Greenland take of polar bears from the DS sub-population.

During the period 1993–1998, an average of 7.0 bears/year (sd=8.1; range: 0–22 bears) have been reported from Nuuk and Maniitsoq.

If it is assumed that also *all* polar bears that have been reported from the areas a little further north (i.e., from Sisimiut, Kangerlussuaq and Kangaatsiaq) were "DS bears", the Greenland kill from DS may have been as high as 13.5 bears/year (sd=11.9; range: 5–35 bears) during 1993–98. An increase in the annual catch from DS during 1993–98 was not statistically significant (r=0.70, p=0.13).

It must be noted that in some areas the summaries of the catch appear very high. For example, it might be suspected that the reports in 1998 of unusual high catches in Maniitsoq (n=22) and Sisimiut (n=12) were artefacts.

Southwestern Greenland: The polar bears that are caught in SW Greenland (*i.e.*, south of Paamiut; Fig. 3) likely arrive into this area with the heavy pack ice ("Stor is"; "big ice") coming around the southern tip of Greenland from the east coast. In SW Greenland the catch of polar bears peaks in the period March–June, when the "Stor is" has its maximum extension. During 1993–98 the reported catch of polar bears in SW Greenland was 7.5 bears/year (sd=5.2; range: 3–14). The annual catch in this area increased during 1993–98 (r=0.85, p=0.03).

There is a stretch of several hundred kilometers of open water between the pack ice along the coast south of Paamiut and the eastern edge of the DS pack ice. Contact between bears in SW Greenland and DS therefore appears highly unlikely.

East Greenland: The catch in East Greenland (i.e., including the catch in SW Greenland) increased significantly during 1993–1998 (r=0.86, p=0.02, n=6). During the period the annual catch averaged 56 bear per year (range: 56–70 bears per year) according to "Piniarneq".

An interview-survey in eastern Greenland, 1999

Based on interviews with 52 hunters in eastern Greenland in 1999, and historical catch data, the polar bear hunt in East Greenland was described in Sandell *et al.* (2001). This survey also provided information on hunting patterns, distribution of polar bears, location of denning areas, migration patterns. The following information was extracted from Sandell *et al*. (2001).

Magnitude of the catch, and its age/sex and seasonal distribution

Illoqqortoormiut municipality: Between 1925 and 1 January 1975 (when regulation of polar bear hunting in Greenland was introduced) there has been a statistically significant decrease in the number of bears taken annually (based on trade of hides and catch reports). However, between 1975 and 1999 no trend was apparent. The mean number of bears per year in both periods did not differ statistically. During 1925–1999 the average catch in this municipality has been around 40 bears per year (sd=19.9; range: 5–99 bears per year; 73 years with records).

The information from 1994–99 was particularly detailed. Of 262 bears that were shot during this period, 11% had been taken north of the fiord of Scoresby Sound (i.e., within the National park of North and Northeast Greenland), 42% at the entrance to Scoresby Sound where the three settlements of the municipality are situated, and 47% south of the entrance to Scoresby Sound (i.e., along Blosseville Coast). During this period fewer bears had been killed in the northern hunting area compared to earlier. It was not clear to what extent this development reflected (a) that a group of bears with fidelity to the northern areas had been over-exploited, or alternatively (b) that younger hunters had been less interested in going on long sled trips north for polar bears.

About 85% of the 262 bears were adults (*i.e.*, non-dependent 2+ bears). Males made up c. 68% and females c. 32% of 216 adult bears with information on sex. The sex ratio and the seasonal distribution of the catch in the three sub-areas did not differ statistically.

Ammassalik municipality: Historically the catch of polar bears was significant in this area. However, between 1925 and 1998 the annual catch decreased markedly. Between 1925 and 1974 (*i.e.*, before hunting regulations were introduced) an average of about 43 polar bears (sd= 22.5; range: 0–92 bears per year; 44 years with records) were caught annually in the Ammassalik area (based on traded hides and catch statistics), whereas the catch averaged 30 bears per year (sd=18.1; range: 7–78 bears per year; 19 years with records) between 1975 and 1998.

Of 213 bears that had been killed during the period 1980–99, 26% had been shot in the areas north of the town of Ammassalik, 52% in the populated areas (i.e., where the town of Ammassalik and the settlements are situated), and 22% south of there.

About 78% were adults (i.e., non-dependent 2+ bears) of 193 bears with information on age group. Males made up 54% and females 46% of 151 adult bears with information on sex. Females made up a significantly larger proportion of the catch in the northern and southern areas compared with the central, populated area. This may suggest that these “remote” areas are used for denning by the females.

Trends in the polar bear catch in eastern Greenland: If the information from the interview survey in the two municipalities is combined, the overall sex ratio in the catch was 62% males and 38% females (n=367 adult polar bears).

During the 20-year period 1979–1998 the catch averaged 69.2 bears per year in eastern Greenland (sd=26.9; range: 26–129 bears per year; 15 years with records, data missing for some years from Ammassalik). To this number the catches in southwestern Greenland south of Paamiut (c. 62 N) must be added. These bears arrive from eastern Greenland to southwestern Greenland and are shot there.

During 1925–1999 the annual catch in eastern Greenland has decreased significantly from about 95 bears per year at the beginning to about 60 bear per year at the end of the period. It is not clear whether this decrease represents an over-exploitation of the population (in a period with increase in the human population in East Greenland), or reflects natural fluctuations in ice conditions and abundance of polar bears within the hunting areas.

During 1925–1998 there was a positive correlation between the catches reported annually from the two municipalities indicating that the accessibility of polar bears in both areas has been governed by the same overall factor(s) – for example annual fluctuations in ice cover.

Changes in distribution and hunting patterns in East Greenland

Generally, the East Greenland polar bear hunters had not noted any differences in distribution and abundance of polar bears. The overall opinion was that the abundance of bears reflected natural fluctuations in abundance of prey (in particular seals) which on the other hand depended on natural variations in the extent and seasonal distribution of ice.

However, in both municipalities the hunters noted that the ice conditions had changed within the last five or six years. The zone of land-fast ice along the coasts had become narrower, which in some cases forced the hunters to drive their dog sleds via inland passages to avoid passing around capes during the spring hunt. In

1999 the unusually early break-up of the land-fast ice (June) allowed the hunters in Illoqqortoormiut municipality to commence the boating season early. Furthermore, light ice conditions during the summer prolonged the boating season. The relatively high proportion of bears that had been taken during the open-water season in Ittoqqortoormiit/Scoresbysund during 1994–99 (c. 30% of all taken) may also reflect general decrease in the ice cover. In the Ammassalik area the light ice conditions had prevented the hunters from going south by sled in spring, but made it easier for them to go north by boat during summer.

These observations have to be seen in the context of the indications of several studies of ice conditions using remote sensing (*e.g.* Parkinson 2000). These studies have indicated that the Arctic sea ice cover, in particular in the eastern Atlantic Arctic region, has become thinner and has decreased in extent.

The interview survey does not allow for an evaluation of how such environmental changes will affect the East Greenland polar bear population, or the hunt. However, studies in western Hudson Bay (Canada) have indicated that a shorter season of ice cover may result in a shortening of the period in which polar bears can feed on seals. The bears will be forced to spend proportionally more time on land and less time hunting seals, negatively affecting their body condition and reproductive success (lowered natality) (Stirling *et al*. 1999). Furthermore, with less severe ice conditions and a longer boating season, hunters may intensify their hunting of polar bears on land.

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Polar bear research and management in Norway 1997–2000

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Management

Norwegian sovereignty over the Svalbard Archipelago was granted by the Svalbard Treaty of 9 February 1920, which came fully into force 14 August 1925. The Governor of Svalbard (Sysselmannen) and staff oversee Norway's rights and duties under the Svalbard Treaty. The Governor's office has management responsibilities for freshwater-fish and wildlife, pollution and oil spill protection, environmental monitoring, the warden service and urban and commercial development. The Governor's office is also the cultural and environmental protection authority in Svalbard. The Svalbard Treaty applies to all the islands situated between 10 and 35 East of Greenwich and between 74 and 81 latitude North and includes the waters up to 4 nautical miles offshore. Beyond this zone, Norway claims an economic zone to continental shelf areas to which Norwegian Law applies. Therefore, under Norwegian Game Law, all game is protected unless otherwise stated. There are disputed areas in the Barents Sea for which jurisdiction is unclear and there has been no resolution of jurisdiction over these areas in the last few years. Lack of jurisdiction certainty creates an area of uncertainty for the protection of bears.

Polar bears in Svalbard and adjoining waters under the Svalbard Treaty continue to have complete protection from harvest. Irrespective of the protection regulations, or other restrictions on hunting, the Governor (or Head of Station in Jan Mayen) can kill, or give permission to kill, polar bears which remain close to permanent or temporary human settlements and thus present a risk of injury to people or of other substantial damage. Similarly, the same authorities can grant permission to kill wildlife that is injured or suffering in other ways.

In 1995, the Norwegian Government presented a White Paper to the Parliament (St. meld. nr. 22 1994–95 *Om miljøvern på Svalbard* (On environmental protection at Svalbard)) that discussed environmental management on Svalbard. According to this White Paper, one of the primary environmental goals of the Government is to preserve the unique wilderness quality of Svalbard. This goal also applies to the management of Svalbard's fauna. In other words, the animals of Svalbard shall have the opportunity to develop naturally and should, as far as possible, be protected from human influence or disturbance. In connection with this White Paper, new legislation was introduced in 2001.

New legislation in Svalbard: relevance to polar bears

A new Environmental Act for Svalbard was passed by Parliament on 5 June 2001. The new Act reflects the need for legislation securing a level of protection of the environment corresponding to the ambitious political goals set for Svalbard. The objectives of the new legislation and regulations for Svalbard were:

- to ensure that the legislation concerning the protection of the environment in Svalbard is consistent and in accordance with the political ambitions,
- to ensure that the conservation of nature at Svalbard will be as solid and strict as on the Norwegian mainland, and
- to deploy and emphasise essential conservation principles in the management of Svalbard, i.e. the "mirror" principle (all nature elements are protected unless specifically mentioned) and the precautionary principle.

New regulations were intended to assist in avoiding confrontations between polar bears and campers by providing rules/guidelines for camping. Previous incidents where people in camps had to shoot bears (e.g., due to poor camp location or improper handling of waste) prompted the need for new guidelines. The new regulations stipulate that people planning to camp outside for a week or more have to report where they will camp, how many people are going to stay there, for how long and how they plan to deal with security related to polar bears.

Per se, the new legislation does not markedly change the protection and management of polar bears. However, there has been a marked increase in the plans to conserve the environment, which result in a stronger awareness and better protection for polar bears and other species in Svalbard. This increased awareness was evident in a 1998 court ruling where two inhabitants of Svalbard were convicted for harassing a polar bear with snowmobiles while trying to photograph it. The harassment was done under the influence of alcohol and resulted in one suspended sentence and "higher than minimum" fines for both.

The weak side of polar bear protection in Norway is (still) marine habitat outside the territorial waters. Even though the general regulations in the Norwegian Wildlife Protection Act formally apply here, national and international advocates, with conflicting interests, have challenged the application of these regulations. However, there have been no cases in which the regulations have been legally challenged in these areas.

The intent of the Norwegian management agencies is to increase monitoring of polar bears in Norwegian Territories. Within this context, several new programs were initiated. Specifically, MØSJ (Miljøovervåkning av Svalbard og Jan Mayen: Environmental Monitoring of Svalbard and Jan Mayen) was partially implemented in 2000 to increase monitoring of polar bears.

Protected areas in Svalbard

Protected areas (National Parks and Nature Reserves) cover approximately 35,000km^2 (56%) of Svalbard's 63,000km^2. A gap assessment of Svalbard has identified additional areas warranting protection. Preparations are underway to give Bjørnøya (Bear Island), Hopen Island, and other areas in the Svalbard Archipelago protection as Nature Reserves.

Tourism and local activities

Tourism continues to increase in the Svalbard Archipelago. The number of snow machines in Svalbard has increased 22% from 1096 in 1995 to 1342 in 2000. In addition, gas consumption has increased 36% from ca. 80,000 litres in 1995 to 107,000 litres in 2000. Most of the increase in gas use coincides with the peak in tourism (March–May). Cruise ship traffic is also increasing. In 1996, there were 47 registered landing places in Svalbard. By 2000, this had increased 89% to 89 sites. The number of registered tourists on land has varied between 20–25,000 people in the 1995–2000 period. However, the number of overnight stays in hotels in Longyearbyen increased 77% from ca. 35,000 nights in 1995 to ca. 62,000 nights in 2000.

The overall effect of increased tourism on polar bears is unknown. However, increased human presence in Svalbard is a potential disturbance to polar bears.

Industrial development in the Arctic seas: increased threat to polar bear habitat

Industrial development of oil and gas resources and a consequent increase in shipping activities are main concerns as future threats for polar bears and their habitats (Isaksen *et al.* 1998). Parallel Norwegian and Russian developments of oil and gas fields and unknown future levels of activity are cause for concern. There is a large potential for further development of petroleum activities in both Norwegian and Russian territories and current development is only in an initial phase.

In 1989 the Norwegian Parliament decided to open the rest of the southern part of the Barents Sea for regulated oil exploration, i.e. the area south of Bjørnøya (Bear Island, 74°30'), after years of more or less unregulated activities. The Snøhvit ("Snow-white") gas field was discovered approx. 100km off the coast of northern Norway. According to existing plans, gas will be sent via pipelines to large-scale liquid natural gas facilities on land. Environmental impact analyses are being carried out, and the Parliament will probably decide whether or not to start full production of LNG from these fields by the end of 2001. The presence of oil in the area has been verified and there is reason to believe that any profitable oil reservoirs in the southern Barents Sea will be developed.

Whether the northern part of the Barents Sea will be opened is still a controversial issue, and it is impossible to predict any outcome. There is considerable scepticism and fear within environmental institutional authorities that macroeconomic interests may make oil development in the northern Barents Sea inevitable, and the federal pollution control authorities have stressed the need for a strategic EIA and management plans for the Barents Sea before large efforts are allocated into exploration.

The increase in petroleum activities in Russian Arctic territories is also a concern, primarily due to the associated increase in shipping activity and consequent increased risk for oil spill accidents. In addition, the use of the Northern Sea Route as a shorter and cheaper freight route between European and Asian markets has been debated for many decades (Brude *et al.* 1998). Although the pressure on this issue is now reduced, due to the associated risks, there is reason to believe that other commercial traffic will increase in northern seas in the future.

The combined increase in oil and gas exploration activities in Norwegian and Russian Arctic territories is a threat to polar bear habitat for many reasons including:

- An associated increase in traffic of oil carriers in Arctic waters increases the risk of oil spills,
- Unknown fate of oil in ice,
- Unknown levels of chronic pollutant exposure,
- Lack of methods to monitor long-term effects of pollution from acute and operational discharges, and
- No development in oil clean-up techniques under arctic conditions.

Polar bears killed in Svalbard 1997–2000

Polar bear hunting in Norwegian territory was banned in 1973. Since then, polar bears have only been shot in acts of self-defense, as precautionary measures or in special cases as acts of mercy. Only bears within settlements represent such a threat that may result in precautionary killing of a polar bear. All such incidents are considered a police matter and are either investigated by, or authorized by, the Governor of Svalbard.

Polar bears that destroy cabins and confrontations between humans and polar bears, are the two most common conflicts handled by the Governor. There are about 250 private cabins on Svalbard. Most of them are found near Longyearbyen, the main settlement. In practice, permission is not granted to kill bears that cause damage.

Nine bears were shot in Svalbard in the four years from 1997 to 2000 (Fig. 5). These bears were killed in defense of property or as mercy killings. Tourists, weather station crew, and the Governor’s staff were responsible for deaths. No charges were laid in any instance although investigations were conducted into the circumstances of the defense kills.

One adult male died in connection with scientific tagging. The bear was severely emaciated at the time of capture but was stable when left. It was found five weeks later within 200m of the capture site. Cause of death was unknown.

Human casualties

In contrast to the 1993–1996 reporting period when there were two human fatalities and one injury in two separate confrontations, no human fatalities or injuries occurred in the 1997–2000 period.

Use and trade of polar bear products

Between 1996 and 2000, Norway exported 16 hides and 636 pieces (Table 8). There was an import of 199 hides and 7 skulls, largely from Canada and Greenland, during the same period (Table 9). All trade in Norway is controlled by CITES permits administered by the Directorate for Nature Management.

Table 8. CITES permits for export of polar bear skins and parts of skins in Norway, 1996–2000.

Year	Items	Destination	Origin of re-export	Comments
1996	2 skins	Japan (1), Mexico (1)	Denmark (1), Canada (1)	
	230 pieces	Canada, Sweden	Canada	
	1 dead animal	Switzerland		
1997	6 skins	Great Britain (3), Finland (1), Sweden (1), Portugal (1)	Canada (5)	
	206 pieces	Canada (158), Italy (48)		Scientific samples
	1 animal	Germany		
1998	5 skins	Sweden (3), France (1), South Africa (1)	Canada (4)	
	1 dead animal	Switzerland		
	71 pieces	Japan (1), Canada (70)		Scientific samples
1999	1 skin	Great Britain (1)	Canada (1)	
	97 pieces	Canada (75), Sweden (21), Great Britain (1)		Scientific samples
	1 dead animal	Denmark	Canada	Educational use
2000	2 skins	Spain (1), Great Britain (1)	USA (1), Canada (1)	
	32 pieces	Great Britain (25), Japan (6), Canada (1)		Incl. scientific samples

Table 9. CITES permits for import of polar bear skins and parts of skins in Norway, 1996-2000.

Year	Items	Country of export/re-export	Origin of re-export	Comments
1996	13 skins	Greenland (3),Canada (9), Denmark (1)	Greenland (1)	
	2 skulls	Greenland (2)		
1997	44 skins	Canada (35),Greenland (9)		
	2 skulls	Canada (1), Greenland (1)		
	6 pieces	Greenland (6)		
	1 dead animal	Denmark	Unknown	Commercial/trade
1998	105 skins	Denmark (90), Canada (13), USA (1)	Greenland (83), Unknown (7)	
	1 skull	Canada (1)		
	1 piece	Greenland (1)		Claws
1999	20 skins	Canada (20)		
	1 skull	Denmark (1)		Confiscated
	1 piece	Australia		Returned piece of skin
2000	17 skins	Canada (14), Denmark (3)	Greenland (3)	
	1 skull	Greenland (1)		
	4 pieces	Denmark (4)	Canada (4)	Skin pieces

Population status

Information is currently inadequate to provide a definitive assessment of population status. There is anecdotal evidence to suggest that the population is stable but concerns from high levels of persistent organic pollution (see Ecotoxicology below) suggest that a classification of stationary or decreasing is most probable. If the population is decreasing, the rate of decline is likely low suggesting no immediate threat to the population.

Population delineation

Earlier research on the population boundaries of the polar bears in the Svalbard area suggested separate Norwegian and Russian populations (Wiig 1995). However, with the deployment of satellite collars in the central Barents Sea (see Norwegian-Russian co- operative studies) and the western Russian Arctic, it is clear that there is a shared population that resides in the Barents Sea and moves widely between Norwegian and Russian areas (Fig. 4, Mauritzen *et al*. 2002). There is also evidence of a smaller and local population in the Svalbard Archipelago. While information is insufficient to determine the structure of the populations east of the Barents Sea, there is new evidence for both a Northern Kara Sea and a Southern Kara Sea population. Further research is required to address this issue.

We propose to redefine the existing population boundary between Norway and Russia to create a Barents Sea population that includes the old Svalbard population and the north-western portion of the Franz-Josef/Novaya Zemlya population. The name for this population should be the Barents Sea population. Support for the existence of a single population in the Barents Sea was provided from the circumpolar genetic study conducted (see Paetkau *et al*. 1999). The adjoining population to the east, should be considered the Kara Sea population and include the northern and southern groups (Mauritzen *et al*. 2002).

Environmental concerns

Persistent organic pollutants, climate change, tourism and oil development are the main environmental concerns for polar bears in the Barents Sea-Svalbard area. No new management policies are directed specifically at polar bears within the Norwegian management authorities although polar bears are used as a flagship species for likely anthropogenic impacts in the Arctic.

Harvest

No harvest exists within the Barents Sea-Svalbard popuation at this time. However, Russia has considered opening their part of the area to harvest. In addition, polar bears living in the north Greenland Sea are

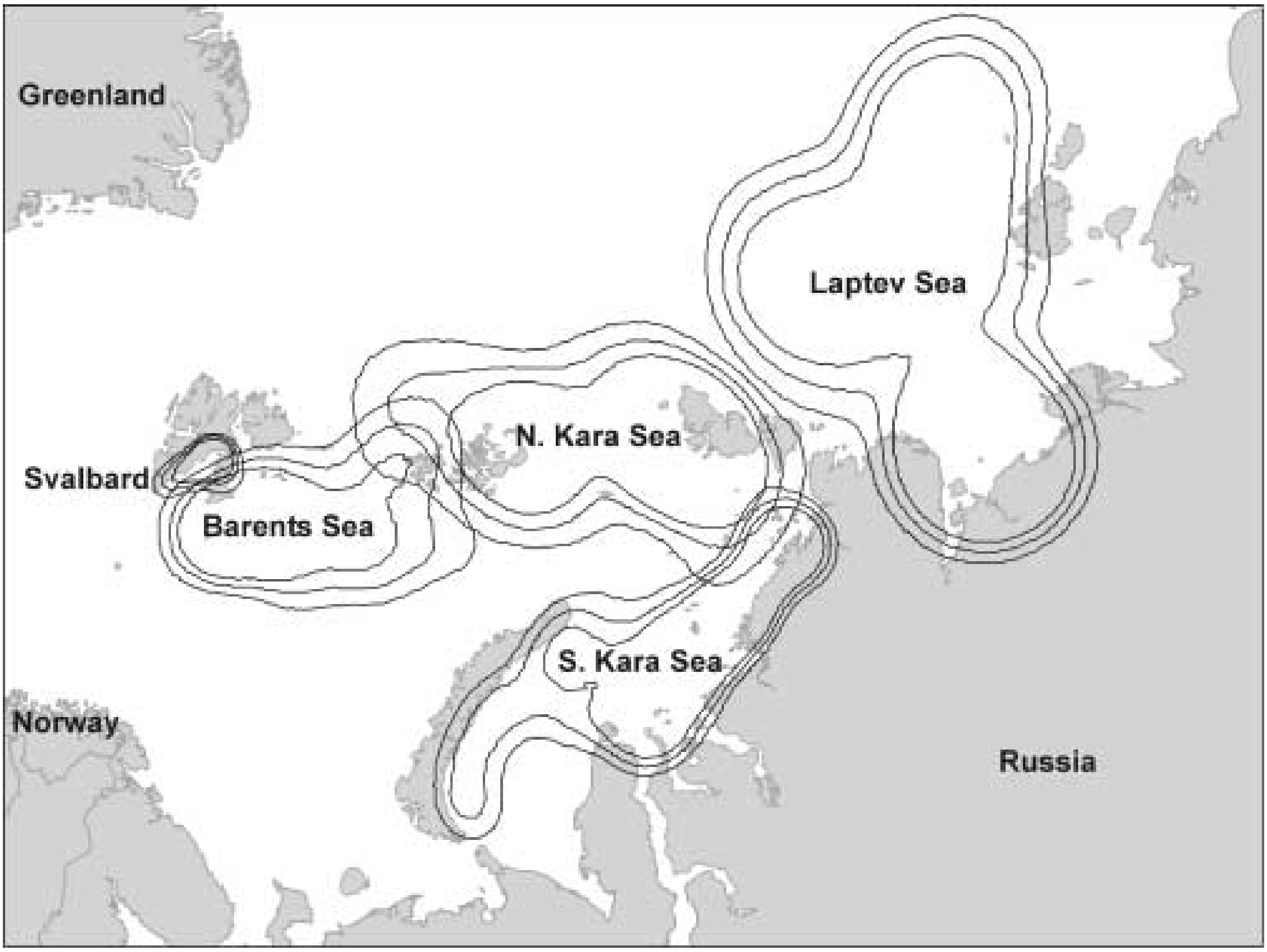

Fig. 4. Delineation of polar bear sub-populations or populations in the Svalbard to Laptev Sea area based on cluster analysis of satellite radio telemetry of adult female polar bears between 1988 and 2000 (from Mauritzen *et al.* 2002).

presumably shared with Greenland and the polar bear harvest in Greenland is unregulated (Derocher *et al.* 1998). It is possible that the joint Norwegian-Greenland population is depleted. Further assessment of this issue is required and could be coupled to further population delineation studies.

Research

Polar bear research in Norway is lead by the Norwegian Polar Institute. A large program of satellite telemetry collaring of adult females initiated in 1988 is being phased out. Since inception, 137 satellite collars were deployed on 125 different bears. These collars were programmed to provide location, activity and temperature data once every six days. In 1997, 18 collars were deployed, followed by 16, five, and seven in 1998–2000, respectively. No collars were deployed in 2001. Analysis of the satellite collar data forms part of a Ph.D. dissertation for Mette Mauritzen at the University of Oslo. This study includes investigation of habitat use, population delineation, space use patterns, and sea ice drift. Completion of this dissertation is scheduled for spring 2002.

In addition to the conventional satellite collars above, three GPS collars were deployed in spring 2000 as a pilot study to assess the new technology. Two of the collars performed well, providing up to six locations per day for over a year. One collar failed to properly initialize and never transmitted to the satellite. The high accuracy of these collars provides much greater insight in movement dynamics. Integration of location information is being linked with high-resolution satellite imagery to identify habitat use patterns.

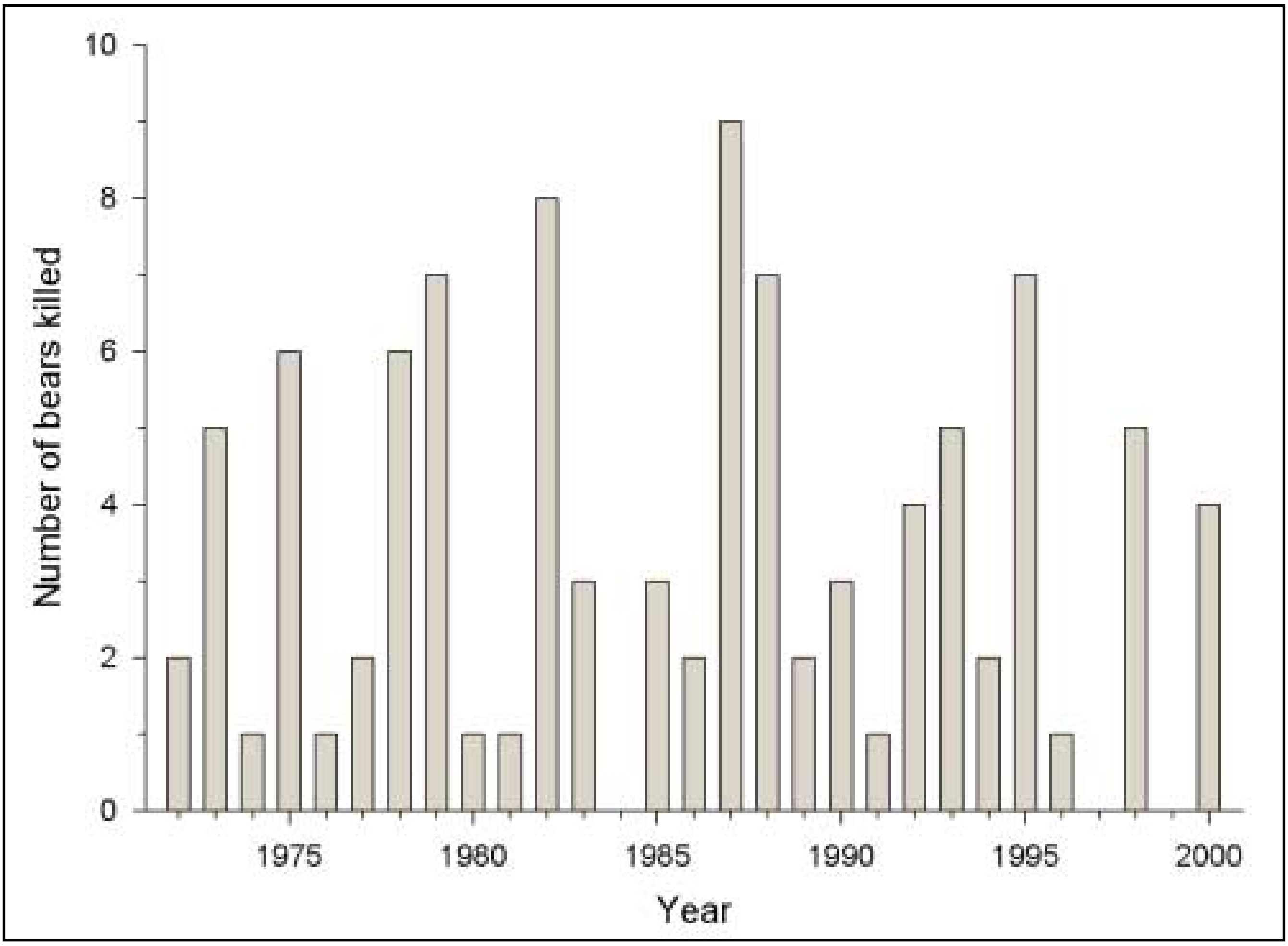

Fig. 5. Number of polar bears killed in Svalbard between 1972 and 2000 in defense of life and property or as acts of mercy.

Population dynamics and reproductive rates

Mark and recapture methods have been applied in the Norwegian Arctic to determine basic demographic rates. Since 1967, 1304 polar bears have been captured. Most of these bears (80%) have been captured since 1990. Samples in 1996–2001 were 87, 125, 236, 74, 163, and 101 respectively. The recapture rate is insufficient and the sampling regime is inadequate to obtain good population estimates. However, available data for 1988–1993 were analysed by Wiig (1998). New analyses of reproductive rates are ongoing. Lack of funding, inaccessibility of the study area, and difficult access and logistics in the Russian areas preclude adequate sampling of the whole population.

Growth rates of Svalbard bears suggests that despite a highly productive ecosystem in the Barents Sea, the bears may be slightly smaller than North American populations (see Derocher and Wiig, in press).

Denning areas and denning ecology

A GIS database of all maternity dens (over 450 dens) in the Svalbard Archipelago has been established. Trend analysis in denning patterns (den entry and emergence), den abundance, den location, and relationships with sea ice are ongoing.

Diet

Ecological studies of polar bears and their prey are continuing in the Svalbard and western Barents Sea area. Studies of fatty acid profiles in polar bears and their prey (ringed, bearded and harp seals) are ongoing in co-operation with Otto Grahl-Nielsen, University of Bergen. Of 28 fatty acids quantified in polar bears, 15 were found in lower relative amounts in their prey, eight were higher in polar bears than their prey and five were higher than the prey. Substantial overlap in fatty acids between all prey species suggests that determination of the prey using this method may be unsuccessful. A workshop planned for the next Marine Mammal Conference in Vancouver will provide an opportunity to explore this method further.

Aerial surveys

This study was designed to test Distance sampling methods for estimating population size of polar bears using aerial survey methods (Wiig and Derocher 1999). Availability of all age and sex classes of bears, adequate light and high densities of bears all suggested that aerial surveys would be most successful during August–October. Further, a basic step in these efforts is the collection of sufficient data during a pilot study to allow estimation of the number of polar bears that must be sighted during an aerial survey. With this background, the Norwegian Polar Institute initiated a pilot survey of polar bears along the northern ice-edge in the Barents Sea.

Research was conducted by Aerospatiale 350 helicopter based from the Norwegian Polar Institute Research Vessel *Lance* between 23 August and 8 September 1999. The survey consisted of two primary strata: sea ice and land. Field conditions during the survey were far from optimal with extensive periods of low cloud (< 150m). However, the methodology was sufficiently flexible that surveys could be conducted at low altitude (ca. 80m) and thus surveys could be conducted in conditions well below those required for capture of polar bears. Of the 14 days of available ship time (excluding transit to the ice edge), surveys were conducted on 24–31 August and 4–6 September. Ability to operate on approximately 80% of the days suggests a robust methodology. Days lost to weather were due to extreme winds and low thick fog in the area from Kvitøya to Kong Karls Land.

A total of 40 hours of helicopter time were flown covering approximately 5,500km of survey line over sea ice and terrestrial habitats. Approximately 50 bears were observed during the survey. Most (30 hours) of the survey was conducted over sea ice in the area from 81 to 83 N latitude and 5 to 35 E longitude. Based on preliminary analyses, the density of bears did not decline with distance from the ice edge up to ca. 100km. However, a notable increase in density from west to east was observed. Terrestrial areas on northern Spitsbergen and western Nordaustlandet were surveyed. Methods for terrestrial habitats require refinement due to the rough terrain.

The preliminary assessment is that the methods are highly applicable to estimating polar bear population size and trend. Further methodological developments are required especially to secure that g(0) = 1.

Ecotoxicology

Ecotoxicology research on polar bears in the Norwegian Arctic was a priority activity in the reporting period. Ecotoxicology research is co-ordinated by the Norwegian Polar Institute in co-operation with the University of Oslo (Ø. Wiig), Veterinary Institute (J. U. Skaare) and the Norwegian College of Veterinary Medicine (H. J. Larsen and E. Ropstad). The scope of these investigations is wide ranging with the central theme of monitoring trends and assessing potential impacts.

Studies of polychlorinated biphenyls (PCBs) and other organic pollutants were conducted to assess exposure levels and possible effects of contaminants on polar bears. High levels of PCBs in Svalbard, compared to North American populations, created concern that the pollutant loads were sufficiently high to negatively impact the population. A study of PCB levels from Svalbard to Alaska suggests that the most polluted bears in the Arctic are those in the Kara Sea (see Andersen *et al*. 2001). This study also suggests that local sources in the Kara Sea (likely the large Russian rivers) may partly explain the high PCB levels. A parallel study investigating pesticides was recently completed (see Lie *et al*. in press).

Correlative studies suggest that PCBs are affecting immune gamma globulin levels (see Skaare *et al*. 2001). Possible immune system impact prompted development of field experimental studies between Norwegian and Canadian researchers (N. Lunn and R. Norstrom, Environment Canada). This study was lead by immunologist H. J. Larsen, Norwegian College of Veterinary Medicine. The effects of high PCB exposure on the immune system were studied by comparing immune system function in polar bears with high (Svalbard) and low (Canada) PCB exposure. Bears were vaccinated with herpes, reo-, and influenza viruses and tetanus toxoid to stimulate the production of protective antibodies such as virus neutralizing antibodies, virus hemaglutination inhibition antibodies and toxin neutralizing antibodies. The immunization also included keyhole limpet hemocyanin (KLH) that together with tetanus toxoid would stimulate cell- mediated immune response. Blood was sampled at five weeks after immunization for detection of antibodies. In addition, i*n vitro* lymphocyte stimulation was performed with mitogens and specific antigens (Phytohemaglutinin, Concanavalin A, Poke weed mitogen, PPD, Lipopolysackarid). By neutralizing virus infections in cell cultures, inhibition of virus hemaglutination and toxin neutralization, the resistance factor was measured directly. Therefore, the effect of PCBs on infection resistance was measured directly. Results from the study are currently in preparation but in summary, there were indications of impaired immune response in more polluted individuals. This has important implications for disease exposure in Svalbard where more polluted individuals could have severely reduced immune response that could result in increased mortality rates. The later result is hypothetical at this time.

Trend analysis of PCB-153 (the most abundant congener) suggests that PCB levels may have declined from higher levels in the early 1990s (Fig. 6, see Henriksen *et al*. 2001). Analysis of archived samples from the late 1960s will provide additional insights into the long- term trends of pollutants in Svalbard (in co-operation with the Norwegian Institute for Air Research and Theo Colborn, World Wildlife Fund U.S.A.).

Studies of hormone levels suggest that normal hormone and vitamin A regulation may be negatively affected by PCBs (see Bernhoft *et al*. 2000). More recent studies suggest that PCBs may alter thyroid hormones but do not affect vitamin A (see Braathen 2001). Studies of female sex steroids suggest that females with higher PCB levels may induce higher circulating progesterone levels but estradiol levels were unrelated to PCBs (Haave 2001).

Analyses of new compounds in polar bears are ongoing. Polybrominated diphenyl ethers have been detected in polar bear adipose tissue but only one congener was sufficiently high to be quantified (pers. comm. B. van Bavel, University of Umeå, Sweden).

Disease and parasites

Studies of disease exposure (e.g., distemper viruses and *Brucella*) were conducted on plasma samples from live-captured bears. The studies indicated spatial variation in exposure to *Brucella* that may have been related to dietary differences (see Tryland *et al*. 2001). Exposure rates varied from 3.6% near Svalbard to 15.9% in the central Barents Sea. Antibody surveys for *Trichinella* and toxoplasmosis are ongoing. Disease and parasite surveys are conducted by the Norwegian Polar Institute in co-operation with the Department of Arctic Veterinary Medicine, The Norwegian School of Veterinary Science, Tromsø, Norway. These studies form part of an ongoing monitoring study providing baseline information on the population.

Norwegian-Russian Co-operative studies

In the central Barents Sea, a total of 69 polar bears were captured in co-operation with Russian scientists (S. Belikov, A. Boltunov, and A. Studenetsky). In spring 1997, 30 bears were captured and eight satellite collars were deployed. In spring 1998, 43 bears were captured with 13 satellite collars deployed. Sampling was

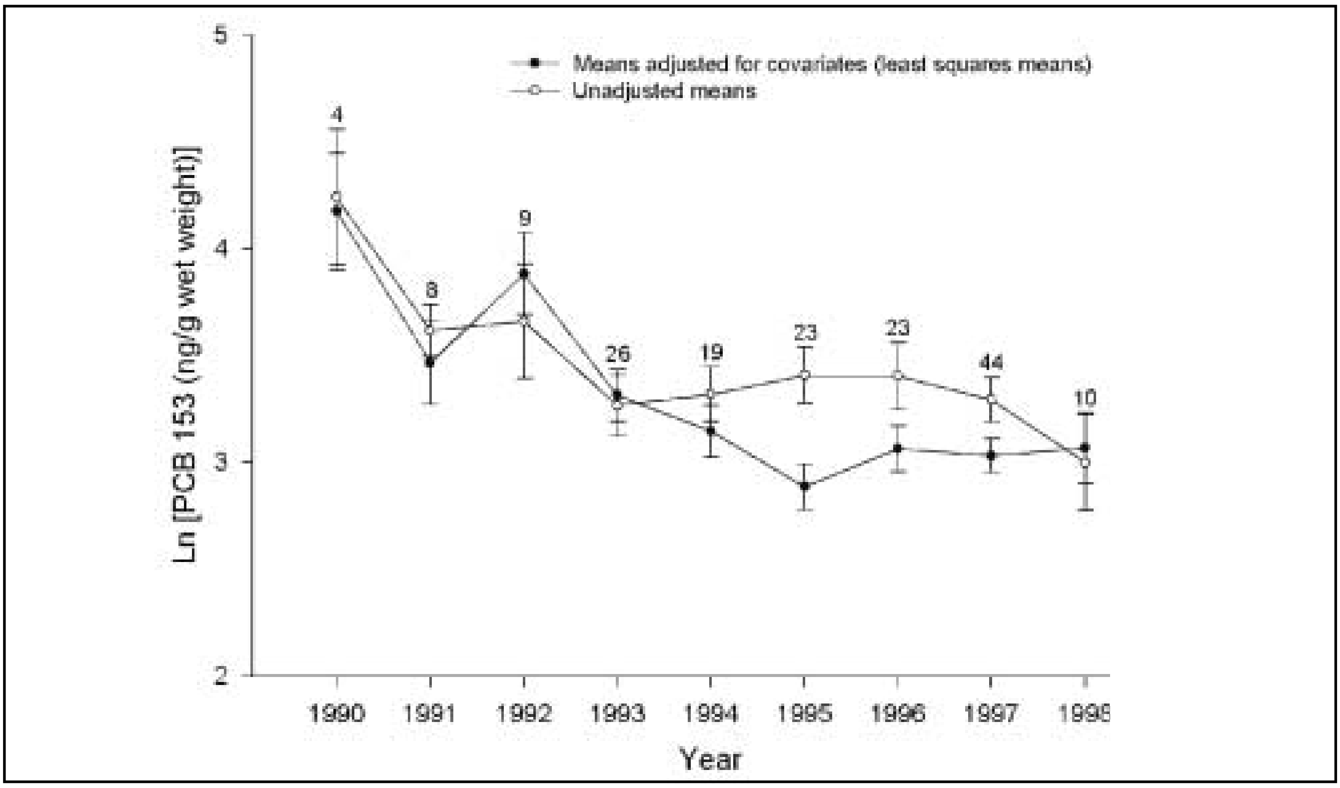

Fig. 6. PCB-153 levels in polar bear plasma between 1990 and 1998 (see Henriksen *et al*. 2001).

concentrated in the central Barents Sea and the western part of the Russian Economic Zone.

Priorities for polar bear research in Norway

In 1996, The Norwegian National Committee on Polar Research, The Research Council of Norway, identified the need to increase and improve the co-ordination of the Norwegian efforts in polar bear research. A working group was therefore appointed in 1999, which commenced its work in 2000.Two documents had recently given a detailed account of research activities and the status of knowledge (Wiig *et al*. 2000) and reviewed the need for research and management actions (Vongraven 2001) of polar bears in Norway. The working group was therefore asked to provide a short report that identified the most important research issues that required attention.

The working group identified the following prioritized issues for Norwegian polar bear research (Wiig *et al*. 2001):

- **Population delineation:** Movement studies of bears in the Greenland Sea and Arctic Ocean.
- **Population size:** Estimate the total population size.
- **Population demographics:** Determine age specific reproductive rates. Identify when (in the season) the cubs die. Determine the reason for an apparent skewed age distribution of females (few females older than 15 years of age in samples).
- **Energetics:** Identify polar bear choice of prey. Determine daily and seasonal changes in activity patterns.
- **Anthropogenic threats:** Study endocrine disruption in females and males. Survey the population for new toxic compounds. Create a predictive model that links polar bear distribution and habitat use with potential oil spill impact regimes. Assess population level effects of climate change, toxic chemicals, oil development, tourism, and harvest.
- **Ecosystem modeling:** Develop an ecosystem model focusing on polar bears in their habitat.
- **Monitoring parameters:** population size, population spatial distribution, life history parameters, pollution levels, diseases, develop new cost-effective monitoring methods.

At the Norwegian Polar Institute, research directions for the near future will be centred on the potential effects of climate change and the effects of toxic chemicals on polar bears. Multidiscipline ecological studies integrating polar bears with prey species, oceanography, remote sensing, and climate models will be a major direction. In ecotoxicology, the focus will be on long-term trends of pollutants, exposure to new pollutants, and effects studies. Ultimately, detecting possible population level effects will form a major part of the research activities. Obtaining a population estimate using aerial survey methods will form the basis for long-term population monitoring.

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Polar bear research and management in Russia 1997–2000

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Research

Polar bear den survey

The second polar bear den survey workshop was held in U.S. Geological Survey, Biological Resources Division, Anchorage, Alaska, January 2000 (the first one was held in Anchorage in 1996). The workshop was initiated by U.S. and Russian polar bear biologists to develop standardized survey methods to estimate the number of polar bear maternity dens on Wrangel Island, as an index to the size of the Chukchi Sea polar bear population. The primary objective of the workshop was to develop recommendations for standardized design protocols and standard operating procedures for den survey methods. The methods developed from the workshop were to be tested on Wrangel Island in the future.

Use of sea ice satellite remote sensing for the study of polar bear ecology

Space Monitoring and Ecoinformation Systems Sector, Institute of Problems of Ecology and Evolution (Russia) and USGS Alaska Biological Science Center (U.S.) continued research on different aspects of polar bear ecology in the Barents, Kara, and Laptev seas (70 N – 87 N, 05 E – 112 E). Satellite tracking data on 27 polar bear females and remote sensed data on sea ice cover were analyzed in this study. Polar bear telemetry was provided by Nimbus satellite system, ice cover information was provided by Russian OKEAN-01, N7, N8 satellites, U.S. Special Sensor Microwave Imager (SSM/I) and Advanced Very High Resolution Radiometer (AVHRR), sea ice drift datasets from the International Arctic Buoy Program (IABP) and the National Centers for Environmental Prediction (NCEP). New methods were developed for calculating the main polar bear movement parameters from satellite tracking data and IABP and NCEP sea ice drift data sets. The satellite telemetry and buoy data in the Barents and Kara Seas were processed, and seasonal variations in mobility and rate levels were examined. The main purpose of the study was to develop methods and assess the differences between polar bear mobility, rate and distribution observed from satellite tracking data and real mobility, rate and distribution estimated considering the sea ice dynamics.

Russian-Norwegian research

In April 1997 the All-Russian Research Institute for Nature Protection (VNIIpriroda) and Norwegian Polar Institute (NPI) started a joint project *"Polar bears of the Barents and Kara seas: their distribution, habitats, and influence of environmental pollution"*, carried out under a joint program of scientific and technical co-operation in the area of Arctic and North Research between the Ministry of Science and Technologies of the Russian Federation and the Norwegian Research Council. Field research was conducted in the spring of 1997 and 1998 from the NPI research vessel *Lance* with onboard helicopter used for searching and immobilizing polar bears and for operative ice reconnaissance. Specialists from VNIIpriroda, NPI, Zoological Museum of Oslo University, and Veterinary College (Oslo) participated in the work. Sampling concentrated in the central Barents Sea. A total of 73 polar bears were captured: 30 in 1997 and 43 in 1998. Satellite radio collars were deployed on 21 adult polar bear females. A special team on snowmobiles inspected ice floes searching for breeding sites of ringed and bearded seals. The main objectives of the research are to study the basic population parameters, and value and character of human- related contamination of polar bears in the Barents and Kara seas. Specific goals were the following:

1. Delineate population boundaries using satellite telemetry;
2. Determine predator-prey interactions in the Barents Sea and the relative importance of ringed, bearded and harp seals to polar bears using fatty acid profiles and field observations;
3. Identify denning areas in Franz-Josef Land and in the multi-year pack ice of the Barents Sea;

4. Determine critical habitats used by polar bears and determine annual variation in habitat use patterns;
5. Determine the variation in the reproduction of female polar bears (inter-birth interval, cub survival, age-specific litter size);
6. Develop an understanding of how sea ice dynamics affect polar bear reproduction;
7. Describe the distribution of ringed, bearded and harp seals in various polar bear habitats;
8. Determine the toxic chemical load of polar bears in the Barents and Kara seas.

Results of the research are published or submitted for publication (Wiig *et al*. 1999, Andersen *et al*. 2001).

Observations of polar bears in the "Wrangel Island" State Nature Reserve

In the "Wrangel Island" State Nature Reserve multiyear autumn observations of polar bears visiting the coast of the island and walrus rookeries were continued. Observers registered number of animals, their general physical conditions, and litter sizes. In addition, when possible, age and sex of observed bears were recorded. The number of polar bear carcasses found was also registered. Stationary autumn observations of polar bears were performed in two sites of walrus rookeries – Cape Blossom and Doubtful Spit. Major research objectives for these observations were group composition, social and hunting behavior with prime focusing on polar bear-walrus interactions. To observe family activity during their first days after leaving dens observations were carried out at the coast during late April 1999, when females with cubs were heading for the ice.

Modeling polar bear den-site selection on Wrangel Island

Information on this project is presented by Howlin *et al*. at this meeting.

Vessel-based observations of polar bears

Specialists from Murmansk Marine Biological Institute of the Kola Science Center, Russian Academy of Science carried out visual observations of polar bears and marine mammals on the Northern Sea Route from nuclear icebreaker cruisers in 1996–2000 (Matishov *et al*. 2000). Animals were also observed from the vessel-based helicopters during reconnaissance flights. Observation effort was concentrated in the Barents and Kara seas. The information received provides additional knowledge on the seasonal distribution of animals in the area of the Northern Sea Route.

Management

Legislative basis for protection and management of polar bear populations

Polar bear status in the Red Data Book of the Russian Federation

The polar bear is listed in the recent (second) issue of the Red Data Book of the Russian Federation (2001). The polar bear population inhabiting the Barents Sea and part of the Kara Sea (Barents-Kara population) is designated Category IV (uncertain status taxa and populations); the population of the eastern Kara Sea, Laptev Sea and the western East-Siberian Sea (Laptev population) – Category III (rare taxa and populations); the population inhabiting the eastern part of the East-Siberian Sea, Chukchi Sea, and the northern portion of the Bering Sea (Alaska-Chukotka population) – Category V (restoring taxa and populations). The Red Data Book is an official document reflecting state policy in terms of protection and restoration of rare and endangered species in Russia. The main governmental body responsible for management of species listed in the Red Data Book is the Environment Protection and Ecological Safety Department of the Ministry of Natural Resources of the Russian Federation. In Arctic regions of Russia regional Committees of Natural Resources are responsible for controlling the status of polar bear populations. Performing the control the committees conform to the federal legislation and local regulations passed by Authorities of certain Arctic subject of the Russian Federation.

Use of polar bears

Polar bear hunting is totally prohibited in the Russian Arctic since 1956. The only permitted take of polar bears is catching cubs for public entertainment and education (zoos and circuses). This last happened just in spring 2001 when six cubs of the year were caught in the Kara Sea. In some years zoos adopt 1–2 orphan cubs.

Russia follows CITES regulations appointing the polar bear to Appendix II. There are no data on illegal trade of polar bears and their derivates.

In 1997–2000 5 cases of forced kills of polar bears were registered. One person was killed by a polar bear on Novaya Zemlya in 1998.

Protection of polar bears and their habitats

In the Russian Arctic, Natural Protected Areas (NPAs) that include marine coast and/or marine areas protect terrestrial and marine ecosystems including polar bears and their habitats. Since the last PBSG meeting (Oslo,

1997) new Nenetskiy State Reserve was established (1997); it covers 313,400ha and includes the mouth of Pechora River and adjacent waters of the Barents Sea. According to a decree of the Russian Federation Government of 15 November 1997 a 12-nm marine zone was added to "Wrangel Island" State Nature Reserve. On 24th of May 1999, according to decree of Governor of Chukotsk Autonomous Okruga, a 24-nm marine protected zone was added to the Reserve.

On the 7th of May 2001 the federal Law "About territories of traditional use of nature by small indigenous peoples of North, Siberia, and Far East of the Russian Federation" came into force. Territories of traditional use of nature (TTUN) are natural protected areas of federal, regional, and local level established to support traditional life styles and traditional subsistence use of nature resources for small indigenous peoples. One of the main purposes of this Law is to protect biological diversity on the TTUNs. This Law along with the Law "About natural protected territories" (1995) regulates protection of plants and animals on the TTUNs. The latest also regulates organization, protection and use of other types of NPAs: State Nature Reserves (including Biosphere ones), National Parks, Natural Parks, State Nature Refuges, etc. Special measures on protection of certain biological objects including polar bears may be ruled by Regulations of certain NPAs.

Outside NPAs protection and use of marine renewable natural resources are regulated by federal legislation, Acts of President of the Russian Federation, regulations of State Duma, Government, and Federal Senate of the Russian Federation, and by departmental standard acts. The most important federal laws for nature protection are: "About environment protection" (1991), "About animal world" (1995), "About continental shelf of the Russian Federation" (1995), "About exclusive economical zone of the Russian Federation" (1998), "About internal sea waters, territorial sea, and adjacent zone of the Russian Federation" (1998).

Russian-American agreement on polar bears

On the 16th of October 2000 the "Agreement between the Government of the United States of America and the Government of the Russian Federation on the conservation and management of the Alaska-Chukotka polar bear population" was signed (see special report presented on this meeting). It was proposed that by the end of 2001 the Agreement would be ratified and come into force. For the most successful realization of the Agreement associations of indigenous peoples of Chukotka and Alaska will complete an agreement on conservation and use of polar bears.

Present and potential impacts on polar bears

Polar bears inhabiting the Russian Arctic are exposed to the impacts of various pollutants and first of all chlorinated organic compounds. An especially high burden of these pollutants are found in bears caught in areas of Svalbard, Franz-Josef Land, and the northern part of Novaya Zemlya. The effects of these pollutants on polar bears are not well studied yet. However anomalies in polar bear development registered in the Barents Sea in 1990s are likely caused by the pollution.

Due to social and economic changes occurring in Russia at the end of the 20th century many people have left the Arctic regions of the country; polar stations and military bases have been closed. Because of that, human-related impact on polar bears (habitat destruction, disturbance, poaching) have decreased considerably. Apparently pressure of illegal hunting of polar bears is not high throughout Russian Arctic with the exception of Chukotka, where it is presumably higher than in other regions. Despite a lack of sound information on the level of polar bear poaching in Chukotka it is necessary to undertake urgent special measures for the control and protection of the Alaska-Chukotka polar bear population.

There are plans to start in the nearest future industrial oil production on the oil fields in the southeastern part of the Barents Sea and gas production on Yamal Peninsula. Realization of these plans will cause human-related impacts on marine and coastal ecosystems including polar bears and their habitats. Another potential threat to polar bear habitats is represented by commercial navigation on the Northern Sea Route through the Russian Arctic seas. In the shallows near Novaya Zemlya, reactors containing nuclear fuel from vessels and submarines are submerged, causing a potential danger of radioactive contamination of marine ecosystems.

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Polar bear management in Alaska 1997–2000

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Since the Twelfth Working Meeting of the IUCN/SSC Polar Bear Specialist Group in 1997, a number of changes in the management of polar bears have occurred in Alaska. On October 16, 2000, the governments of the United States and the Russian Federation signed the "Agreement on the Conservation and Management of the Alaska-Chukotka Polar Bear Population." This agreement provides substantial benefits for the effective conservation of polar bears shared between the U.S. and Russia. It will require enactment of enabling legislation by the U.S. Congress and other steps by Russia before the agreement has the force of law. A copy of the agreement is included as Appendix 1 to this report. Also, during this period, regulations were developed to implement 1994 amendments to the Marine Mammal Protection Act (MMPA), which allow polar bear trophies taken in approved Canadian populations by U.S. citizens to be imported into the U.S. A summary of the regulatory actions and a table listing populations approved for importation and the number of polar bears imported into the U.S. since 1997 is included in this report. Regarding oil and gas activities in polar bear habitat, three sets of regulations were published authorizing the incidental, non-intentional, taking of small numbers of polar bears concurrent to oil and gas activities.

Cooperation continued with the Alaska Nanuuq Commission, representing the polar bear hunting communities in Alaska, as well as with the North Slope Borough and the Inuvialuit Game Council in their agreement for the management of the Southern Beaufort Sea polar bear population. Harvest summaries and technical assistance in designing and assistance in conducting a National Park Service/Alaska Nanuuq Commission study to collect traditional ecological knowledge of polar bear habitat use in Chukotka were provided. In addition, a long-range plan was developed to address and minimize polar bear-human conflicts in North Slope communities.

We continued to monitor the harvest of polar bears in Alaska and collect and analyze specimens for presence and level of organochlorine compounds and trace elements. A paper on genetic assessment of hunter reported sex of harvested bears was recently published (Schliebe *et al.* 1999). Population status and trend assessment efforts continued. An aerial survey of polar bears in the Eastern Chukchi Sea and western portions of the Southern Beaufort Sea was conducted from the U.S. Coast Guard icebreaker "Polar Star" in August 2000. The first year of a multi-year survey of barrier islands and coastlines during the open water and freeze-up phase was conducted in the central Southern Beaufort Sea during fall 2000.

Polar bear kills

Alaska harvest summary

The total Alaska harvest of polar bears from July 1996 to June 2000 was 317 animals (Table 10), with a mean of 79 animals per year (range: 60–105). In addition to the subsistence harvest, there was one research mortality and one orphaned cub placed into a zoo. Comparing harvest rates from the 1980 to 1990 period ($\bar{x}$=131) and the 1991 to 2000 period ($\bar{x}$=85), reveals that there has been a general downward trend in harvest state-wide. The decline is caused primarily by a decreased harvest in the Chukchi/Bering seas stock. Harvest levels from the Chukchi/Bering seas population were significantly different between 1980–90 and 1991–2000 ($t=2.42$, $df=12.5$, $p<0.03$), whereas harvest levels in the Southern Beaufort Sea during the same periods were not significantly different. A combination of factors may be responsible for the declining harvest.

Table 10. Number of polar bears killed in Alaska by village, harvest year[1], and sex.

	1996/97			1997/98[2]			1998/99			1999/2000[3]			Total		
Village	**M**	**F**	**U[5]**	**M**	**F**	**U**	**M**	**F**	**U**	**M**	**F**	**U**	**M**	**F**	**U**
Atqasuk[4]	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
Barrow[4]	19	18	2	11	4	2	9	4	3	15	–	2	54	26	9
L. Diomede	6	–	–	2	2	3	3	1	–	7	2	2	18	5	5
Gambell	4	3	–	1	1	–	11	9	1	1	3	–	17	16	1
Kaktovik[4]	1	1	2	1	–	1	–	1	–	1	–	–	3	2	3
Kivalina	–	–	–	–	–	–	2	1	–	–	–	–	2	1	–
Kotzebue	–	1	–	–	–	–	2	2	–	–	–	–	2	3	–
Nome	–	–	–	–	–	–	–	–	2	–	–	–	–	–	2
Nuiqsut[4]	–	–	–	2	–	–	2	1	–	5	1	1	9	2	1
Point Hope	9	3	2	3	7	2	11	4	2	6	–	2	29	14	8
Point Lay	4	2	–	2	1	–	–	–	–	2	–	1	8	3	1
Savoonga	1	1	–	3	2	–	6	5	–	2	2	–	12	10	–
Shishmaref	–	–	–	2	1	–	12	3	–	1	–	1	15	4	1
Wainwright[4]	5	1	2	2	2	2	1	–	1	3	1	–	11	4	5
Wales	–	1	1	1	–	–	4	2	–	1	–	–	6	3	1
Sub-total	**49**	**32**	**9**	**30**	**20**	**10**	**63**	**33**	**9**	**44**	**9**	**9**	**186**	**94**	**37**
Total		**90**			**60**			**105**			**62**			**317**	

[1] harvest year is from July 1 to June 30
[2] subsistence harvest does not include 1 cub sent to a zoo
[3] subsistence harvest does not include 1 research mortality
[4] village harvests polar bears from the Southern Beaufort Sea population
[5] unknown sex

Table 11. Numbers of polar bears harvested in Alaska, 1996/97–1999/2000, in relation to age class. Ages are based on counts of cementum annuli in the first premolar tooth (cubs, 0–2.3 yrs; subadults, 2.33–4 yrs; adults, 5+ yrs). Percentages in parentheses.

	1996/97[1]	1997/98	1998/99	1999/2000[2]	Total
Cubs	12 (27.9)	3 (9.1)	7 (9.2)	0 (0.0)	22 (14.3)
Subadults	8 (18.6)	8 (24.4)	38 (50.0)	1 (50.0)	55 (35.7)
Adults	23 (53.5)	22 (66.7)	31 (40.8)	1 (50.0)	77 (50.0)
Total bears	**43**	**33**	**76**	**2**	**154**

[1] harvest year is from July 1 to June 30
[2] ages have yet to be determined for 19 additional bears

Changes in the demographics of Native hunting communities may be partly responsible for the reduced harvest. In addition, weather and ice conditions may have altered polar bear distribution and availability to the hunters. Another possibility is that fewer bears may be available to Alaska hunters due to increased harvesting in Chukotka.

From 1996–2000, hunters from villages harvesting Beaufort Sea stock (Northern Area) polar bears accounted for 41% (Table 10) of the total statewide kill. Declines in the Chukchi/Bering seas polar bear harvest, in the 1990s, have resulted in the Southern Beaufort Sea harvest accounting for a greater proportion of the annual statewide harvest. The sex ratio of the harvest from 1996–2000 was 66 males: 34 females. Long-term

Table 12. Mean age of polar bears harvested in Alaska, 1995/96–1998/99[1] in relation to sex. 'N' is the number of known age bears.

	1995/96			1996/97			1997/98			1998/99		
Sex	**n**	$\bar{x}$	**sd**	**n**	$\bar{x}$	**sd**	**n**	$\bar{x}$	**sd**	**n**	$\bar{x}$	**sd**
Southern Beaufort Sea												
Male	8	5.8	4.2	11	8.3	7.3	9	8.8	5.2	2	3.0	–
Female	2	4.0	–	8	8.6	9.4	2	3.0	–	4	4.5	2.4
Unknown	9	5.9	5.7	0	–	–	0	–	–	0	–	–
Chukchi Sea												
Male	1	4.0	–	14	6.5	5.7	10	10.3	8.4	45	5.7	4.6
Female	1	11.0	–	9	6.5	6.1	12	10.4	7.6	24	5.0	2.9
Unknown	0	–	–	1	22.0	–	0	–	–	1	3.0	–

[1] harvest year is from July 1 to June 30

differences in the sex ratio were not detected for either the northern or western areas, although annual variation by region was evident. Complete information on the age and sex of harvested bears was available for 51% of the kill, which is a decline since the last PBSG report. The harvest age class composition from 1996 to 2000 was 14.3% cubs, 35.7% sub-adults, and 50.0% adults (Table 11). Mean age of harvested polar bears is presented in Table 12.

State-wide, harvests occurred in all months during 1996–2000. The greatest monthly harvest for the period occurred during March (14.8%). The combined months of November to May, when the pack ice is in proximity to shore, accounted for 79.1% of the harvest. The months of June to September, when the pack ice is retreating to its minimum, accounted for 20.9% of the harvest, which is an increase of approximately 11% from the period 1990–1995. Differences in the chronology of the harvest were evident between the Beaufort Sea region and the Chukchi and Bering seas region. The harvest in the northern area occurs primarily from September to December (56.0%) and during April and May (15.2%). The harvest in the Chukchi and Bering seas is later because the pack ice arrives later. The harvest in the Chukchi and Bering seas region is more evenly distributed through the mid-winter and spring from January to May (88.2%). Since 1980, significantly

Table 13. Number of polar bears harvested from the Southern Beaufort Sea by village, harvest year and sex.

	1996/97[1]			1997/98[2]			1998/99			1999/2000[3]			Total		
Village	**M**	**F**	**U**	**M**	**F**	**U**	**M**	**F**	**U**	**M**	**F**	**U**	**M**	**F**	**U**
Atqasuk	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–
Barrow	19	18	2	11	4	2	9	4	3	15	–	2	54	26	9
Kaktovik	1	1	2	1	–	1	–	1	–	1	–	–	3	2	3
Nuiqsut	–	–	–	2	–	–	2	1	–	5	1	1	9	2	1
Wainwright	5	1	2	2	2	2	1	–	1	3	1	–	11	4	5
Sub-total	25	21	6	16	6	5	12	6	4	24	2	3	77	35	18
Total		**52**			**27**			**22**			**29**			**130**	

[1] harvest year is from July 1 to June 30
[2] subsistence harvest does not include 1 research mortality
[3] subsistence harvest does not include 1 research mortality

more bears have been harvested in the fall (October–December) in the Southern Beaufort Sea than in the Chukchi/Bering seas (X^2=181.58, df=2, p<0.001). Pack ice is generally absent from coastal Alaska during July and August, resulting in low harvests (3.5%).

Southern Beaufort sea harvest summary

The total Alaska harvest, from July 1996 to June 2000, by Alaska villages party to the agreement was 130 animals, an average of 32.5 bears per year (range 22–52) from a quota of 40. Two additional removals not included in the subsistence harvest were one orphaned cub that was sent to a zoo and one research mortality (Table 13).

The sex ratio of the harvest from 1996–2000 was 69 males: 31 females. Complete information on the age and sex of harvested bears (38/130) was available for 29.2% of the kill. Net annual mean removal of females was calculated based upon summing the known sex females and adding 50% of the unknown sex bears for the 1996–2000 period and then dividing the sum by the number of years. The net mean removal of females (11) for this period was below the sustainable yield calculation (12.6), which was based upon a 2:1 male to female sex ratio in the harvest. The harvest age class composition, from 1996 to 2000, was 7.9% cubs, 44.7% sub-adults, and 47.4% adults. Although statewide the harvest occurred in all months, the harvest in the Beaufort Sea area was bimodal and favored the September to December (56.1%) and April to May (15.4%) periods.

Bio-monitoring

Specimens from polar bears have been collected and analyzed since 1995 for contaminant levels. Compared to Canada, Greenland, and Norway, relatively little recent information on heavy metal and organochlorine contamination is available on polar bears in Alaska and Russia. The Arctic Monitoring and Assessment Programme (AMAP) has identified polar bears as a focal species due to their wide distribution, upper trophic level position in the marine food chain, and their value to Native subsistence users. Program objectives are to determine baseline levels of trace elements in liver, kidney and muscle, and organochlorine pesticides in fat tissues of adult male polar bears in Alaska and determine if there are significant differences in contaminant levels between other Arctic populations and between the two Alaska populations. Samples from 27 adult male polar bears have been acquired to date, 11 from the Beaufort Sea population and 16 from the Chukchi/Bering seas population.

PCB levels analyzed to date are low relative to higher levels found in polar bears in eastern Hudson Bay, Canada and Svalbard, Norway. Levels of total polychlorinated biphenyls (S-PCBs ppm. wet weight) averaged 3.02 ppm (n=27, range 0.90–8.72 ppm). The highest levels of S-PCB in Alaska were found in four bears from Barrow (8.72 ppm, 6.06 ppm, 5.06 ppm, 5.01 ppm) and one from Savoonga, (5.05 ppm). Seven congeners (99, 153, 138, 180, 170/190, 194, and 206) constituted approximately 91% of the S-PCB sampled.

Average HCH levels are among the highest levels reported in the Arctic. Mean level of total hexachlorocyclohexane (S-HCH ppm wet weight) for the 27 bears analyzed was 0.91, similar to the high levels reported for the Chukchi and Bering seas by Norstrom *et al.* (1996). Beta-HCH, the most persistent HCH isomer, constituted about 93% of the sum HCHs. However the role of HCH levels with respect to the health of polar bears, human consumers, and the Arctic ecosystem is not known.

Nineteen trace elements in the muscle, livers, and kidneys of 22 adult male polar bears taken in northern and western Alaska were analyzed. Samples from 14 bears were used to calculate the average methyl mercury levels because some of the mercury levels in the muscle samples were below the detection limit. The methyl mercury/mercury ratios in the muscle tissues averaged 37%. Several elements (Al, As, B, Ba, Be, Mo, Pb) were near the detection limit in all tissues. Results from 22 Alaska polar bears (both population stocks combined) indicate that Hg levels were lower but concentrations of Cd and Cu higher in the livers of Alaska bears compared with those reported for western Canada in 1986.

Samples have also been collected for long-term storage with the Alaskan Marine Mammal Tissue Archival Project (AMMTAP) for future use as analytical techniques improve and to assist in the development of spatial and temporal trends of contaminant levels in the Arctic. Standardization of quality assurance and quality control procedures will help reduce past limitations that have hindered making meaningful comparisons among various data sets. The contaminant data collected from the polar bear bio-monitoring program have been used for inter-laboratory comparisons, analysis of polychlorinated naphthalenes and perfluorooctane sulfonate in livers, and physiological studies on contaminant accumulation and effects on polar bears, uptake between trophic levels in the Arctic ecosystem, and the health of local consumers.

Marine Mammal Protection Act

Importation of Polar Bear Trophies

The 1994 Amendments to the Marine Mammal Protection Act allow for the issuance of permits to import sport-hunted polar bear trophies from Canada provided that the following legal and biological findings are made: 1) Canada has a monitored and enforced sport hunting program consistent with the purposes of the Agreement on the Conservation of Polar Bears; 2) Canada has a sport hunting program based on scientifically sound quotas ensuring the maintenance of the affected population stock at a sustainable level; 3) the export and subsequent import are consistent with the provisions of the Convention on International Trade in Endangered Species of Wild Fauna and Flora and other international agreements and conventions; and 4) the export and subsequent import are not likely to contribute to illegal trade in bear parts.

In July 1995 a proposed rule was published to allow import of polar bear trophies taken in six approved populations in the Northwest Territories. The final rule (February 1997) approved the import of polar bear trophies from five populations, one less than originally proposed. The Gulf of Boothia population was deferred because of the lack of scientific data to support the population estimate and the harvest of females exceeded harvest guidelines. The final rule added a provision to allow the import of pre-Amendment polar bear trophies if they were taken prior to the 1994 MMPA amendments from approved populations. The final rule did not include "grandfathering" of bears taken between the 1994 MMPA amendments through the date of the final rule. In June 1997, the MMPA was amended to allow, by permit, the import of all pre-Amendment bears legally taken before April 30, 1994. In January 1999, polar bear trophy imports from Lancaster Sound and Norwegian Bay were approved.

On January 10, 2001, an emergency interim rule was published that found the M'Clintock Channel population no longer met the import requirements of the MMPA. Regulations were amended to reflect that polar bears sport hunted from this population after May 31, 2000, would no longer be eligible for import under the 1997 finding, which approved this population for multiple harvest seasons. The emergency interim rule was in response to new information provided by the Canadian Wildlife Service, which indicated that this population was in a depleted state and that harvest quotas had not ensured a sustainable population level. A final rule that addresses comments received on the emergency interim rule is expected to be published in June 2001.

As of June 2001, six of the 14 polar bear populations in Canada have been approved for the import of trophies by permit: 1) Southern Beaufort Sea; 2) Northern Beaufort Sea; 3) Viscount Melville Sound; 4) Western Hudson Bay; 5) Lancaster Sound; and 6) Norwegian Bay. Lancaster Sound and Norwegian Bay were approved in January 1999. The M'Clintock Channel

Table 14. Number of import permits issued for polar bear trophies by year and population.

		Year				
Status	**Population**	**1997**	**1998**	**1999**	**2000**	**Total**
Approved (includes pre-Amendment bears)	Lancaster Sound	19	16	105	31	171
	M'Clintock Channel[1]	25	13	10	14	62
	Northern Beaufort Sea	40	3	8	9	60
	Norwegian Bay	0	0	1	1	2
	Southern Beaufort Sea	32	13	16	18	79
	Viscount Melville Sound	5	4	0	0	9
	Western Hudson Bay	0	2	2	2	6
Deferred (pre-Amendment bears only)	Baffin Bay	3	2	0	0	5
	Davis Strait	2	3	1	1	7
	Foxe Basin	5	2	0	0	7
	Gulf of Boothia	1	2	0	0	3
	Kane Basin	0	0	0	0	0
	Southern Hudson Bay	0	0	0	0	0
	Queen Elizabeth Islands	0	0	0	0	0
	Total all populations	**132**	**60**	**143**	**76**	**411**

[1] bears taken on or before 31 May 2000

population was approved for bears sport hunted on or before May 31, 2000.

Polar bear hunting is not allowed in the Queen Elizabeth Islands population. The remaining six populations have been deferred pending the completion of comprehensive population studies or the development of joint management agreements for shared populations. Except for the Gulf of Boothia, Nunavut shares jurisdiction of the other five deferred populations with Greenland, other Canadian jurisdictions, or both.

Funds from a US$1,000 permit issuance fee are dedicated to support conservation initiatives for polar bear stocks shared between the U.S. and Russia and have been used to: 1) develop a bilateral conservation agreement; 2) conduct population surveys; 3) collect knowledge of polar bear habitat use; 4) develop standard surveying protocols; and 5) develop outreach materials.

A total of 411 polar bear trophy import permits were issued between April 1997, when regulations authorizing these imports went into effect, and December 2000 (Table 14).

A scientific review of the impact the issuance of import permits may have on the polar bear populations in Canada is underway. The draft report is based on an analysis of current information, including data provided by the Canadian Wildlife Service and Canada's Polar Bear Technical Committee; comments on the draft report will be solicited in 2001.

The number of permits issued for public display or research purposes is included in Table 15.

Stock assessments

Development of stock assessment reports for polar bears and other marine mammal species was required through MMPA amendments in 1994. Information on stock bounds, calculation of Potential Biological Removals (PBRs), and an assessment of whether incidental fishery takes are "insignificant and approaching zero mortality and serious injury rate" are included. Alaska Chukchi/Bering Seas Stock and Beaufort Sea Stock assessments were recently published (Schliebe and Evans 1998). The status of both stocks was determined to be "non-strategic." Stock assessments will be revised in 2001 and incorporate the most recent scientific information developed since 1995.

Co-Management: Alaska Nanuuq Commission

The Alaska Nanuuq (polar bear) Commission represents 14 villages from northern and western coastal Alaska. The Alaska Nanuuq Commission has been active in developing the U.S.-Russia bilateral agreement and in drafting a companion implementation Native-to-Native Agreement between Alaska and Chukotka. In addition the Commission is coordinating a National Park Service-funded project to collect traditional ecological knowledge of polar bear habitat use in Chukotka.

Incidental take by oil and gas operators

Section 101(a)(5) of the MMPA authorizes the incidental, but not intentional, taking of polar bears by citizens engaged in specific activities in specific

Table 15. Number of permits issued/reissued and number of live polar bears and polar bear parts authorized for export from the U.S., for the purpose of public display or scientific research, 1 January 1996 to 31 December 2000 (U.S. Fish and Wildlife Service CITES unpublished data).

		1996		1997		1998		1999		2000	
Reason	**Type**	**Permits**	**Parts**	**Permits**	**Parts**	**Permits**	**Parts**	**Permits**	**Parts**	**Permits**	**Parts**
Public display	live			1	2	1	1			1	1
Scientific research	skin/fur					2	5	2	var	1	var
	teeth	4	600	1	200	2	400	4	400+	3	400+
	claws							2	var	1	var
	bones							2	var	1	var
	biological specimens	3	740	4	504	3	500	4	400+	5	400+
	total (scientific research)[1]	6		5		7		5		7	

[1] multiple types of specimens may be authorized on each permit for the purpose of scientific research

geographical areas provided that the total taking during a five-year period will have a negligible impact on the species and will not have an unmitigable adverse impact on the availability of such species for taking for subsistence uses. Three sets of incidental take regulations had been developed since 1997.

Incidental take regulations require that operators conduct a program to monitor and report the effects of their activities on polar bears. Letters of Authorization provide details on project specific monitoring conditions and reporting requirements. An upward trend in the number of Letters of Authorization issued and corresponding number of polar bears observed have been noted since 1993, although monitoring results to date do not indicate there have been site-specific impacts to polar bears. From 1997–2000 there were 125 LOAs issued and 229 polar bear observations associated with industrial activities. Fifty-nine percent of observations occurred at production facilities, and 85% of deterrent activities occurred at production facilities. The most recent regulations included activities associated with the first offshore oil production facility to transport crude oil to land via sub-sea pipeline. Current Beaufort Sea incidental take regulations will expire in March 2003.

International Treaties and Conventions

U.S./Russia Bilateral Agreement

On October 16, 2000 the United States and Russia, following more than eight years of discussions and negotiations, signed a long-term bilateral agreement for the conservation and management of polar bears shared between the two countries (see Annex 1). David Sandalow, Assistant Secretary of State, and Yuriy Ushakov, Russian Ambassador to the U.S., signed the Agreement in Washington, D.C.

The Agreement represents a significant effort by the United States and Russia, parties to the 1973 Agreement on the Conservation of Polar Bears with Denmark (for Greenland), Norway, and Canada, to implement ground-level unified conservation programs for this shared population. The primary purpose is to assure the long-term conservation of the population and its habitat through science supported programs, which can be carried out in both countries. The Agreement is unique in the international arena since it provides for meaningful involvement by both Alaska and Chukotka native people and their organizations through a joint Commission, which would administer implementation of the Agreement.

Specific management and research programs would be identified collaboratively through the Commission, comprised of a government and a Native representative from each country. A scientific group would also be formed to provide technical advice to the Commission.

The Agreement recognizes the needs of native people to harvest polar bears for subsistence purposes and includes provisions for developing binding harvest limits, allocation of the harvest between jurisdictions, and compliance and enforcement. Each jurisdiction is entitled to up to one-half of the harvest limit. The Agreement reiterates requirements of the 1973 multilateral agreement and includes restrictions on harvesting denning bears, females with cubs, or cubs less than one year old, and prohibitions on the use of aircraft, large motorized vessels, and snares or poison for hunting polar bears. The Agreement does not allow hunting for commercial purposes or commercial uses of polar bears or their parts. It also commits the Parties to the conservation of ecosystems and important habitats, with a focus on conserving polar bear habitats such as feeding, congregating and denning areas.

In the past, the shared Alaska-Chukotka polar bear population has been subject to different management strategies, and coordination of research and studies has been difficult. In the former Soviet Union, hunting of polar bears was banned in 1956. Recently, that level of protection has diminished due to an inability to enforce the nationwide ban. In Alaska, subsistence hunting by natives is not restricted provided that the polar bear population is not depleted. In addition, while several joint research and management projects have been successfully undertaken in the past, comparable efforts are either no longer occurring or are conducted unilaterally. Therefore the primary factors motivating the development of this agreement were the need to coordinate and regulate harvest practices, to protect polar bear habitat, and to conduct or expand joint research and management programs.

In the U.S., a number of procedural steps are required in order to effect this Agreement. The U.S. Congress must enact enabling legislation to augment the provisions of the Marine Mammal Protection Act. In Russia, the need for legislative steps, if any, to provide authorities for implementation are being determined. Once legislation is in place, the Commission will be formed, management structures put into place, and implementation begun.

North Slope Borough/Inuvialuit Game Council Agreement

Modifications of the Inuvialuit Game Council/North Slope Borough (IGC/NSB) Agreement on the Management of Polar Bears in the Southern Beaufort Sea were accepted by villages party to the Agreement and ratified during the annual meeting of the Joint Commissioners and Technical Advisors in Inuvik, Canada on March 3–4, 2000 (see Annex 2). The Agreement will remain in effect indefinitely. The Agreement was amended to include terms indicating that the annual sustainable harvest will be determined by the Joint Commission with the consultation of the Technical Advisory Committee and that prior notification and consultation with the Joint Commission will be necessary prior to undertaking research. In addition, problem kills or research handling deaths are now included as part of the calculation of sustainable yield and the sustainable yield calculation now formally establishes a target sex ratio of two males to one female in the harvest.

A manuscript evaluating the effects of the first 10 years of the IGC/NSB Agreement has been submitted for publication.

The total Alaska harvest by Alaska villages party to the agreement from July 1988 to June 2000 was 404 animals with an average of 33.6 bears per year (range 21–58). Three additional removals not included in the subsistence harvest were three cubs that were orphaned and sent to zoos and one research mortality.

The sex ratio of the harvest from 1988–2000 was 73 males: 31 females. Complete information on the age and sex of harvested bears (174/404) was available for 43.0% of the kill. Net annual mean removal of females was calculated based upon summing the known sex females and adding 50% of the unknown sex bears for the 1988–2000 period and then dividing the sum by the number of years. The net mean removal of females (10.5) for this period was below the sustainable yield calculation (12.6), which was based upon a two male: one female sex ratio. The harvest age class composition from 1988 to 2000 was 12.6% cubs, 37.4% sub-adults, and 50.0% adults. Although state-wide the harvest occurred in all months, the harvest in the Beaufort Sea area was bimodal and favored the September to December (56.1%) and April to May (15.4%) periods.

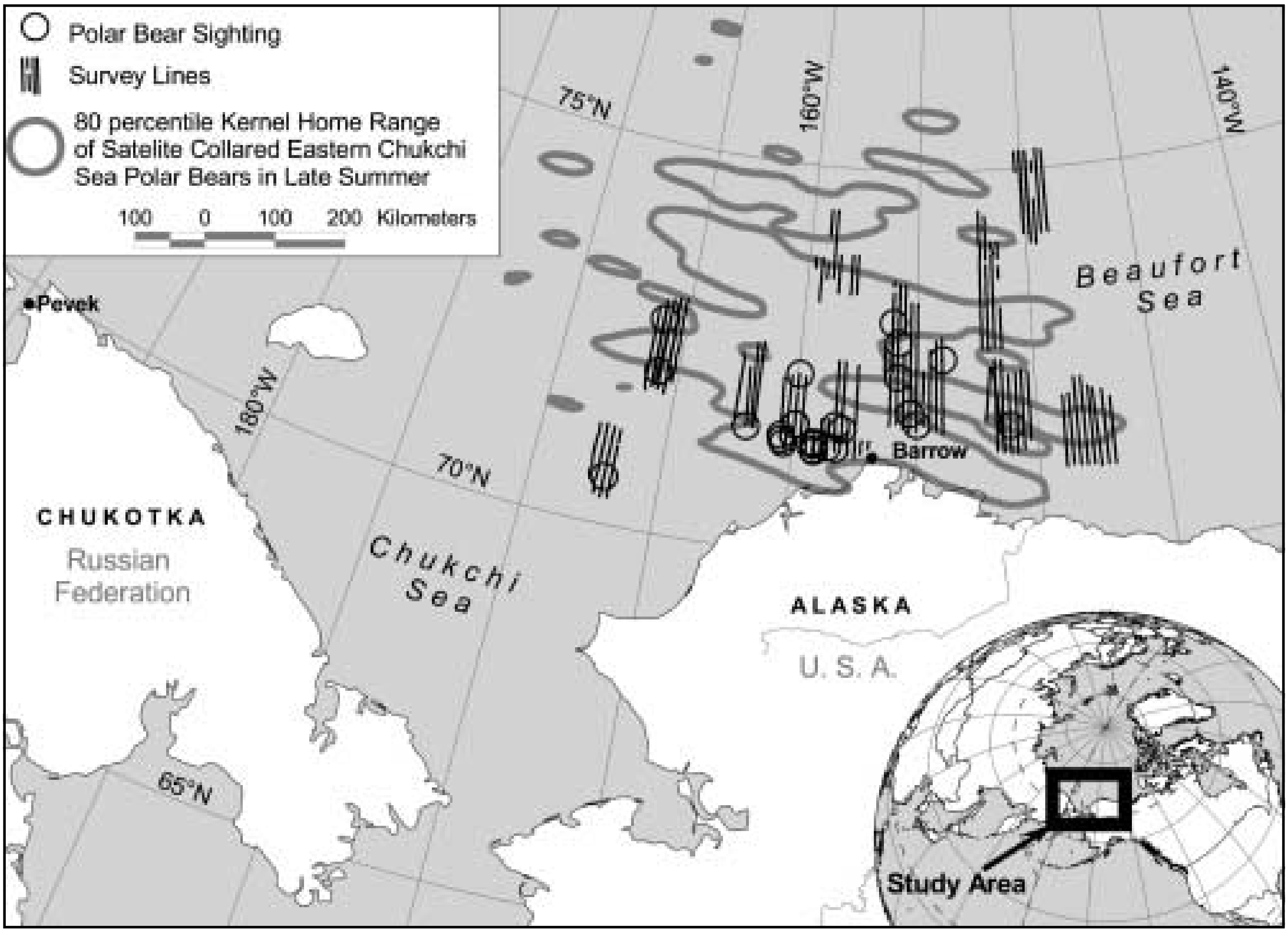

Fig. 7. Transects flown during August 2000 polar bear survey in the eastern Chukchi and Beaufort seas.

Population status and trend

Den Surveys: Russian Arctic

The high density of polar bears denning on Wrangel Island, Herald Island and the mainland on the Chukotka Peninsula provides a unique opportunity to gather scientific data that may provide an index for the Chukchi/Bering seas population. Reliable data on the number of females denning in these critical denning areas over time may be used to monitor the Chukchi/Bering seas population status and trend.

A December 2–6, 1996 workshop evaluated previous den surveys and standardized protocols for conducting polar bear den surveys on Wrangel Island, Herald Island and the mainland on the Chukotka Peninsula in Russia. The U.S. Geological Service, FWS, Wrangel Island Nature Reserve, and the All-Russia Research Institute for Nature Conservation participated in the workshop. Final Workshop Proceedings, "Polar Bear Maternity Den Surveys in the Russian Arctic: Development of Protocols and Standard Operating Procedures," (McDonald and Robertson) were published in December 1998 and revised in May 2000.

A project to model denning habitat use on Wrangel Island was designed and initiated to stratify denning habitats that would serve as a basis for future surveys. Mikhail Stishov reports on the results of this effort.

Aerial Survey Eastern Chukchi Sea

Aerial polar bear surveys were conducted during August 2000 from the U.S. Coast Guard (USCG) icebreaker *Polar Star*. Objectives were to develop a population density estimate for the Eastern Chukchi Sea and to determine the utility of conducting future surveys from this platform. Line transect surveys were conducted using two Delphine H-65 helicopters. The study area extended from 168° to 146° west longitude between 70° and 75°30' north latitude with survey efforts focused in the general area delineated by the 80% contour for the "Eastern Chukchi Sea" population (Amstrup pers. comm.) (Fig. 7). This area was determined from 335 satellite locations of 36 satellite radio-collared female polar bears collected from 1984 to 1998 (Amstrup *et al*. 2000).

Randomly selected survey lines were flown at 91m and at an airspeed of 145km/hr. The data recorder noted wildlife sightings, sighting angles, altitude, ice conditions, and weather from the observations. Ice conditions including ice stage, ice form, percentage ice cover, and percentage of snow cover were based on the NOAA Observers Guide to Sea Ice (Smith 2000). Survey effort included distance, area, and flight duration as determined from a GPS (Garmin III+) set to record locations of the plane every 15 seconds. Microsoft's Access database software was linked to the track log time and observation to provide location.

Bears observed on the transect line by the primary observers during good to fair visibility were included in the analysis, which was conducted using Distance Program Version 3.5 software (Buckland *et al*. 1993). Density estimates were calculated using both empirical and poisson distributions, with and without a detection correction factor, and for all ice coverages and for those greater than 10%. Four detection functions (uniform, half normal, hazard-rate, and negative exponential) were modeled. The preferred model was selected considering the minimum Akaike's Information Criterion (AIC) (Thomas *et al*. 1998) and the coefficient of variation.

A total of 71 flight hours of aerial survey were flown during 43 flights between 2 August, 2000 and 28 August, 2000. We flew 8,265km of transect lines (n=94) during the survey. Fifty-two polar bears were seen during the aerial survey and 12 additional polar bears were seen from the USCG icebreaker *Polar Star*. Twenty-five polar bear groups consisting of 29 individuals were seen on transect by the primary observers during the line transect survey. Density estimates from the selected models ranged from 0.005 to 0.01 bears/km^2. We used detection rate values (0.67) as default values (McDonald *et al*. 1999) since survey conditions were comparable.

The half-normal distribution with a simple polynomial correction was chosen since it best fitted the detection curve of groups as a function of distance from the inside transect line, and because it had the lowest CV. Density of polar bear groups was estimated in our study area as 0.006 bears per km^2 with upper and lower 95% confidence bounds of 0.003 and 0.01 respectively. This equates to an average of 179km^2 per bear (339 UCL and 95 LCL). If only survey effort that was flown over areas of 10% or greater ice coverage (7,525km) were considered, the polar bear density would be 0.0065 (0.0033 UCL, 0.013 LCL), which equates to 153km^2 per bear (307 UCL, 76LCL). The density estimate has a CV of 36.5%.

The results of this survey are promising although modifications would improve the precision of the density estimate. A manuscript is currently under review. Future aerial surveys will be designed to enhance sample sizes and improve confidence intervals for density and population estimates.

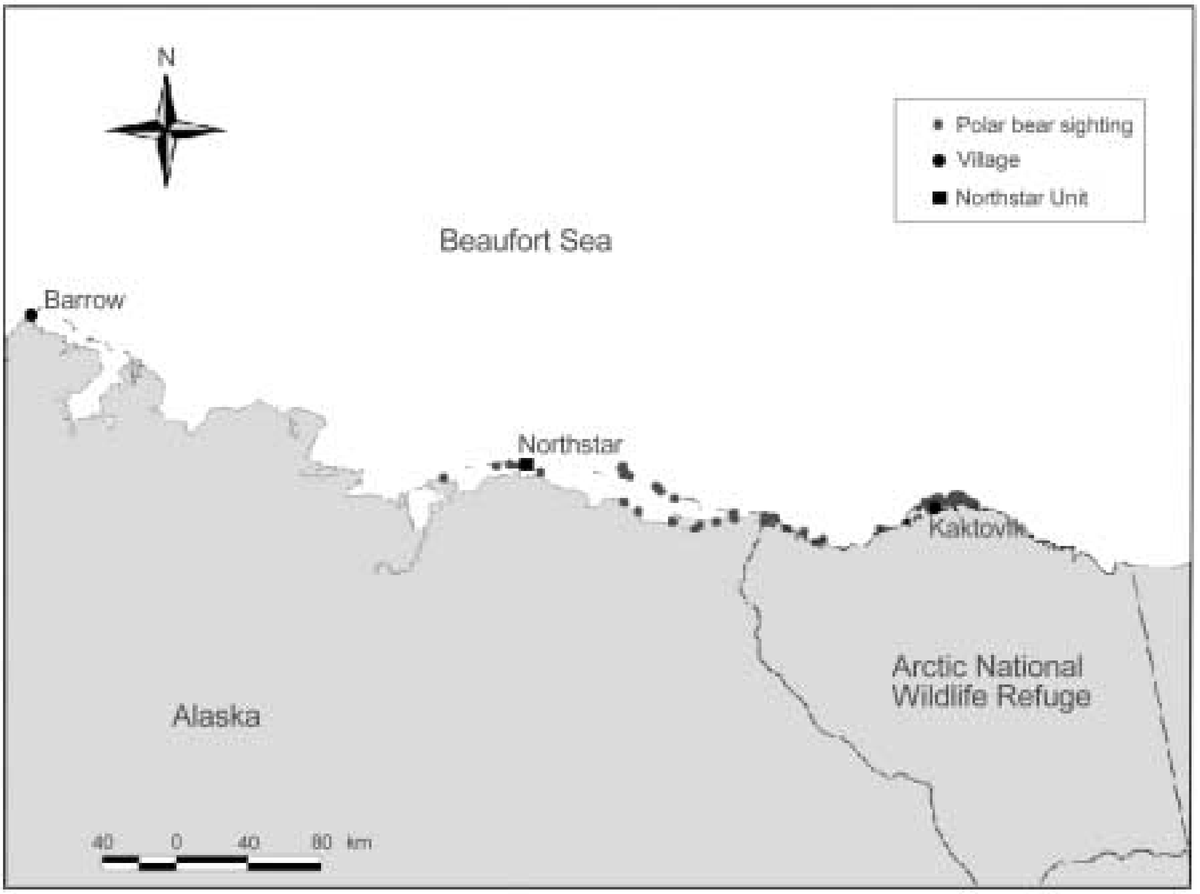

Fig. 8. Locations of polar bears sighted during aerial surveys of the coastal and barrier islands, central Beaufort Sea, Alaska, during September and October, 2000.

Aerial survey of coastlines and barrier islands: southern Beaufort Sea

The Northstar Project was the first offshore oil production facility incorporating sub-sea pipeline technology in Arctic North America. The Northstar EIS included stipulations to mitigate for potential effects, which included the requirement to fly polar bear aerial surveys during the open water and freeze-up phase in an area subject to effects of a potential oil spill to better understand the ecological significance of these areas to polar bears, and to more accurately forecast effects of on- and offshore exploration and production activities on polar bears.

The U.S. Fish and Wildlife Service conducted four aerial surveys along the coastline and barrier islands of the Beaufort Sea, in cooperation with BP Exploration and LGL Research from September 21, 2000 to October 12, 2000. The area flown included the barrier islands and the shoreline between Cape Halkett, west of Prudhoe Bay to Jago Spit, east of Kaktovik (Fig. 8). A Shrike Aero Commander was flown parallel and slightly offset to the shoreline at a speed of 100 knots and an altitude of approximately 300 feet. Two primary observers were located on the left side of the aircraft, a secondary observer in the right front seat, and a data recorder on each flight. The observers counted all bears and attempted to identify sex and age-class whenever possible. The data recorder was responsible for recording all wildlife sightings, time of sighting, sex and age-class for each group of bears, start and stop times, and changes in weather conditions. Location information from a GPS, which recorded locations every 15 seconds, was used to map the area surveyed, calculate survey effort, and map the wildlife sightings.

A total of 232 polar bears were observed over approximately 2,772 survey km during four surveys (49, 73, 72, and 38 polar bears observed on September 21, September 28, October 5, and October 12, 2000, respectively). Individual bears may have been present for multiple surveys. Barrier islands habitat was used most frequently (72%), followed by mainland (17%), shore ice (9%), and open water (2%). Adult females and dependent cubs comprised 53% of observed bears. Follow-up aerial and ground-based studies are planned.

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Annex 1

Agreement between the Government of the United States of America and the Government of the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population

October 16, 2000

The Government of the United States of America and the Government of the Russian Federation, (hereinafter referred to as the "Contracting Parties");

DESIRING to further the goals of the 1973 Agreement on the Conservation of Polar Bears (hereinafter referred to as the "1973 Agreement");

AFFIRMING that the United States and the Russian Federation have a mutual interest in and responsibility for the conservation of the Alaska-Chukotka polar bear population;

ACKNOWLEDGING the vital interest of the Autonomous Region of Chukotka and the State of Alaska in the conservation and management of the Alaska-Chukotka population of polar bears;

RECOGNIZING that reliable biological information, including scientific data and traditional knowledge of native people, serves as the basis for development of an effective strategy for the conservation and management of this population;

RECOGNIZING that polar bears represent a valuable subsistence harvest species for the native people of Alaska and Chukotka;

AFFIRMING the authorization of the native people of Alaska and Chukotka, in accordance with each Contracting Party's domestic laws, to hunt polar bears to satisfy their traditional subsistence needs, and to manufacture and sell handicrafts and clothing;

DESIRING to meet the subsistence needs of native people while affording further protection to polar bears;

RECOGNIZING that illegal taking, habitat loss or degradation, pollution, and other human-caused threats could compromise the continued viability of the Alaska-Chukotka polar bear population;

RECOGNIZING the important ecological role and aesthetic value of the polar bear and the need to maintain broad public support for the conservation of polar bears;

AFFIRMING the essential role of the native people of Alaska and Chukotka in the conservation of the Alaska-Chukotka population of polar bears, welcoming the steps taken by those people with the goal of cooperation in the conservation and management of this population, and desiring to ensure their full involvement in the implementation and enforcement of this Agreement.

HAVE AGREED AS FOLLOWS:

ARTICLE I

In this Agreement the following definitions shall apply:

(a) "sustainable harvest level" means a harvest level which does not exceed net annual recruitment to the population and maintains the population at or near its current level, taking into account all forms of removal, and considers the status and trend of the population, based on reliable scientific information.

(b) "taking" means hunting, killing or capturing.

(c) "native people" means the native residents of Alaska and Chukotka as represented by the Alaska Nanuuq Commission and the corresponding Union of Marine Mammal Hunters, or their successor organizations recognized as such by the Contracting Parties.

ARTICLE II

The Contracting Parties shall cooperate with the goal of ensuring the conservation of the Alaska-Chukotka polar bear population, the conservation of its habitat, and the regulation of its use for subsistence purposes by native people.

ARTICLE III

This Agreement applies to the waters and adjacent coastal areas subject to the national jurisdiction of the Contracting Parties in that area of the Chukchi, East Siberian and Bering Seas bounded on the west by a line extending north from the mouth of the Kolyma River; on the east by a line extending north from Point Barrow; and on the south by a line describing the southernmost annual formation of drift ice. The Contracting Parties may, by mutual agreement, modify the area to which the Agreement applies.

ARTICLE IV

The Contracting Parties shall undertake all efforts necessary to conserve polar bear habitats, with particular attention to denning areas and areas of concentration of polar bears during feeding and migration. To this end, they shall take steps necessary to prevent loss or degradation of such habitats that results in, or is likely to result in, mortality to polar bears or reduced productivity or long-term decline in the Alaska-Chukotka polar bear population.

ARTICLE V

Any taking of polar bears from the Alaska-Chukotka population inconsistent with the terms of this Agreement or the 1973 Agreement is prohibited.

ARTICLE VI

1. Native people may take polar bears of the Alaska-Chukotka population for subsistence purposes, provided that:
   (a) the take is consistent with Article III(1)(d) of the 1973 Agreement;
   (b) the taking of females with cubs, cubs less than one year of age, and bears in dens, including bears preparing to enter dens or who have just left dens, is prohibited;
   (c) the use of aircraft, large motorized vessels and large motorized vehicles for the purpose of taking polar bears is prohibited; and
   (d) the use of poisons, traps or snares for the purpose of taking polar bears is prohibited.
2. Consistent with the 1973 Agreement, polar bears from the Alaska-Chukotka population may be taken for the conduct of scientific research, for the purpose of rescuing or rehabilitating orphaned, sick, or injured animals, or when human life is threatened. Animals being maintained in captivity for purposes of rehabilitation or which are determined by either Contracting Party not to be releasable to the wild may be placed on public display.

ARTICLE VII

1. Nothing in this Agreement is intended to authorize the taking of polar bears for commercial purposes, or to limit the ability of native people, consistent with the domestic law of the Contracting Parties, to create, sell, and use traditional articles associated with native harvest of polar bears.
2. The Contracting Parties shall undertake, in accordance with domestic law, measures necessary for the prevention of illegal trade in polar bears, including their parts and derivatives.

ARTICLE VIII

1. To coordinate measures for the conservation and study of the Alaska-Chukotka population of polar bears, the Contracting Parties hereby establish the U.S.-Russia Polar Bear Commission, hereinafter referred to as "the Commission," to be composed of two national sections, a United States Section and a Russian Section.
2. Each national section shall consist of two members appointed by the respective Contracting Party in order to provide for inclusion in each section of a representative of its native people, in addition to a representative of the Contracting Party.
3. Each section shall have one vote in the Commission. A decision or recommendation of the Commission shall be made only with the approval of both sections.
4. The Contracting Parties shall be responsible for organizing and supporting the activities of their respective national sections as well as the joint activities of the Commission.
5. The Commission, at its first meeting, shall adopt rules of procedure, including provisions for accreditation of observers who can attend Commission meetings as representatives of interested organizations who can contribute to the Commission's work.
6. The Commission shall hold an annual meeting and may hold other meetings at the request of either Contracting Party, or on such a schedule as the Commission may determine. Annual meetings shall alternate between the United States and Russia.
7. The Commission shall carry out the following tasks:
   (a) promoting cooperation between the Contracting Parties, between the native people, and between the Contracting Parties and the native people;
   (b) determining on the basis of reliable scientific data, including traditional knowledge of the native people, the polar bear population's annual sustainable harvest level;

(c) determining the annual taking limits not to exceed the sustainable harvest level;

(d) adopting measures to restrict the take of polar bears for subsistence purposes by the native people within the framework of the established annual taking limits, including seasons and restrictions on sex and age additional to those in Article VI(1) of this Agreement;

(e) working to identify polar bear habitats and developing recommendations for habitat conservation measures;

(f) considering scientific research programs, including jointly conducted programs, for the study, conservation, and monitoring of polar bears, and preparing recommendations for implementing such programs, and determining criteria for reporting on and verification of polar bears taken;

(g) participating in the examination of disagreements between the native people of Alaska and Chukotka on questions regarding subsistence use of polar bears and their conservation and facilitating their resolution;

(h) issuing recommendations concerning the maintenance in captivity of orphaned and rehabilitated polar bears;

(i) examining information and scientific data about polar bears, including information on harvested polar bears and those taken in cases where human life is threatened;

(j) preparing and distributing conservation materials and reports of each Commission meeting; and

(k) performing such functions as are necessary and appropriate for the implementation of this Agreement.

8. The Commission shall establish a scientific working group and other working groups as it deems necessary to assist in carrying out its tasks.

9. The Commission shall bring to the attention of the competent authorities of the Contracting Parties and of native people its determinations with respect to the matters covered in this Article.

ARTICLE IX

Each Contracting Party shall have the right to harvest one-half of the annual taking limit of polar bears determined by the Commission. If a Contracting Party does not intend to harvest one-half of the annual taking limit it may, subject to the agreement of the Commission, transfer to the other Contracting Party part of its remaining share of the annual taking limit and shall so notify the other Contracting Party through diplomatic channels.

ARTICLE X

1. Each Contracting Party shall take such steps as are necessary to ensure implementation of this Agreement.

2. Each Contracting Party shall monitor the harvest of polar bears in those areas subject to its national jurisdiction.

3. Each Contracting Party shall report to the Commission annually on:

   (a) steps taken in accordance with Paragraphs 1 and 2 above, including the adoption of laws and regulations, and measures to enforce them;

   (b) steps taken to involve native people in the implementation and enforcement of this Agreement; and

   (c) scientific data and information on the Alaska-Chukotka polar bear population, including harvest information provided by native people.

ARTICLE XI

Nothing in this Agreement shall be interpreted as limiting the right of each Contracting Party to take additional measures, including designation of specially protected natural areas, to protect polar bears in areas under its national jurisdiction.

ARTICLE XII

In the event of any disagreement with regard to the interpretation or application of the provisions of this Agreement, the Contracting Parties shall consult with a view to resolving the disagreement through negotiation. At the request of either Contracting Party, the Commission shall examine any point of disagreement. The recommendations of the Commission in such matters shall be presented to the Contracting Parties.

ARTICLE XIII

1. This Agreement shall enter into force 30 days after the date on which the Contracting Parties have exchanged written notification through diplomatic channels that they have completed their respective domestic legal procedures necessary to bring the Agreement into force, and shall remain in force unless terminated in accordance with paragraph 2 of this Article.

2. Either Contracting Party may terminate this Agreement upon written notification to the other through diplomatic channels. Any such notification shall be made not later than June 30 of any calendar year for termination to become effective on January 1 of the following year. Notifications made later than June 30 shall become effective on January 1 of the year after the following year.

DONE AT WASHINGTON, D.C. on October 16, 2000, in duplicate in the English and Russian languages, both texts being equally authentic.

FOR THE GOVERNMENT OF THE UNITED STATES OF AMERICA:

David Sandalow, Assistant Secretary of State

FOR THE GOVERNMENT OF THE RUSSIAN FEDERATION:

Yuriy Ushakov, Ambassador to the United States

Annex 2

Inuvialuit-Inupiat Polar Bear Management Agreement in the Southern Beaufort Sea

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 provides 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 Pearce Point, Canada, to Icy Cape, USA, along the mainland coast, and extending north to a line approximately equidistant between Banks Island and the mainland coast.

(c) The people covered by this Agreement are the Inuvialuit of Canada and the Inupiat of the North Slope of Alaska.

(d) The settlements and their outpost camps whose hunting practices may be affected by this Agreement are Barrow, Nuiqsut, Wainwright, Atqasuk and Kaktovik in the United States and Inuvik, Aklavik, Tuktoyuktuk and Paulatuk in Canada.

(e) Sustainable yield means a harvest level which does not exceed net annual recruitment to the population and accounts for all forms of removal from the population, and which considers the status of the population, based on the best available scientific information.

(f) A cub-of-the-year is a young polar bear that is less than one year of age; a yearling polar bear is older than one year of age but less than two years of age and still with its mother; a family group consists of a mother with one or more cubs-of-the-year or yearlings.

(g) A Joint Commission with responsibility to implement this agreement will be formed and shall consist of two (2) representatives designated by each of the Inuvialuit Game Council and the North Slope Borough Fish and Game Management Committee. A Technical Advisory Committee with responsibility for collecting and evaluating scientific data and making recommendations 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 manage polar bears on a sustained yield basis in accordance with all the best information available.

(c) To provide increased protection to female polar bears by encouraging that the female portion of the harvest not exceed one-third of the sustainable total.

(d) To encourage the collection of adequate scientific, traditional, and technical information in a timely manner to facilitate management decisions.

(e) To minimize detrimental effects of human activities, especially commercial activities, on important bear habitat.

(f) To identify research priorities, such as to further refine the eastern and western boundaries of the population of polar bears, and to re-estimate the population size.

(g) To encourage the wise use of the polar bear population and all polar bear products.

(h) To continue facilitation of the cultural exchange of polar bear meat and products between traditional users in Alaska and Canada.

(i) To facilitate the export to the USA of hides and other products from polar bears harvested by Inuvialuit hunters in Canada.

(j) To legalize the sale of hides and other products from polar bears harvested by the traditional Alaskan users in Alaska (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).

(l) To meet annually to review the best available information on the polar bear population in the southern Beaufort Sea, and make recommendations for research and management; then, to review this Agreement every 10 years, or sooner if requested.

ARTICLE III

Regulations:

This Agreement supersedes the previous Agreement between the Inuvialuit and the Inupiat on Polar Bear Management in the Southern Beaufort Sea signed in January 1988.

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) All members of a family group are protected.

(c) The hunting season shall extend from August 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 Joint Commission in consultation with the Technical Advisory Committee and shall be divided between Canada and Alaska according to an annual review of scientific evidence. Allocation agreements shall be negotiated and ratified annually that will apply to the next hunting season. Each signatory to this Agreement shall determine for itself the distribution of the harvest within its jurisdiction.

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

(f) 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.

(g) Polar bears in villages during closed seasons should, whenever possible, be deterred from the area.

(h) Polar bears threatening human safety or property, including those killed during research activities, may be taken at any time of the year and will be counted as part of the total quota as allocated by the Joint Commission.

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

(j) Quotas will not be reduced in future years just because the full quota is not taken.

(k) Any readjustment of the boundaries may necessitate a readjustment of user allocations under the management plan, and an amendment of this Agreement by mutual agreement, as outlined in Article V (c).

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 the kill, and hunter's name.

(b) The following specimens should be collected from each bear killed: the lower jaw or an undamaged post-canine tooth to be used for age-determination, ear tags, lip tattoos, and radio collars if present, the baculum from each male, and other specimens as agreed to by the hunters of either jurisdiction for additional studies.

(c) A summary of all harvest information and pertinent research plans or results 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.

(e) There shall be prior notification and consultation prior to undertaking research.

ARTICLE V

Duration and Administration of Agreement:

(a) This Agreement shall enter into force when it has been signed by the representatives of each party.

(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, then accepted or rejected by mutual agreement after consultation with the North Slope Borough Fish and Game Management Committee and the Inuvialuit Game Council. Formal written notification of any management changes or amendments to the Agreement approved and accepted by both parties should be made to the Marine Mammals Management section of the U.S. Fish and Wildlife Service in Anchorage, U.S.A. and the Department of Resources, Wildlife, and Economic Development in Yellowknife, Canada.

The Alaskan signatories of this document have no authority, to bind 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.

SIGNED on this the 4th day of June, 1999, in the Town of Inuvik, Northwest Territories, Canada

On behalf of the North Slope Inupiat

Fenton Rexford
Chairman, North Slope Fish & Game Mgmt. Comm.

Charlie D.N. Brower
Director, North Slope Borough Department of Wildlife Mgmt.

On behalf of the Inuvialuit Game Council

Duane Smith
Chairman, Inuvialuit Game Council

Frank Pokiak
Vice Chairman, Wildlife Mgmt. Advisory Council (N.W.T.)

Polar bear research in the Beaufort Sea

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George M. Durner, *Alaska Biological Science Center, United States Geological Survey, Biological Resources Division, 1011 E. Tudor Road, Anchorage, Alaska, 99503, USA*
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Geoff Weston-York, *Alaska Biological Science Center, United States Geological Survey, Biological Resources Division, 1011 E. Tudor Road, Anchorage, Alaska, 99503, USA*

Introduction

This report summarizes work completed after the last meeting of the Polar Bear Specialist Group in 1997. Since that time, research efforts have continued to focus on various aspects of the movements and distribution of polar bears in northern Alaska. In addition to general descriptions of movement patterns, we have developed a way to model radio-telemetry data to help predict probabilities of occurrence of polar bears at various locations along the coast of Alaska. Those models have suggested ways to improve our understanding of the sources of harvested bears, and the relative vulnerabilities of polar bears to potential oil spills in the Beaufort Sea. Although still a big shortcoming of polar bear research in general, we have also made some progress in understanding the movement patterns of male polar bears.

We have continued since our last meeting to study aspects of polar bear denning ecology in northern Alaska. Specific endeavors related to denning have included creating a map of the most likely denning habitats in a large part of the northern coastal region. Also, we have been testing whether polar bears in their dens can be detected through the snow with Forward Looking Infrared (FLIR) viewing.

We have continued to explore better ways to estimate the numbers and trends in polar bear populations in Alaska, and have developed a new modeling approach that makes better use of our data than previous attempts. Those efforts also have pointed out shortcomings in the data and techniques of the past.

A new aspect of the polar bear research program in Alaska is the Marine Mammal Tissue Archival Project. This program involves collection of tissue samples from marine mammals harvested by local people. Samples are divided into two portions. One portion is available for near-real-time analysis, the other is specially prepared for long-term archiving. This project exemplifies the transition of the polar bear project to a more general arctic ecology program with polar bears and their prey as principal foci.

Movements and distribution of polar bears

Radio-telemetry studies of the movements of polar bears have continued since the last meeting of the PBSG. Dozens of animals have been either re- instrumented or instrumented for the first time. As in all years after 1985, the majority of radio-collars deployed were platform transmitter terminals (PTTs) that communicated with satellites. Analyses of the data generated from those PTTs was a major activity during this period.

General movement patterns

A principal effort revolved around describing the general movement patterns of polar bears in the Beaufort Sea region of Alaska and adjacent Canada with data from PTTs deployed between 1985 and 1995. During this period, we deployed 152 PTTs onto 104 adult female polar bears along the mainland coast of the Southern Beaufort Sea (SBS) and obtained 39,554 location records. Our Canadian colleagues also deployed 21 PTTs onto 17 polar bears along the north and west coast of Banks Island and the west coast of Prince Patrick Island. We called this the Northern Beaufort Sea (NBS) region. Those PTTs provided 6,568 location records between April 1989 and December 1995. After we excluded multiple daily locations and those with inadequate precision, we were left with 12,267 location records from all of the Beaufort Sea. Those data formed the basis for descriptions of polar bear movements in this region. Fig. 9 illustrates example movements of radio-collared female polar bears.

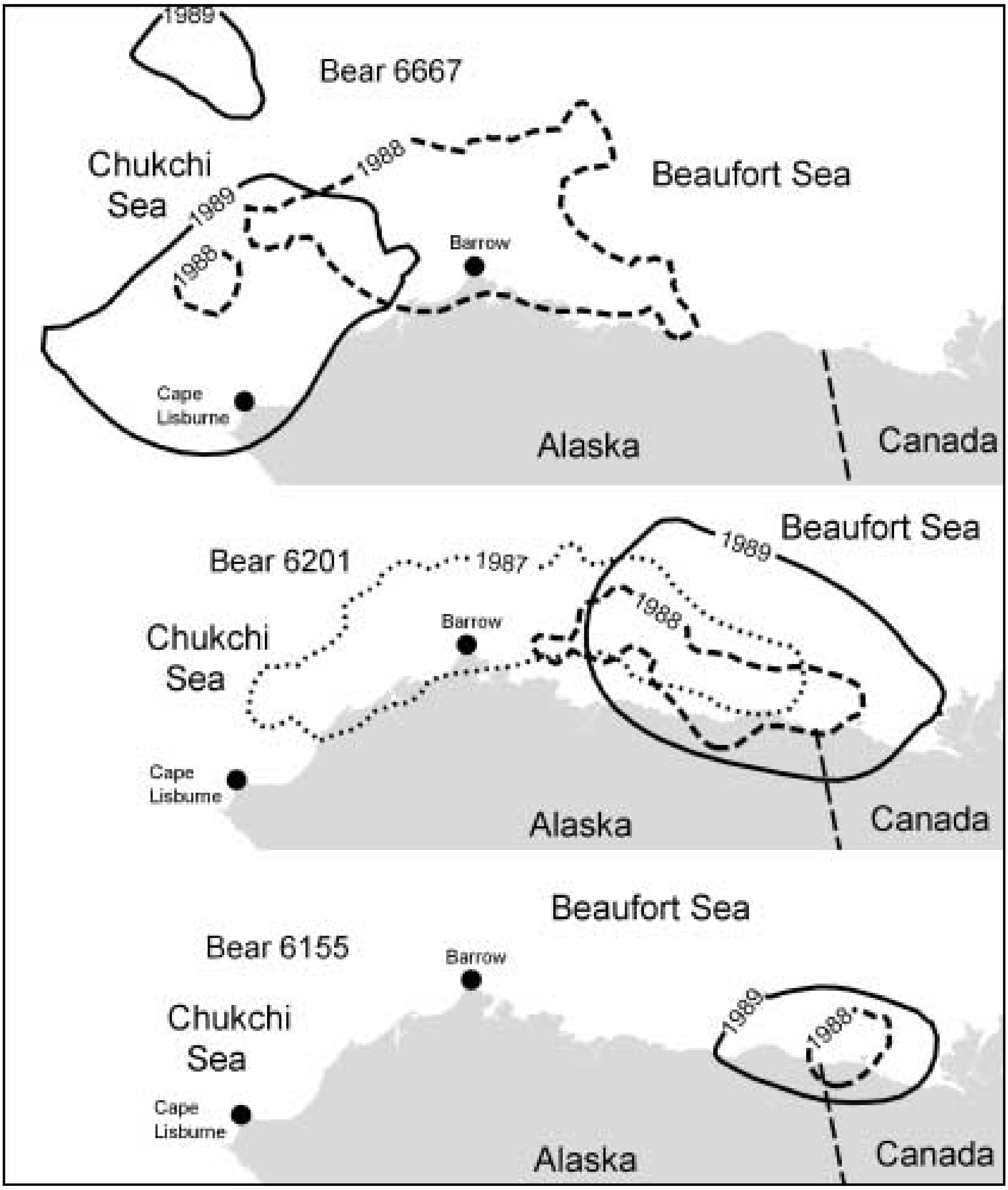

Fig. 9. Sample activity area boundaries of three female polar bears followed by satellite radio-telemetry in 1988 and 1989. Note overlap in activity areas among years, and the variation in sizes of areas occupied among individuals. The 1987 activity area of #6201 and the activity areas for #6667 illustrate that variation among years, as well as overlap, is a common trait of polar bear activity areas.

Amstrup *et al*. (2000) summarize details of these and other aspects of the movement patterns of polar bears in the Beaufort Sea region between 1985 and 1995.

Movements of instrumented male polar bears

Effective satellite telemetry systems have allowed gains in understanding the movements of mobile animals that live in remote habitats. The polar bear may be among the greatest beneficiaries of this technology. Building Platform Transmitter Terminals (PTTs) into neck-collars and attaching them to polar bears has provided previously unobtainable insights into polar bear movements, behaviors, and denning ecology (Amstrup *et al*. 1986, Amstrup and Gardner 1994, Messier *et al*. 1992, Bethke *et al*. 1996, Amstrup *et al*. 2000). Neck-collar

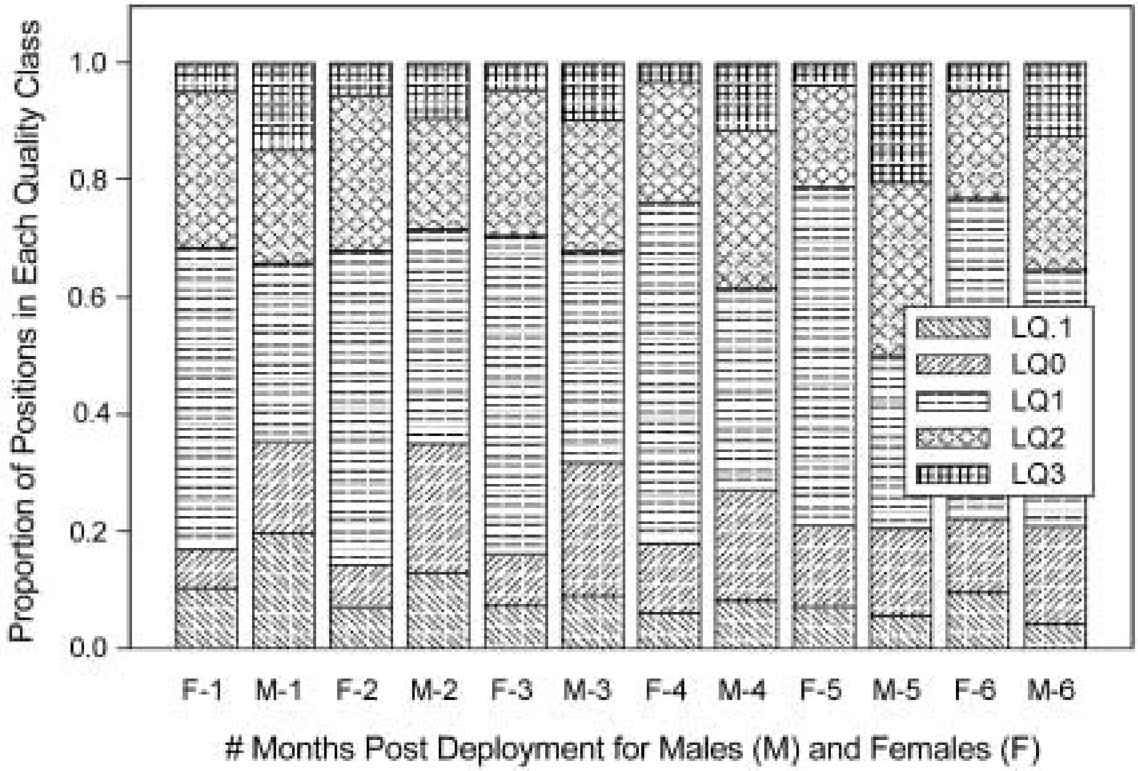

Fig. 10. Proportion of satellite radiolocations of each quality class collected from male and female polar bears during the first six months post deployment. Location accuracy increased from class LQ1, for which there was no gauge of accuracy, to LQ3, which were guaranteed to be within ±100m of true location.

radios, however, can only be attached to adult female polar bears. Young animals cannot be fitted with collars for fear of injury that could result as they grow and the collar doesn't. Likewise, because the neck diameter of adult male polar bears exceeds that of their heads, even tight fitting collars slide off during the normal activities of the animal. In 1996 and 1997, Dr Gerald Garner (deceased) surgically implanted seven adult male polar bears with subcutaneous PTT implants. We recently completed analysis of the data generated by these males.

Transmitter performance
Implanted transmitter life ranged from 30–161 days, with a mean of 97 days. This was far short of the projected life span of 20–24 months. Only one implanted bear has been subsequently recaptured. He was implanted as an 8-year-old in 1997. Upon recapture in spring 2000 at age 11, he had shed his radio transmitter and examination revealed only a scar where the surgical implantation had been performed.

Although longevity was poor, signal strength of implanted radios was generally good prior to transmitter failure (Fig. 10).

Movements
The 7 implanted male bears provided 3217 relocations during the months of April through September. Movements of those males were compared with 104 radio-collared females instrumented between 1985 and 1995 (Amstrup *et al.* 2000). Short-term movement rates of male polar bears were consistently lower than those of solitary females ($p < 0.0001$), those with cubs ($p = 0.0083$), and those with yearlings ($p = 0.0013$). Fig. 11 summarizes the differences, among months and status categories, in short-term movements. In contrast, when measured over longer time periods, males moved at rates that were comparable to those of females.

In contrast, mean total monthly distances moved by males, over all months, were significantly greater than those moved by females with cubs ($p = 0.011$). They were qualitatively greater, but not significantly greater than total monthly movements of other classes of females. Total distances moved by males did not differ significantly among months for which we have data, and there were no significant monthly interactions between month and class of bear (Fig. 12).

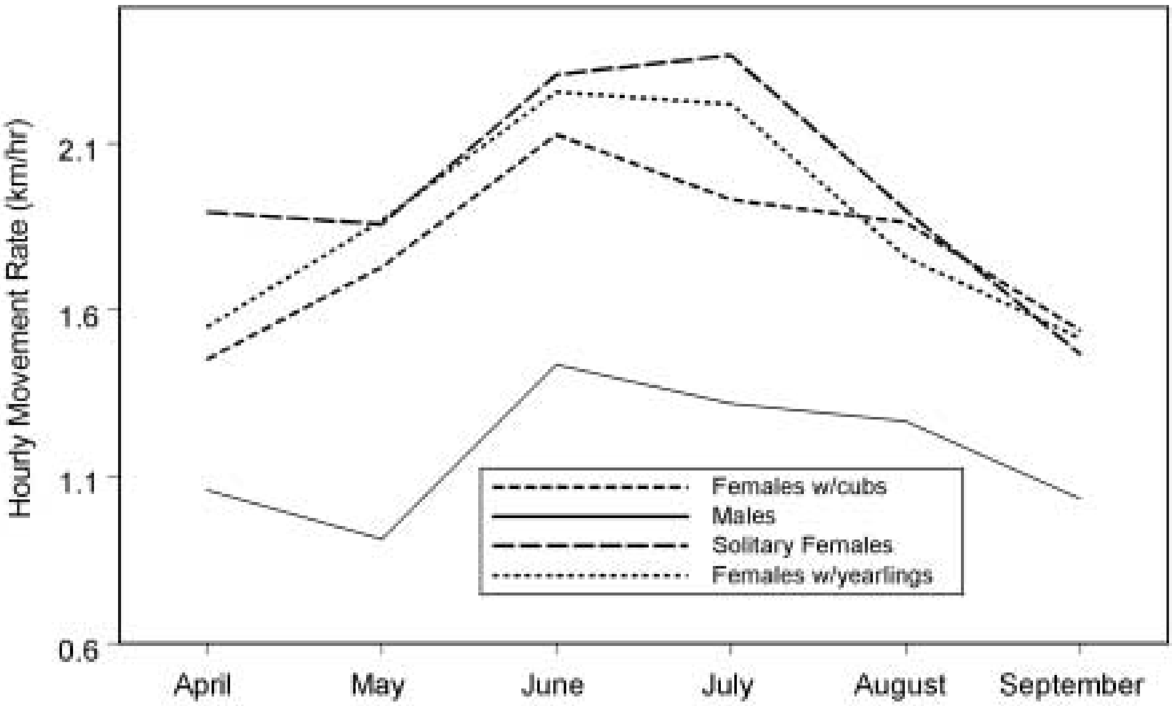

Fig. 11. Mean short-term rates of movement of seven male and 104 female polar bears fitted with satellite radio-transmitters. Movement rate was the quotient of distance traveled between consecutive relocations divided by the number of hours separating those locations. Short-term rates of movement were calculated only when temporal separation of relocations was ≤8 hours.

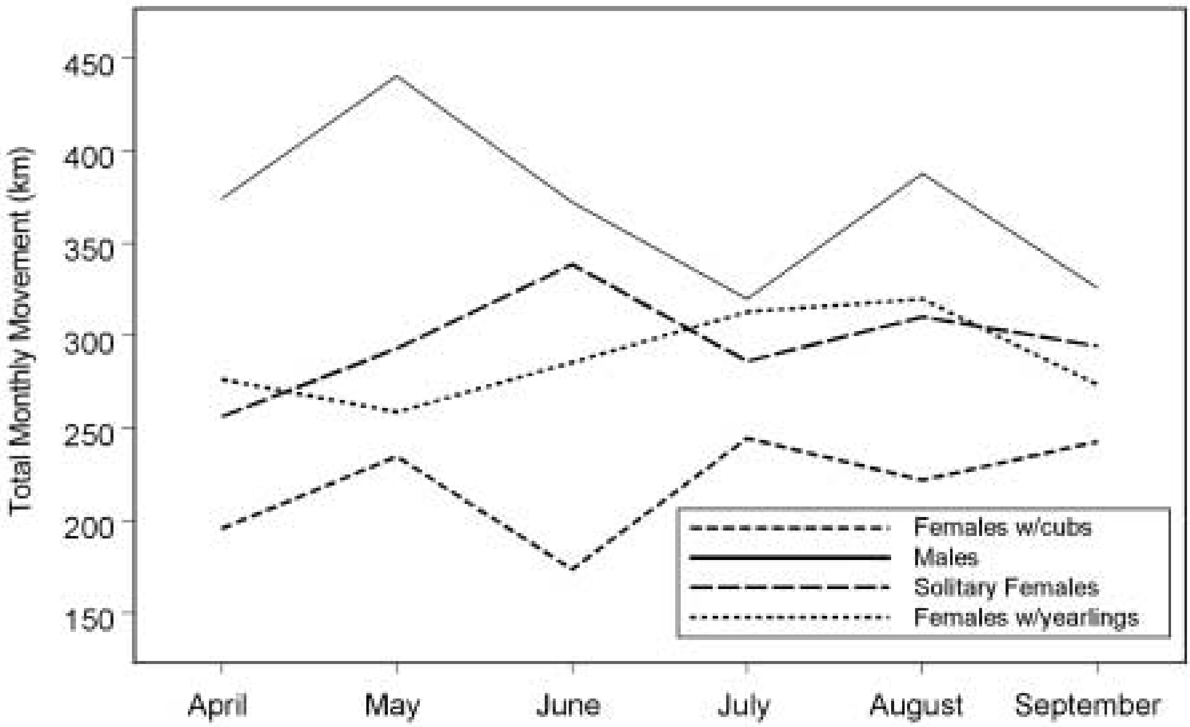

Fig. 12. Means of total monthly movement of seven male and 104 female polar bears fitted with satellite radio-transmitters. Total movement was the sum of the distances separating all consecutive relocations obtained for each bear each month.

Despite greater total monthly movements (Fig. 12), the sizes of monthly activity areas occupied by males were comparable to the range of activity area sizes of females (Fig. 13). These activity area boundaries corroborate the similarities between movement patterns of males and females suggested by other measurements we recorded.

Amstrup *et al*. (2002) provide further details of the movement patterns of male polar bears.

Using telemetry data to predict probability of occurrence

Because of economic considerations, telemetry data usually are plagued by small sample sizes. Yet management decisions such as harvest regulations must operate at the population level. Also, the normal products of radio-telemetry are entirely retrospective. That is, movement rates, distances traveled and areas occupied during times in the past are evaluated and compared with similar retrospective data from other species or populations. Maps showing dots where animals were re-observed and lines connecting the dots are all too familiar. Such products, while conveying abundant descriptive information, are often difficult to apply to management questions. Descriptive and retrospective views of data are of little value to managers who need to work in a predictive sense. For these reasons, managers still group animals subjectively according to where they were captured or observed at particular times of year (e.g., winter ranges or calving areas). These groups, herds, populations, or stocks, simplify communications but do little to address actual management or jurisdictional issues because there has been no way to quantify interactions among them. We know that individual polar bears, for example, move among described population units and occasionally move across the ranges of several such units to make new homes (Bethke *et al*. 1996, Durner and Amstrup 1995).

We have begun to develop a method to move beyond the usual descriptive analysis of radio-telemetry data toward predictive capabilities. For two management challenges, assessing oil spill risks to polar bears and allocating harvests, radiolocations of polar bears were converted from dots on a map to probabilistic predictions of numbers of bears at various locations in our study areas. Radiolocations came from bears captured in the Beaufort Sea and surrounding areas and fitted with satellite radio-collars.

We generated a distribution density map based on satellite locations and estimates of polar bear population size for bears of the Beaufort and Chukchi seas. Location data for polar bears equipped with satellite

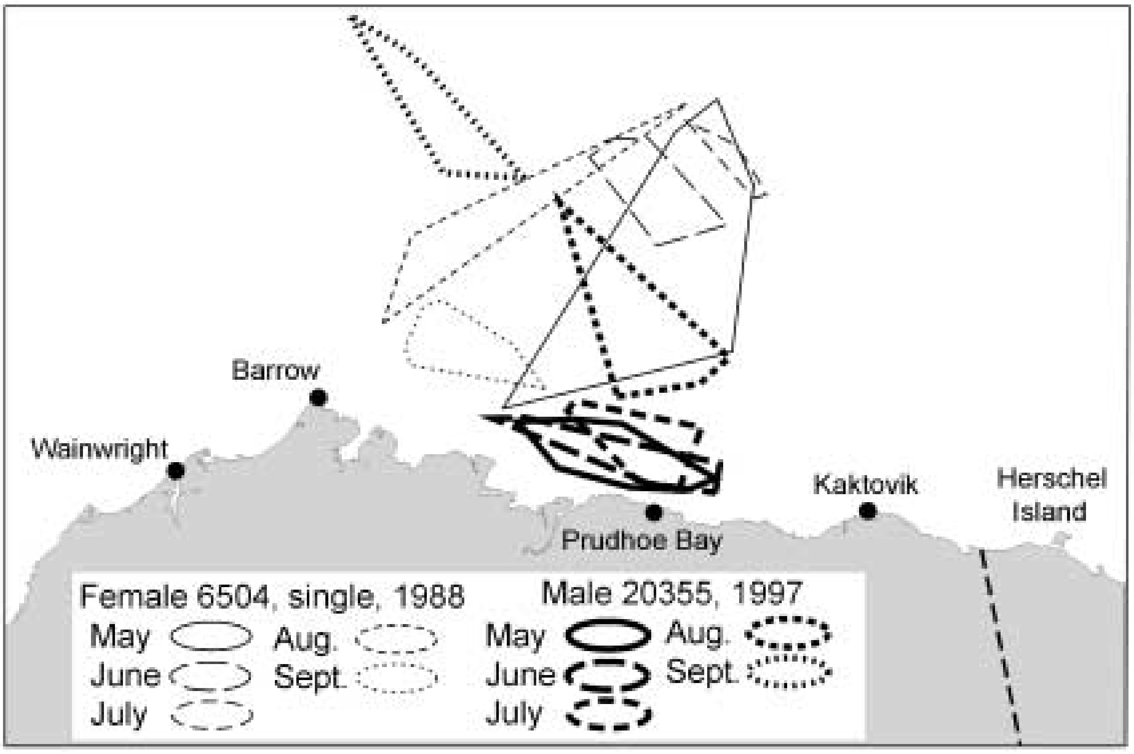

Fig. 13. Monthly activity area boundaries (calculated by convex polygon method – Hayne 1949) for a PTT-implanted male polar bear and a radio-collared female polar bear that occupied similar geographic areas in the months for which we had data on the males.

radio collars (PTTs) were collected from 1985 to the present by USGS in Alaska and by the Canadian Wildlife Service in western Canada.

We estimated the number of polar bears present in each cell of a grid overlying our study area by smoothing the raw frequencies (ie. the actual radio-tracking locations) in each cell with a 2-dimensional Gaussian kernel smoother with fixed elliptical bandwidth (Wand and Jones 1995). Kernel smoothing made it possible to use existing data structure for predictive purposes without presuming any particular statistical distribution in the data.

We used the Fast Fourier Transform (FFT, Cooley and Tukey 1965, Yfantis and Borgman 1981) to speed computations, otherwise, calculation of the variance of our estimates would have been unobtainable (Kern *et al.* submitted).

Predicting sources of harvested bears

The impetus for this work was the observation that radio-collared polar bears traveled from the Canadian Beaufort Sea into the eastern Chukchi Sea of Alaska (Amstrup *et al.* 1986, Amstrup and DeMaster 1988, Amstrup 1995, Amstrup 2000). Recognition of sharing between Canada and Alaska prompted development of the "Polar Bear Management Agreement for the Southern Beaufort Sea" (Treseder and Carpenter 1989, Nageak *et al.* 1991).

A principal assumption of this Agreement was that polar bears harvested between about Baillie Island, NWT, Canada and Icy Cape, Alaska, came from the same SBS population. That assumption was based upon analyses of radio-telemetry data collected between 1981 and 1988 (when the agreement was signed) and mark-recapture data collected from 1971 through 1988 (Amstrup *et al.* 1986, Amstrup and DeMaster 1988, Amstrup 1995, Stirling *et al.* 1988).

Since the Management Agreement was drafted we have collected much additional telemetry information and re-evaluated information with a quantitative view of population bounds and probabilities of occurrence. That re-evaluation suggests three subpopulations or stocks of polar bears in this region (Fig. 14).

Kernel smoothing of bear observations provided estimates of the proportion of time bears from each population would spend in each cell of our grid (Fig. 15). This information would allow managers to more accurately interpret the impacts of hunting in different locales or jurisdictions upon different stocks or subpopulations of polar bears.

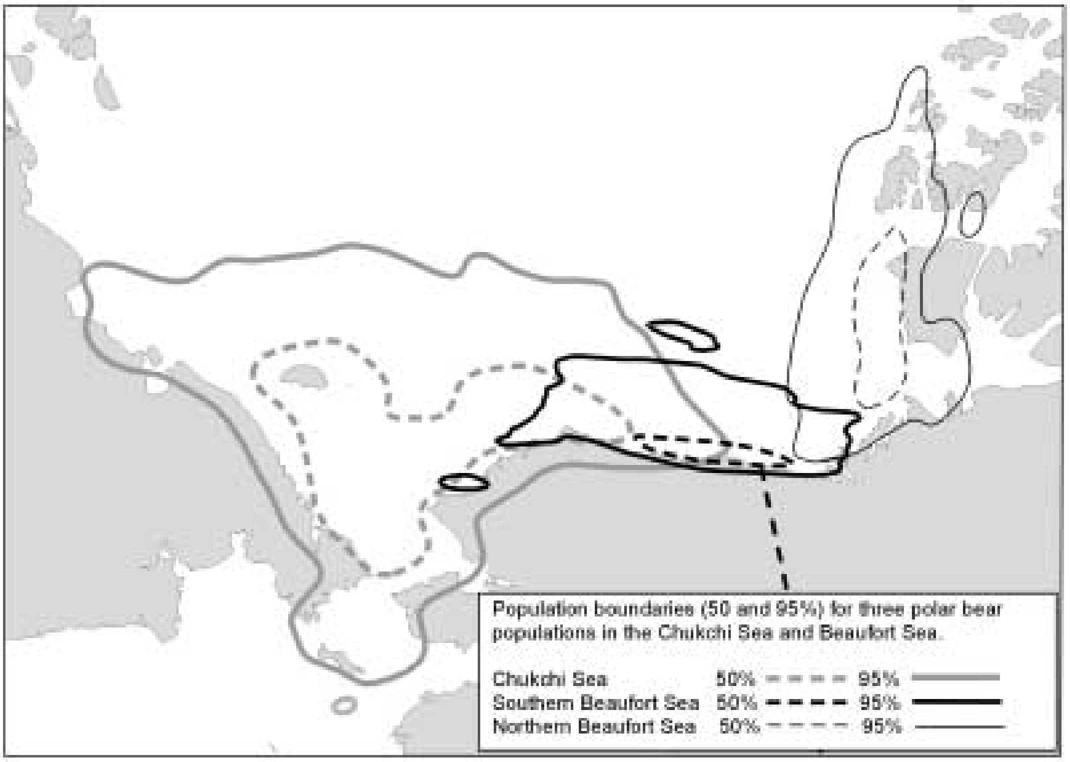

Fig. 14. Fifty and ninety-five per cent contour boundaries for three clusters of polar bears identified in the Chukchi and Beaufort seas of northern Alaska, Canada and Russia. Contours were calculated by kernel smoothing of satellite radio-telemetry data and indicate that 95 (or 50)% of the area occupied by bears of each population was within each contour.

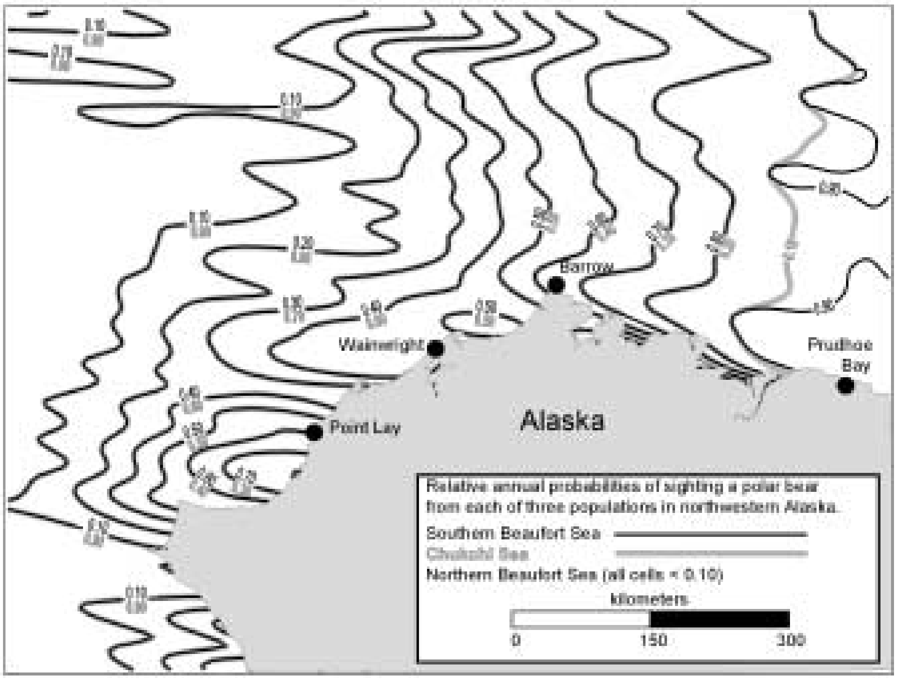

Fig. 15. Contours showing relative probability of encountering a polar bear from each of three populations at locations along the northwestern coast of Alaska.

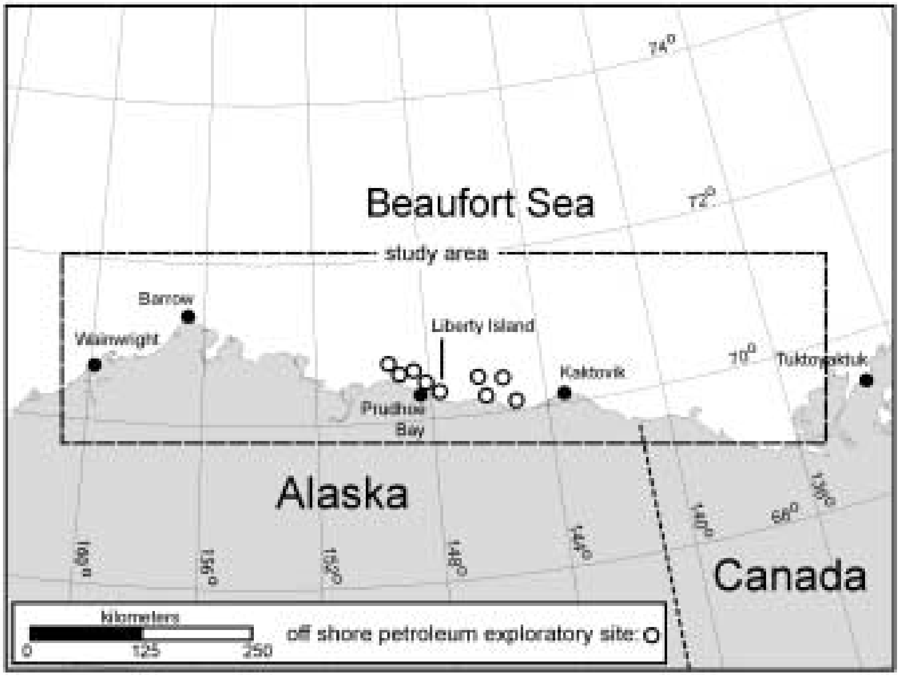

Fig. 16. Map of study area showing place names and locations of active or proposed offshore oil production products.

Predicting impacts of oil spills on polar bears

The second application for our ability to predict polar bear occurrence was oil-spill impact prediction. Petroleum exploration and extraction have occurred on the coast of northern Alaska for more than 25 years. Until recently, most activity has taken place on the mainland or at sites connected to shore by a causeway. In 1998/99, BP Exploration (Alaska) began construction of the first artificial production island designed to transport oil through sub-sea floor pipelines. Application has been made for other similar projects to begin in the next several years (Fig. 16). Stirling (1990) documented the concerns regarding the proximity of oil exploration and development to principal polar bear habitats. With the advent of true off-shore development projects, these concerns are compounded. Contact with oil and other industrial chemicals by polar bears, either through grooming, consumption of tainted food or direct consumption of chemicals, may be lethal (Øritsland *et al.* 1981, Amstrup *et al.* 1989, St. Aubin 1990). The active ice where polar bears hunt is also where spilled oil may be expected to concentrate during spring break- up and autumn freeze-up (Neff 1990). Because of this, we could expect that an oil spill in the waters and ice of the continental shelf would have profound effects on polar bears. Assessment of effects of spills, however, has not been done until now.

The general strategy used in this study was to: 1) calculate the probabilistic distribution of polar bears in our study area; 2) map the "footprints" of a series of oil-spill scenarios centered at Liberty Island; and 3) use GIS layering to overlap the oil-spill footprints with polar bear distributions to estimate the numbers of bears that would be exposed to oil in each scenario.

We used hypothetical oil spill scenarios created by Minerals Management Service (MMS) with modifications of their Oil-Spill-Risk Analysis model (OSRA, Smith *et al.* 1982). Based on a review of oil spills in similar environments, MMS predicted that oil spills resulting from catastrophic events might range in size between 102 and 1580 barrels (F. King, MMS, pers. comm.). MMS predicted that spills under the sea-ice could be as large as 2956 or even 5912 barrels if all detection and prevention devices failed for extended periods. The large accumulations of oil under the ice could behave as catastrophic releases when the ice melted in spring, and were the "worst-case scenarios" deemed possible. We focused our attention on those two largest possible spill sizes.

We hypothesized that the effects of an oil spill would be most severe during summer and autumn. Summer (22 August – 30 September) is the period of open-water when we hypothesize the spread of spilled oil would be greatest. During autumn (1 October – 9 November), when broken ice is prevalent, polar bears occur at their highest near shore densities. Oil spread might be hampered by ice but still could travel great distances, and risks to polar bears, we hypothesize, would be maximal.

The behavior of oil on water can be thought of as a plume or fan-shaped pattern spreading over the surface. The characteristics of the plume are determined by winds and currents. MMS simulated oil spills by modeling the movements of hundreds of particles (spillets) pushed by winds and currents and impeded by ice. Each trajectory was composed of 500 spillets. We converted linear spillet paths to aerial coverages by treating each spillet as a disk of oil on the water. Studies have shown that oil on water will spread only until reaching a terminal thickness (Lehr pers. comm., Lehr 2001). That terminal thickness, along with the volume of oil spilled, determines the diameter of each disk. For example a spill of 5912 barrels of oil would be represented by 500 spillets of 12 barrels each. Spillets of 12 barrels will quickly spread to approximately 47m at which point they have reached their terminal thickness. Available wind and current data allowed up to 500 independent spills, or trajectories, each month. For overlap with our bear grid, we converted those line coverages to GIS raster (grid) coverages with cells that were 25m (for the 2956 barrel spill) and 50m wide (for the 5912 barrel spill).

We generated a population distribution grid of polar bears based on PTT locations and estimates of population size in the Chukchi, southern Beaufort and northern Beaufort Seas. The number of bears apportioned to each cell of the grid was determined by smoothing and scaling the actual radio-tracking locations in each cell, i.e., cells with many radiolocations had a greater proportion of the population than cells with few radio locations.

We overlaid a grid of cells 1000m on a side over the area potentially affected by spilled oil from Liberty. In order to estimate the monthly distribution of polar bears, we needed to determine how many of the bears, from each of the four populations, were present in the smaller area. After smoothing, attributes of each grid cell included x- and y-coordinates, bear density and standard error of density for each cell.

Because spillet paths were estimated to have a maximum width of 47m (for the larger of the 2 spill sizes we modeled), only a small proportion of any 1 km^2 density cell would be intersected by the narrow spillet path. To prevent an overestimation of oiled bears, we subdivided our grid into cells the size of which matched spillet width (25m and 50m). For the larger of our spills, each 1km^2 cell was divided into 400 cells (50 x 50m, or 2500m^2). For the smaller spill size, 1km^2 cells were divided into 1600 cells (25 x 25m, or 625m^2).

Bear density and SE values were assigned to trajectory grid cells by matching each trajectory grid cell with the closest cell center from the bear density or SE grid (Fig. 17). These cells were considered "oiled." Bears estimated to populate each "oiled" grid cell were considered killed. Therefore, we allowed no sub-lethal effects of oiling. One estimate of the number of polar bears impacted by an oil spill resulted from each overlap

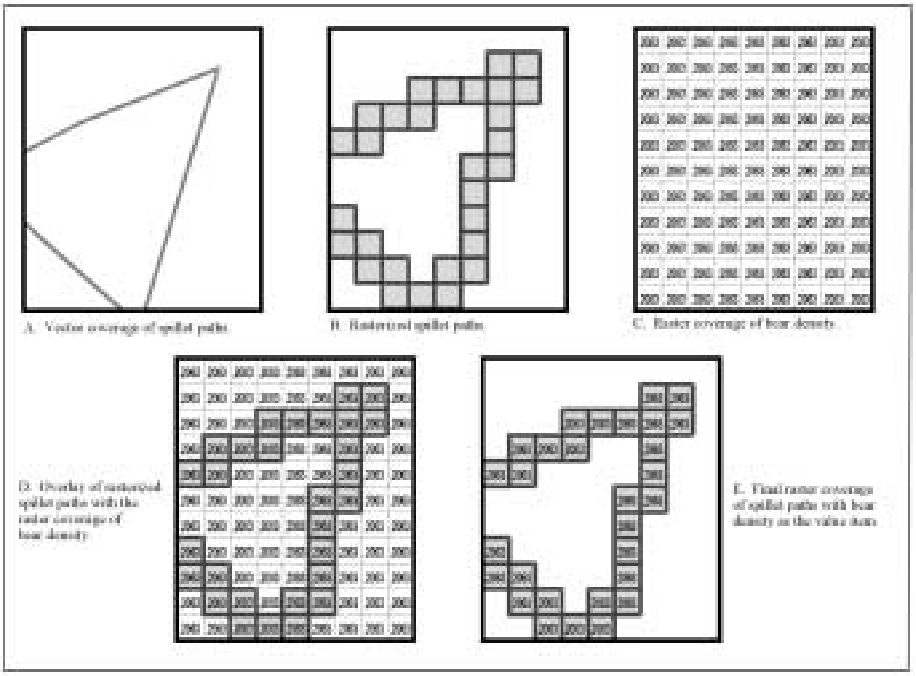

Fig. 17. Calculation methods for determining the numbers of polar bears potentially oiled in a simulated oil spill in the Beaufort Sea.

of a spill trajectory grid with a polar bear density grid. Because each trajectory was simulated under different and independent weather and sea state conditions, each trajectory could be regarded as a simple random sample of oil spills from a larger (infinite) population of oil spills that might occur in the future.

Final products depicting polar bear distributions in the study area included the estimated number of bears (actually fractions of a bear) and the standard error of those estimated numbers in each cell of our grid. For presentation and interpretation purposes, we developed contour bands showing variation in monthly intensity of polar bear use over the whole study area.

Variable oil-spill footprints translated into varying numbers of polar bears potentially affected by each spill trajectory. The high densities of polar bears projected for the near coastal regions of the SBS in October occasionally corresponded with large numbers potentially being exposed to oil (Fig. 18). Depending upon which direction and how far a particular trajectory traveled, numbers of bears affected varied greatly. Trajectories simulating the 5912 barrel spill in September, oiled as few as 0.007 bears and as many as 25 bears. The mean number affected was four, while the median value was one bear. In October, minimum and maximum numbers of bears oiled by the 5912 barrel spill were 0.05 and 60. The mean and median were 9.5 and 2.9 bears respectively. Variation in our estimates of numbers of bears oiled was due almost entirely to variation among trajectories.

For additional information on predicting possible impacts of oil spills on polar bears see Amstrup *et al.* (2000) and Durner *et al.* (2000).

Population size estimation in polar bears

In the latest effort to develop estimation procedures for Alaskan polar bears, we described an approach to open population mark-recapture modeling to derive population estimates. We described how covariates measured, over the years, explained complex capture histories and improved estimates. A key feature of our modeling process was construction of capture probability models to simultaneously account for conventional recapture and radio-telemetry data. We used a model selection technique that blended improved model fit with improved prediction variance.

Our best model suggested increase from around 500 females early in the study to as many as 1500 at study end (Fig. 19). Assuming the increase in numbers of males was comparable to that recorded for females, this could suggest a total population size of over 2500 animals – many more than previously hypothesized.

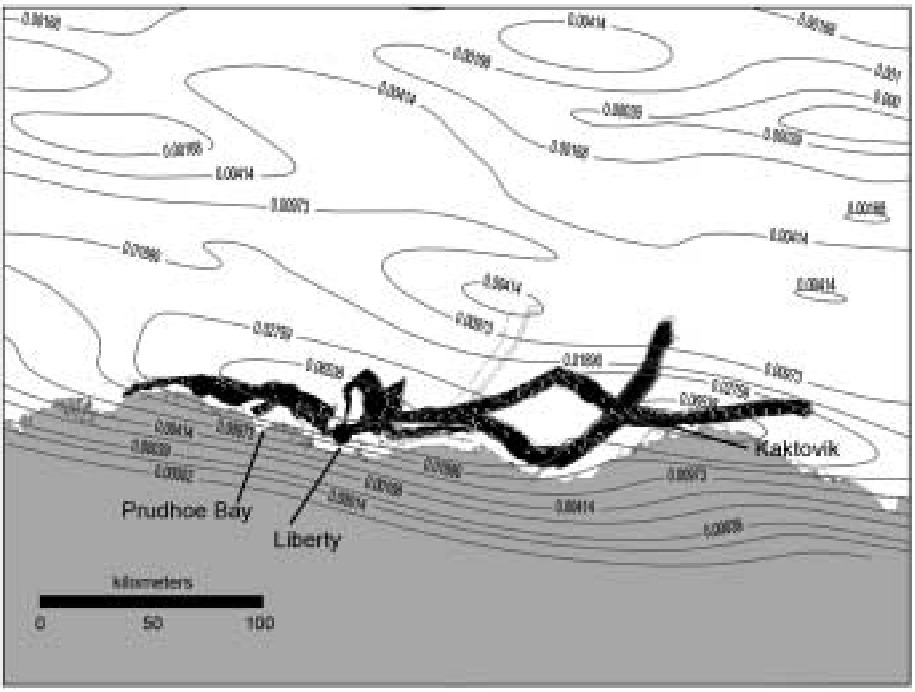

Fig. 18. Polar bear density contours (bear/km^2) and oil spill trajectory examples, 1 October–9 November.

Despite the significant improvements in estimates provided by our model, we recommend a conservative approach to management of polar bears in the SBS. The of 1.035 we observed is near the maximum that seems possible for a hunted polar bear population (Taylor *et al.* 1987), and should be viewed cautiously. Likewise, simulation studies suggested there might be a small positive bias in $\hat{N}_j$ when the data set contains significant heterogeneity. This heterogeneity bias could inflate $\hat{N}_j$. Finally, lower 95% confidence bounds on $\hat{N}_j$ were <1000 females, which would translate into <2000 bears. Cautious harvest management, therefore, still is advised, and collection of a more intensive SBS mark-recapture data set is recommended.

McDonald and Amstrup (2001) and Amstrup *et al.* (2001) provide additional information on this modeling process.

Denning ecology of polar bears

Prior to our denning studies beginning in 1981, only 35 locations of polar bear maternity dens in Alaska were known (Lentfer and Hensel 1980). Many of those 35 were known only approximately, from reports of local residents and early explorers, and the degree of confirmation was highly variable. This dearth of records of dens led many to speculate that “Alaska’s” polar bears were really not “Alaska’s” but visitors from breeding areas in other countries. We found over 100 dens between 1981 and 1991 and reported their distribution

Table 16. Distribution of polar bear maternity dens along the mainland coast of Alaska and adjacent Canada between 167° W and 137° W discovered by radio telemetry during spring 1982 through spring 2001.

		Arctic National Wildlife Refuge									
		Area 1002			All areas including 1002			Other coastal areas			
Period	Pack ice	Fast ice	Land	% of all fast ice and land	Fast ice	Land	% of all fast ice and land	Fast ice	Land	% of all fast ice and land	Total
1982–1991	58	1	12	35	1	16	46	5	14	54	94
1992–2001	19	1	10	29	2	13	39	4	18	61	56
Total	**77**	**2**	**22**	**32**	**3**	**29**	**43**	**9**	**32**	**57**	**150**

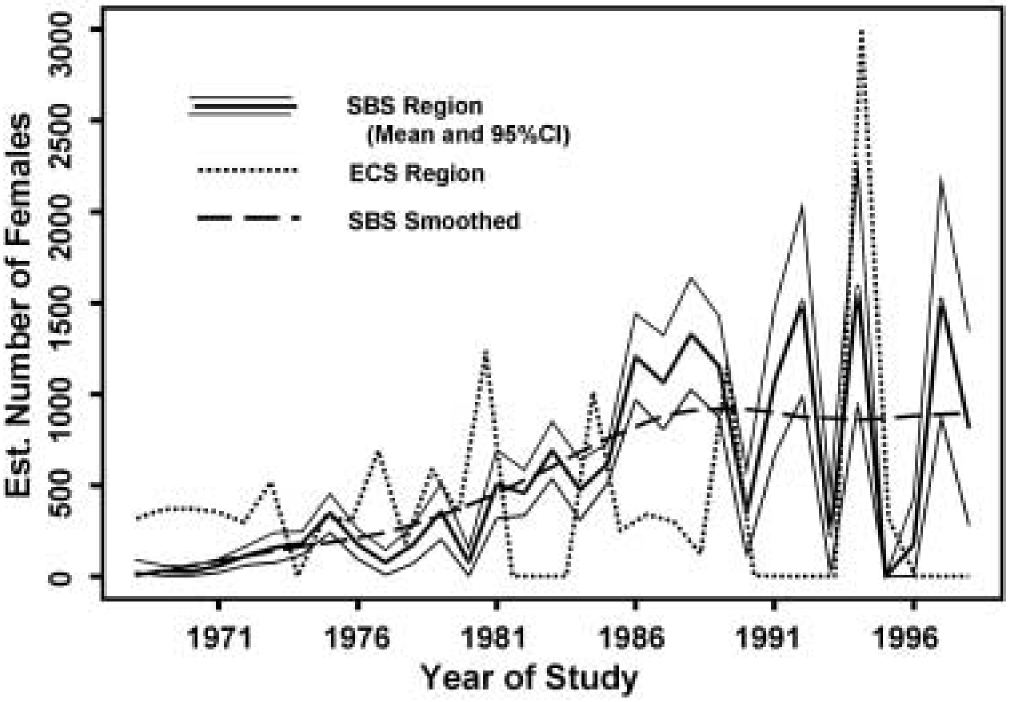

Fig. 19. Population estimates for female polar bears in the southern Beaufort Sea as predicted by best fitting model. Note relatively smooth growth pattern shown when geographic components of capture bias are removed.

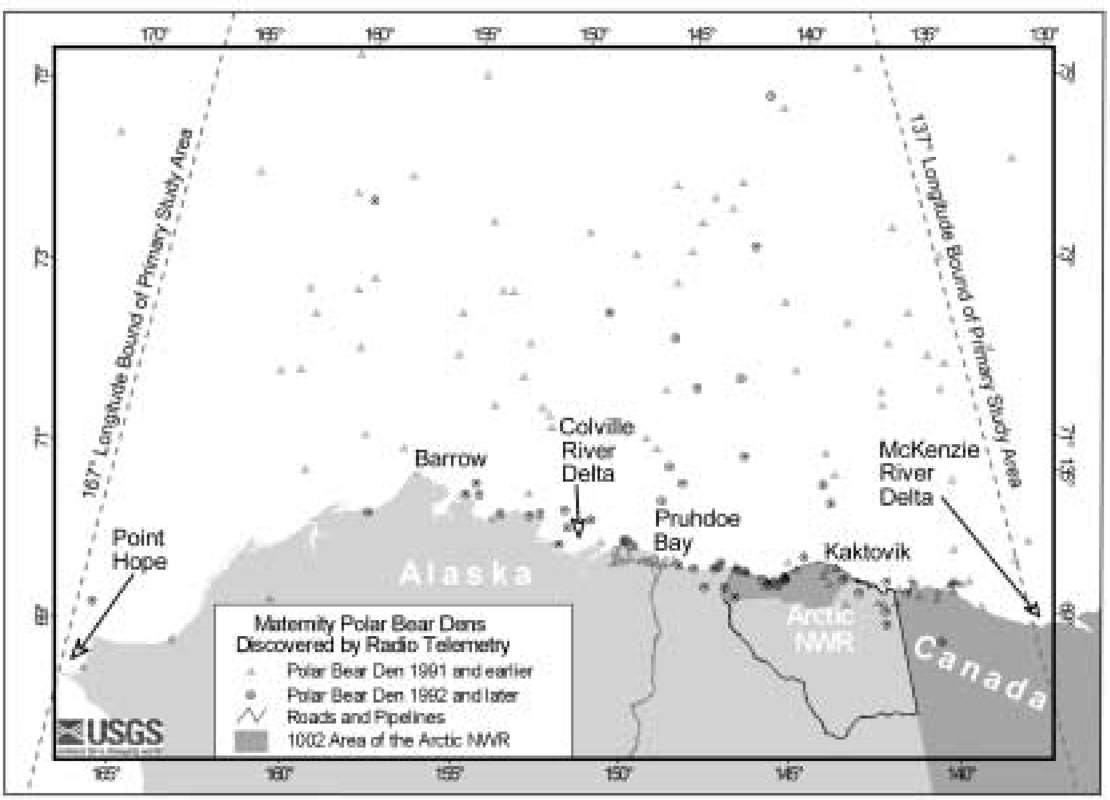

Fig. 20. The distribution of polar bear maternal denning in the coastal region of Alaska, 1981–1992.

previously (Amstrup and Gardner 1994, Amstrup 1993). Denning studies have continued since those reports were published, and many new insights have been developed since then. Here, we summarize progress on aspects of continuing denning studies.

Because of the controversy and public interest in the potential for oil development on the coastal plain of the Arctic National Wildlife Refuge (ANWR) we have subdivided the distribution of dens on land to indicate denning frequencies there. Of the 73 dens on land (or fast ice), 32 (44%) were within the bounds of ANWR and 24 (33%) were in the 1002 Area. The proportion of dens located on ANWR dropped from 47% to 41% between the first and second half of the study; while the proportion of dens located within the bounds of the 1002 area dropped from 36% to 30% (Table 16). The proportion of pack ice dens dropped dramatically in the latter half of the study. The decrease in proportion of land dens on ANWR was accompanied by an increase in the proportion of dens found on land areas west of ANWR (Fig. 20). Although this distribution shift is apparent on a map, we cannot currently explain it and it is not statistically significant (Chi-square test, $p = 0.88$). The decrease in off-shore effort in the latter half of the study may explain a portion of the decline in numbers of dens on pack-ice.

Maternal denning habitat in northern Alaska

In the southern Beaufort Sea, terrestrial dens occur throughout the coastal plain of northern Alaska with their greatest frequency in northeast Alaska and northwest Yukon Territory (Amstrup and Gardner 1994). Much of this region is currently being considered for, or is undergoing, petroleum exploration and extraction. While oil exploration and construction generally occur during winter when disruption of tundra habitats and most arctic wildlife species are at a minimum, disturbance to polar bear maternal dens is possible and could result in reproductive failure. Knowledge of polar bear den chronology provides a defined boundary for temporal management of human activities (Amstrup 1993,Amstrup and Gardner 1994), however, spatial management has not been possible because the location of future dens has been known only retrospectively. Sufficient snow accumulation, which is important for the establishment of maternal dens (Harington 1968, Lentfer and Hensel 1980, Kolenosky and Prevett 1983, Amstrup and Gardner 1994), is dependent on topographic features such as banks and bluffs (Belikov 1980, Lentfer and Hensel 1980, Benson 1982).

Beginning in 1995, we identified landforms suitable for denning and developed a map of polar bear denning habitat to aid in the spatial management of human activities. We quantified habitat components surrounding known den sites and characterized den site habitat. We then examined 3000 aerial photographs (scale: 2.56cm = 457.2m) taken over Alaskan coastal areas between the Colville River (151º W) and the Tamayariak River (145º 30'W) and identified similar features across the study area by examining all photos. Suspected den habitats were first located and drawn on aerial photos as arcs and then transferred into a final digital format (ARC/INFO, ver. 7.0.2, ESRI, Inc., Redlands, CA). We field-verified the habitat map for precision of plotted arcs and omission of suitable habitats by examining habitat along transects throughout the study area.

The final map provides the best available tool for allowing resource managers and researchers to identify polar bear maternal den habitat. This knowledge will hopefully reduce the potential for disruptions of maternal dens by winter petroleum exploration activities. Additional details are provided by Durner *et al.* (2001).

Use of Forward Looking Infrared (FLIR) viewing to locate polar bear maternal dens: A preliminary assessment

Because the snow drifts under which polar bears den, look like other drifts, winter detection is difficult. Denning bears, however, warm the chamber they occupy. If enough heat escapes through the snow above a den to increase its temperature relative to adjacent snow, infrared sensors might detect that temperature difference or $\triangle$T. To help protect polar bears and workers in areas where human activities coincide with maternal denning, we tested whether we could detect polar bear dens when viewed with Forward Looking Infrared (FLIR Systems, Inc., Portland, OR).

We viewed bank and bluff habitat features in which 12 known dens were located with a FLIR Safire II mounted on the nose of a Bell 212 helicopter. Transects were flown at 800ft AGL and 40 knts. To avoid solar warming of the landscape, we attempted to fly transects at night or during civil twilight of the Arctic winter. Transects were ground referenced by GPS, and all were video recorded. Transects included other thermal signatures (hotspots) known not to be dens. We also recorded verification flights during which the helicopter hovered over each hotspot at low altitude and varying view angles. We visited most dens multiple times and noted whether known dens were detectable. We also determined whether other hotspots were dens. Naïve observers reviewed segments of videotapes containing dens, and other hotspots. They viewed tapes individually and in groups, and noted whether transect segments included a den or other suspicious hotspot. They also viewed tape segments of verification flights and decided whether each hotspot was a den.

We detected 10 of 12 known dens on at least one FLIR visit, and we discovered 3 dens not known by telemetry. Only 2 dens, however, were seen on all visits. We are in the process of trying to understand which co-variates associated with each visit to these dens allowed or prevented their detection.

Panel reviews of video taped portions of FLIR surveys indicated that naïve observers performed better than if they simply guessed a "yes" or "no" answer to each tape snippet. However, their rate of correct answers was insufficient to indicate that FLIR surveys could be effectively accomplished without training. For panels of individual subjects viewing the transect video, 63.76% of the responses were correct (95% Confidence Interval: 62.1% to 65.42%). Confidence intervals that do not encompass 50% indicate that the subjects performed better than if they simply guessed. For panels of individual subjects viewing the hover video, 71.23% of the responses were correct (95% Confidence Interval: 69.01% to 73.45%). For groups of subjects viewing the transect video, 69.55% of the responses were correct (95% Confidence Interval: 66.13% to 72.98%). For groups of subjects viewing the hover video, 73.17% of the responses were correct (95% Confidence Interval: 68.65% to 77.69%).

These results suggest panels made up of groups did not perform significantly better that panels made up of individual subjects. Individual subjects performed significantly better on the FLIR video of "hover" snippets than "transect" snippets. Comparisons can be made by looking at the 95% confidence intervals for each estimated percentage. If the confidence intervals overlap, then there is no significant difference at the =0.05 level of significance for each comparison. When other hotspots were disregarded, we found that correct identification of known dens was barely above half, however. Naïve viewers overlooked known dens on transect legs 45% of the time and correctly identified dens from verification flights only 55% of the time.

Although Arctic winter weather is often cold and clear, our studies were plagued by atmospheric moisture, which is known to inhibit FLIR effectiveness. We faced fog or freezing fog and snow or blowing snow on 19 survey days, haze or mist on 11 days, and had clear air on only one survey. Other factors reducing FLIR effectiveness included: heat rising through cracks in sea or river ice; heat re-radiated from soil or snow warmed by the sun; and variegation in snow surface temperatures resulting when falling or blowing snow at one temperature is deposited irregularly over older snow at a different temperature. We concluded FLIR can be an effective tool for detecting polar bear maternal dens on the Alaskan Coastal Plain provided operators are cognizant of the effects of ambient light, atmospheric moisture, and uneven snow surface temperatures in limiting its effectiveness. Yet to be analyzed is the frequency of "false positives". That is, hotspots that are not dens, but that have thermal signatures like dens and are defined as dens by FLIR. Thus far, we have not had opportunity to test this aspect of FLIR performance due to very small area sampled in our testing and due to the consistent poor weather.

Alaska Marine Mammal Tissue Archival Project

The banking of environmental specimens under cryogenic conditions for future retrospective analysis is an important part of wildlife health and environmental

Table 17. Tentative sampling locations and target numbers for samples to be collected by the Alaska Marine Mammal Tissue Archival Project for archival in the National Biomonitoring Specimen Bank. The sampling target number of specimens for tissue banking is 70 animals/year.

Species	Sampling location	Target number
Bowhead whale	Barrow	10
Beluga	Cook Inlet	1
	Point Lay	5
Bearded and ringed seal	Barrow	10
	Katovik	10
	Kotzebue	5
	Nuiqsut	10
Harbor seal	Gulf of Alaska	10
Sea lion	Gulf of Alaska	Opportunistic
Polar bear	Beaufort Sea	30 blood samples; 5 tissue samples
Walrus	Bering Sea	Opportunistic
Sea otter	Sitka/Prince William Sound	5

monitoring programs. The goal of the Alaska Marine Mammal Tissue Archival Project (AMMTAP) is to collect tissue samples from marine mammals for archival in the National Biomonitoring Specimen Bank (NBSB) at the National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland, USA. Samples are collected under exacting protocols and stored under the best conditions so that they can be analyzed for a variety of environmental parameters in the future (Table 17).

This program was brought under the umbrella of the Alaskan Polar Bear Project in 1998. It began, however, under NOAA's National Ocean Service Outer Continental Shelf Environmental Assessment Program in 1987. The USGS, Alaska Biological Science Center (ABSC), the NOAA Fisheries, Office of Protected Resources (NMFS), and the NIST conduct this partnership project. Minerals Management Service (MMS) is the primary client agency for the AMMTAP providing programmatic guidance and review.

A substantial part of the sample collection is from Arctic species and, since most of the animals sampled are from Alaska Native subsistence harvests, the project relies on cooperation and collaboration with several Alaska Native organizations and local governmental agencies. Through AMMTAP, samples are collected for real-time contaminant monitoring in the Marine Mammal Health and Stranding Response Program. In addition, the project has provided samples and/or data for many research programs, both inside and outside the U.S., on a variety of subjects, including: genetics research, the circumpolar distribution of chlorinated hydrocarbons in beluga whales, baseline levels of trace elements in tissues, the identification of arsenic and mercury species in marine mammal tissues, biomarker research, nutritional studies, and studies on potential human health effects of Alaska Native subsistence foods.

A new emphasis of collaborative research between AMMTAP cooperators is polar bear-ice seal ecology. This Arctic focus appropriately addresses U.S. Department of Interior strategic goals for research and management of trust resources. Further, it brings attention to rural concerns related to subsistence resources as well as larger-scale international environmental concerns under address by the Arctic Monitoring and Assessment Programme. This emphasis provides greater integration of the AMMTAP into U.S. Geological Survey polar bear population and ecological research. The new focus will apply to both the Chukchi and Beaufort Seas, although initial effort will focus on the Beaufort Sea population.

Polar bears (*Ursus maritimus*) occupy most ice-covered seas of the northern hemisphere including the Beaufort and Chukchi seas adjacent to northern Alaska. The 1994 amendments to the Marine Mammal Protection Act (MMPA) required the periodic assessment of marine mammal populations. Meeting MMPA requirements demands new measures (or indices) of population status and new estimates of population size ultimately will be required. Human activities in Arctic Alaska are increasing. Already there is mounting evidence of behavioral changes in bears associated with this human presence. For instance, today polar bears regularly feed on the remains of bowhead whales (*Balaena mysticetus*) killed by Eskimo hunters, as well as other anthropogenic food sources. Correspondingly, satellite telemetry data suggests that the number of polar bears occurring on and near land has increased since the early 1970's. This near shore occurrence may increase exposure to toxins and disease agents which polar bears are exposed. These new and at times multiple stressors could predispose polar bears to unusual morbidity and mortality. Proximity to land may increase the likelihood of interactions between humans and bears to anthropogenic disease agents similar to those recently causing population drops in seals (Osterhaus *et al*. 1989, Heide-Jorgensen *et al*. 1992). Understanding natural and anthropogenic factors that contribute to population fitness of polar bears will hopefully provide new indices to the status of population health.

Although real-time studies of tissues collected as part of AMMTAP have been a small part of the program, our plan is to expand them as time and resources are made available. One recent example of the sort of work for which we strive is a study conducted to evaluate levels and transfer rates of contaminants within the Arctic marine community. Blubber samples of ringed seal (*Phoca hispida*; n=8) and polar bear (n=5) were collected from Barrow, Alaska in 1996 as part of the Alaska Marine Mammal Tissue Archival Project (AMMTAP) and retained in the National Biomonitoring Specimen Bank at the National Institute of Standards and Technology in Gaithersburg, MD. The samples were analyzed for a variety of persistent organochlorine pollutants including polychlorinated biphenyls (PCBs), hexachlorocyclohexanes (HCHs), chlordane and metabolites, hexachlorobenzene (HCB) and DDTs and metabolites. Wet mass concentrations of PCBs (sum of 29 congeners or congener groups) were 732 ± 282 ng/g in seals (n=9) and 3395 ± 1442 ng/g in polar bears (n=5). Wet mass DDTs, HCHs (-, - and - HCH) and HCH concentrations in seals and bears were 562 ± 261 ng/g versus 74.8 ± 39 ng/g, 380 ± 213 ng/g versus 515 ng/g, and 17.4 ± 10.1 ng/g versus 183 ± 153 ng/g, respectively. chlordane (sum of *cis*- and *trans*-chlordane, *cis*- and *trans*-nonachlor, oxychlordane

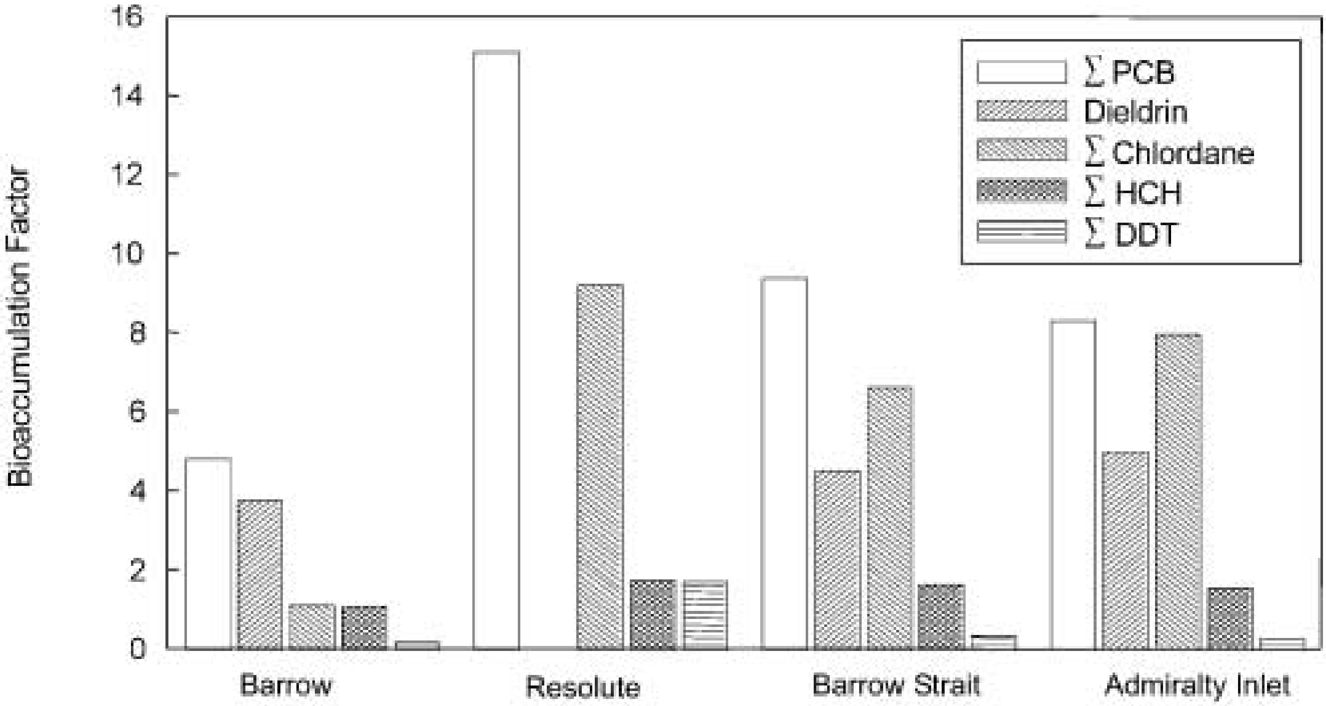

Fig. 21. Bioaccumulation factors versus location. Data from Barrow Strait and from Admiralty Inlet are given in Muir *et al.* (1998); data from Resolute are from Letcher (1996).

and heptachlor epoxide) and dieldrin concentrations in ringed seals and polar bears were 753 ± 617 ng/g (mean ± 1 SD) versus 720 ± 315 ng/g and 38.6 ± 22.8 ng/g versus 130 ± 65 ng/g, respectively. Bioaccumulation factors (polar bear/ringed seal wet mass concentration of organochlorines) were lower in the Barrow, AK animals than in those from locations in the Canadian Arctic (Fig. 21). This suggests that polar bears may be also preying on marine mammals from lower trophic levels than ringed seals with lower organochlorine levels, such as bowhead whale carcasses or bearded seals. An examination of the PCB congener patterns in the samples showed a reduction or elimination of congeners metabolized phenobarbital-type p450 enzymes in the polar bear relative to the ringed seals in agreement with previous studies.

Kucklick *et al.* (in prep.) provide further details of this project. More information regarding the AMMTAP program and its history can be found in Becker *et al.* (1993).

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Den site selection by polar bears on Wrangel Island

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We investigated landscape level characteristics of survey units containing female polar bear dens on Wrangel Island. Female polar bears create maternity dens in snow banks during the fall and emerge with cubs during the late winter and early spring period. There may be more than one opening associated with each maternity den. Temporary dens may also be dug by female polar bears before leaving the island in the spring, particularly during periods of severe weather. This analysis is concerned with building models to predict: (1) the relative probability of use of a unit for at least one of the den types, and (2) the density of den openings in a unit as a function of physical characteristics measured on the unit. Four models were created, each one involves data from aerial or ground surveys and one of two scales: 1x1km and 100 x100m units.

Methods and data

Aerial surveys
Aerial surveys for openings to polar bear dens (maternity and temporary) were conducted on Wrangel Island from 1982 through 1991 during the months of late February to late April. Surveys were conducted using the Russian Helicopter Mi 8 or fixed wing airplane AN 2. Survey routes were flown 50 to 150m above ground surface at 150 to 200km per hour. Survey routes and effort varied year to year depending on the amount of suitable weather and logistical support available. Survey effort was stratified approximately in proportion to the density of polar bear dens based on professional judgement. The most intensive survey effort occurred in four study plots where ground surveys of maternity dens were also conducted. The data from the aerial surveys may be maternity dens or temporary dens. There were a total of 673 sightings judged to be openings to maternity and temporary dens during the aerial surveys. These sightings were recorded on working maps with scales from 1:100000 to 1:500000.

Ground surveys
Four study plots have been used for intensive ground surveys of maternity dens. Ground surveys of the entire survey plots were conducted five to 10 times per month during the time period late February to early May. The number of maternity dens detected was recorded within each study plot for each survey year and locations were plotted on large-scale field maps. We have 13 years (1983–95) of complete observations on Cape Waring (266 dens), six years (1987–88, 1990–93) on Dream-Head (128 dens), five years (1984–86, 1991–92) on Cape Thomas (50 dens) and three years (1983–84, 1993) on Cape Pillar (86 dens).

Primary data
A basic Geographical Information System (GIS) of Wrangel Island was created by the Department of Biological Resources of the US Geological Survey (USGS), Anchorage, Alaska. A 1:100000 scale map with 20m contour intervals was digitized along with the shoreline and rivers. Using ArcView drawing tools we added data layers for aerial flight lines, sectors, geomorphological regions of Wrangel Island, borders of ground study plots, locations of all detected den openings located during aerial surveys, and locations of all maternity dens located during ground surveys within the four study plots. Locations of these objects were digitized with the help of the geographic relief displayed on the working maps and the corresponding GIS coverages.

ArcView coverages were exported to GIS IDRISI and IDRISI tools were used to compute primary data. We computed for each 100x100m cell:

- **number of all dens detected during aerial surveys** for each year;
- **number of maternity dens detected during ground survey** plots for each year;
- **aerial survey effort** (defined to be 1 for each cell intersected by the aerial flight lines at least one time and 0 otherwise);

Also values for the following variables, judged to be related to the selection of sites for maternity and temporary dens by female polar bears, were computed for the same cells:

- **elevation** – elevation of the cell center;
- **slope** – slope of cell;
- **aspect** – aspect of cell;
- **distance from coastline** – the shortest distance from the center of the cell to shoreline;
- **distance from nearest river –** shortest distance from the center of cell to nearest river;
- **distance from the plain** – the shortest distance from the center of the cell to the 50m contour line with the exception that plain is defined to be 0.0 for cells having elevation values less than 50m ;
- **distance from high elevation area –** the shortest distance from the center of the cell to the 350m contour line with the exception that mountain is defined to be 0.0 for cells having elevation values more than 350m;
- **distance from outstanding tops** – the distance from the center of the cell to the closest outstanding mountain top among the set judged to be readily visible from the sea or plain;
- **codes for sectors;**
- **codes for geomorphological regions.**

Study scales

Den site selection by female polar bears was studied on two different scales: 1x1km and 100x100m units. We first considered selection of 1x1km units to avoid artifacts and biases that occur due to the low accuracy of mapping den openings and flight lines. Also, use of the 1x1km units allowed us to define predictor (independent) variables based on the proportions of different landscape elements present within the unit thereby describing general landscape complexity and diversity of habitat within units. We also investigated selection at the 100x100m scale to compare the influence of important predictor variables with the results from study at the 1x1 km scale.

To conduct the 1x1km scale study Wrangel Island was first divided into approximately 13,000 1x1km units. We eliminated 1x1km units that were not surveyed in at least one year and one 100x100m cell. Thus, statistical inferences are limited to regions of Wrangel Island where surveys occurred. This resulted in 4,340 1x1km units that could be used in the study of den site selection at the 1x1km scale. Each of these units contains 100 cells each of size 100x100m, with the exception that those units intersecting the shoreline contain fewer than 100 cells.

For analyses with the 100x100m cells as the basic sampling unit we defined cells to be used if at least one den opening was recorded during the ten years of aerial surveys. There were 549 used cells in the study area. Because of the unnecessarily large total number of "available" cells (Erickson *et al.* 1998), the used ones were contrasted to a systematic sample of available cells selected from the set of 100x100m cells above 50m *elevation that were included in the aerial surveys at least once*. We selected a systematic sample of available units as nodes of a regular grid with 1km intervals resulting in 3,450 cells, or approximately one cell in one hundred. An analysis based on a sample of this size will not vary much from an analysis based on a census of available cells.

Variables for 1x1km scale study

For study of den site selection at the 1x1km scale, we derived the following variables (note: units that intersect the shoreline have fewer than 100 cells and require obvious modifications in the definitions):

- **cells,** number of 100x100m cells in the unit that intersect Wrangel Island;
- **numXX,** number of den openings located in the 100x100m cells in the unit in year XX;
- **effortXX,** number of 100x100m cells in the unit intersecting aerial flight lines in year XX;
- **altavg,** average elevation (m) of cells;
- **altrange,** range of elevation (m) of cells;
- **altndc,** number of different elevation classes present where cells are classified into one of the categories: 0 to 30m, 30 to 60m, 60 to 120m, 120 to 240m, 240 to 480m, and > 480m;
- **alt0-60,** proportion of cells below 60m elevation;
- **alt60-120,** proportion of cells 60m to 120m elevation;
- **alt120-240,** proportion of cells 120m to 240m elevation;
- **alt240-1000,** proportion of cells 240m or higher elevation;
- **slpavg,** average slope (degrees) of cells;
- **slprange,** range of slope (degrees) of cells;
- **slpndc,** number of different slope classes present where cells are classified into one of the classes: 0

to 2, 2 to 4, 4 to 8, 8 to 16, 16 to 32 and greater than 32 degrees);

- **slp4-8,** proportion of cells in the 0 to 4 degree category;
- **slp4-8,** proportion of cells in the 4 to 8 degree category;
- **slp8-16,** proportion of cells in the 8 to 16 degree category;
- **slp16-60,** proportion of cells in the 16 to 60 degree category;
- **aspndc,** number of different aspect classes present where cells are classified into one of the classes: northern slope (0 to 45 and 315 to 360 deg), eastern slope (45 to 135 deg), southern slope (135 to 225 deg), and western slope (225 to 315 deg);
- **asp-N,** proportion of cells with northern slope;
- **asp-E,** proportion of cells with eastern slope;
- **asp-S,** proportion of cells with southern slope;
- **asp-W**, proportion of cells with western slope;
- **rivdens,** proportion of cells intersecting rivers;
- **cstd,** average distance of cells from the shoreline;
- **plnd,** average distance of cells from the 50m contour (with all cells below 50m defined to be 0.0);
- **mtnd,** average distance of cells from the 350m contour (with all cells above 350m defined to be 0.0);
- **rivd,** average distance of cells from the nearest river;
- **topd,** average distance of cells from the nearest outstanding mountain top;
- **plain,** intersection of the plain (m) with the shortest line from the center of units to shoreline where the plain is defined to be cells with elevation below 50m;
- **region,** mode for region codes;
- **sector,** mode for sector codes;
- **altdiv,** and **alteven,** diversity and evenness of the cells when classified into the six elevation classes;
- **slpdiv,** and **slpeven,** diversity and evenness of the cells when classified into the six slope classes;
- **aspdiv,** and **aspeven**, diversity and evenness of the cells when classified into the four aspect classes;
- **altcv, slpcv,** and **aspcv**, coefficient of variation of primary data for altitude, slope and aspect of the cells.

The diversity and evenness indices involved the proportion of cells belonging to each of the elevation, slope, and aspect classes and the formulas:

$$\textit{Diversity} = -\sum_{i=1}^{k} p_i \log p_i$$

$$\textit{Evenness} = \frac{\textit{diversity}}{\log k}$$

where p = proportion, k = number of non-zero classes, and the log is base e.

Variables for 100x100m scale study
For the study of den site selection on 100x100m scale the following variables were involved:

- **survXX** – aerial survey effort in each cell for year XX (defined to be 1 for each cell intersected by the aerial flight lines at least one time and 0 otherwise);
- **numXX** – number of openings to maternity or temporary dens in cell for year XX;
- **yrs** – number of survey years (for ground plots only);
- **elev** – elevation of the cell center (m);
- **slope** – slope of cell (deg);
- **aspect** – aspect of cell (deg);
- **cstd** – the shortest distance from the center of the cell to shoreline (km);
- **rivd** – shortest distance from the center of cell to nearest river(km);
- **plnd** – the shortest distance from the center of the cell to the 50m contour (with all cells below 50m defined to be 0.0) (km).

Data sets
In summary, four data sets were prepared:

a) data for aerial surveys of Wrangel Island with the number of openings to maternity and temporary dens and independent variables in 4,340 1x1km units;

b) data for aerial surveys of Wrangel Island with the number of openings to maternity and temporary dens and independent variables in the 549 100x100m cells with dens and a selection of 3,450 cells over the island;

c) four sets of data for ground surveys of the study plots with the number of maternity dens and independent variables in the 1x1km units in each of the ground study plots; and

d) four sets of data for ground surveys of the study plots with the number of maternity dens and independent variables in the 100x100m units in each of the ground study plots.

The first two datasets are suitable for investigation of den distribution and site selection over the surveyed part of Wrangel Island while the latter datasets are useful for study of den distribution within relatively small areas with high den density and homogeneous habitat.

Statistical methods

Statistical methods for den site selection at the 1x1km scale

Using the aerial survey data, we defined an indicator variable for use of the 1x1km units for denning activity to be 1 for any unit with **numXX** > 1, and 0 otherwise. We used logistic regression to model the relative probability of use using independent variables measured on the 1x1km units. Because the number of land cells and survey effort differed from unit to unit, we included the effort variable, **effortXX,** as a predictor variable in the model. Cells with extreme values of effort (below fifth percentile or above 95th percentile) were removed from the analysis resulting in 3,928 cells for the analysis.

Model selection for the multivariate logistic models began with reducing the candidate variable set through univariate logistic regression models. A univariate model was fit for every independent variable and the Wald chi-square p-values were compared. Variables that were not significant at the alpha=0.10 level of significance where dropped from consideration in a multivariate model. The remaining variables were examined to remove variables from the candidate list that are highly correlated with each other. We used a list of the univariate p-values to ensure the variable with the smallest p-value was kept from the group of correlated variables. We fit the 255 models created from all possible combinations of the top 8 variables left on the univariate list and compared the top models based on the CAIC (consistent Akaike's information criteria) (Anderson *et al.* 1994). The top three models were then compared to the model obtained using forward selection procedures involving all 36 predictor variables.

A separate analysis at the 1x1km scale was conducted using data from the ground surveys in the four study plots. The sum of the number of maternity dens in each 1x1km unit was computed as a measure of use (dependent variable). There were 179 observations of maternity dens in this data set, 52 from Dream Head, 43 from Pilar, 60 from Thomas, and 24 from Waring. Poisson generalized linear regression was used to regress use against the derived independent variables. The number of 100x100m land cells times the number of years each cell was surveyed was included in the model as a measure of effort (an offset in the model). Model selection proceeded similarly to the Island-wide analysis described above.

Statistical methods for den site selection at the 100x100m scale

We estimated the relative probability of a 100x100m cell being selected as a den site as a function of the independent variables using a log-linear model (Manly *et al.* 1993, p. 126). We fit the 63 models created from all possible combinations of these six variables and selected the top model based on the CAIC.

For analysis of the ground study plots at the 100x100m scale, the presence and absence of dens observed in a cell was modeled using a logistic model with binomial errors. The 100x100m cells from each ground study plot were compiled together. There were 1,836 cells surveyed on Cape Waring, 2,982 on Pillar, 3,614 on Dream Head, and 4,704 on Cape Thomas. Logistic regression of used and unused cells was conducted to model the probability of use as a function of the independent variables: **elev, slope, aspect, cstd, plnd** and **rivd**. The data on cells within the ground study plots should be considered more reliable than that obtained in aerial surveys because the mapping of den locations during ground surveys is more accurate. We fit the 63 models created from all possible combinations of these six and selected the top model based on the CAIC. The number of years each cell was surveyed was included as a predictor variable in each model.

Results

Den site selection at the 1x1km scale

The forward selection model was chosen as the final model for all of Wrangel Island at the 1x1km scale, because it had the highest correlation of the predicted probability of use with observed use during the study period. There was little difference, as is common, in the correlations of predicted probability of use with observed use between this model and the "best" models selected by the CAIC criterion. Coefficients of variables in the logistic regression model based on data from all of Wrangel Island are listed below.

Parameter	d.f.	Estimate	Standard error
Intercept	1	-4.3538	0.3491
EFFSUM	1	0.0299	0.0036
SLPDIV	1	2.5958	0.3200
PLND	1	-0.1267	0.0194
TOPD	1	-0.1077	0.0227
ASP_S	1	-0.7976	0.2143
ALTRANGE	1	-0.0048	0.0013
SLP8	1	2.1059	0.5545

The estimated standard errors are all small compared to the magnitude of the coefficients indicating that the predictions of probability of use have small standard errors based on this model. It is likely that the other CAIC models would fit the data about equally well.

The sign on the parameter estimate can be used to help interpret the influence of the variable on the predicted relative probability of use. Effort (EFFSUM) is included in the model because we can only predict the relative probability that a unit will contain a den and be detected. ***Probability of detection*** of a den is clearly related to the amount of survey effort expended in the unit, i.e., as the number of surveyed cells within a unit increases, the model estimates an increase (0.0229 is positive) in the relative ***probability of detection*** of a den. Effort should be held constant when predicting relative probability of use with this model. The interpretations of the other variables are as follows:

Increased diversity of slope classes and proportion of area with slope between 8 and 16 degrees increases the estimate of relative probability of use. Increased distance to areas below 50m contour line (plain), distance from an outstanding mountain top, proportion of south-facing slopes and range of elevations in the unit decreases the estimated relative probability of use.

We emphasize that the other top CAIC models would have similar interpretations and would fit the data about equally well. For details on using this model to predict relative probability of use, see Annexes 1 and 2.

The final model for the ground survey data at the 1x1km scale is presented below (Fig. 22). The forward selection model was chosen as the final model, because it had the highest correlation (0.85) of the predicted den density with observed den density during the study period. The first, second, and third models in the ranking of models by CAIC had correlations of 0.83, 0.84, and 0.84 with the observed den density, respectively. Coefficients of variables in the Poisson regression model based on data from the model plots is listed below.

Parameter	d.f.	Estimate	Standard error
Intercept	1	-9.5558	0.3812
ALTEVN	1	5.7987	0.6159
ASPDIV	1	4.8265	0.5359
RIVD	1	0.6807	0.0938
SLP8	1	0.0278	0.0035
CSTD	1	-0.2084	0.0402
ALT60	1	0.9375	0.2044
ALTDIV	1	-1.1041	0.2905

The estimated standard errors are all small compared to the magnitude of the coefficients indicating that the predictions of probability of use have small standard errors based on this model. The sign on the parameter estimate can be used to help interpret the influence of the variable on the predicted relative probability of use.

Increased evenness of elevation, diversity of aspect, average distance to a river and proportion of the cells with slope between 8 and 16 degrees, proportion of the cells with altitude between 60 and 120m increase the estimated number of dens.

Increased *average distance to the coast* and *diversity of elevations* decrease the estimated number of dens.

Den site selection at the 100x100m scale

The forward selection model was chosen as the final model for Wrangel Island at the 100x100m scale (Fig. 23). Coefficients of variables in the logistic regression model are listed below.

Parameter	d.f.	Estimate	Standard error
Intercept	1	-0.5149	0.1140
ELEV	1	-0.0031	0.0006
SLOPE	1	0.0603	0.0075
CSTD	1	-0.0588	0.0098
PLND	1	-0.1223	0.0221

The estimated standard errors are all small compared to the magnitude of the coefficients indicating that the predictions of probability of use have small standard errors based on this model. It is likely that the other CAIC models would fit the data about equally well.

Increased *slope* increases the estimated relative probability of use. Increased *elevation*, *distance to coastline, distance to the plains (areas below 50m contour)* decreased the estimated relative probability of use.

The final model for the ground survey data at the 100 x100m scale is presented below (Fig. 24). The forward selection model and the CAIC top model were the same. Coefficients of variables in the logistic regression model based on data from the model plots are listed below.

Parameter	d.f.	Estimate	Standard error
Intercept	1	-4.5629	0.1649
YRS	1	0.1844	0.0134
SLOPE	1	0.0253	0.0050
PLND	1	-0.2182	0.0501

The estimated standard errors are all small compared to the magnitude of the coefficients indicating that the predictions of probability of use have small standard errors based on this model. It is likely that the other CAIC models would fit the data about equally well. The number of years a model plot is surveyed (YRS) is included in the model. Probability of detection of a den is clearly related to the amount of survey effort expended in the unit, i.e., as the amount of effort increases, the model estimates an increase (0.184 is positive) in the relative probability of detection of a den. Effort should be held constant when predicting relative probability of use with this model.

Increased slope increases the estimated relative probability of use while increased distance to the plains (areas below 50m contour) decreases the estimated relative probability of use.

Conclusions

The models contain several variables with consistent indication of their association with the relative probability of use by polar bears for den sites. The probability of use significantly increases when the sites are more close to coast and inner border of the coastal lowland areas below 50m. The models also indicate higher use in areas with the higher diversity of slope and aspect, but lower use in the areas with especially abrupt elevation changes. Then it appears polar bears prefer areas where slopes from 8 to 16 deg and elevation from 60 to 120m are predominant and avoid the river bottoms as well as the areas with predominately south facing slopes. Apart from that there is indication of some probability of use increasing towards outstanding mountain tops, which may be orientation points for bears coming to the island or just indicators of preferable landscape structure.

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Annex 1

Predicting relative probability of use on 1kmx1km units using the logistic regression model

The logistic regression model response was a 1 if a den had been observed in the cell at any time during the 10 years of surveys, 0 otherwise. Cells with extreme values of effort (where effort was the number of cells surveyed across 10 years) were not included in the analysis. The final model was of the form:

Log(P/(1-P)) = EXP(**-4.3538** + (EFFORT***0.0299**) + (SLPDIV2E***2.5958**) + (PLND***-0.1267**) + (TOPD***0.1077**) + (ASP_S***-0.7976**) + (ALTRANGE***-0.00485**) + (PSLP8***2.1059**))

An example from the dataset

UNIT	PREDOBS	EFFSUM	PREDCON	PREDEFF	PSLP0	PSLP4	PSLP8	PSLP16	SLPDIV	PLND	TOPD	ASP_S	ALTRANGE
111	0.01943	35	0.01228	20	0.9790	0.0105	0.0105	0	0.1167	0	7.819	0	20
112	0.03281	42	0.01692	20	0.92	0.07	0.01	0	0.3089	0	8.721	0	35

PREDOBS: predicted value of relative probability of use at the observed effort

EFFSUM: sum across years of the number of cells surveyed

PREDCON: predicted value of relative probability of use at a constant effort (effort=20)

PREDEFF: value used in calculation of PREDCON

PSLP0: proportion of cells with slopes from 0 to 4 degrees

PSLP4: proportion of cells with slopes from 4 to 8 degrees

PSLP8: proportion of cells with slopes from 8 to 16 degrees

PSLP16: proportion of cells with slopes greater than 16 degrees

SLPDIV: diversity of slope calculated as the negative of the sum (across non-zero slope classes) of p*ln(p). For example, for observation unit 111, diversity = - (.98*ln(.98) +.01*ln(.01) +.01*ln(.01)) = 0.117

PLND: average distance (across cells) of distance from 50m contour line

TOPD: average distance from outstanding mountain tops

ASP_S: proportion of cells with Southern slopes

ALTRANGE: range of elevations in cells

Prediction for observation unit 111,

PREDOBS = exp(**-4.3538** + (35***0.0299**) + (0.1167***2.5958**) + (0***-0.1267**) + (7.819***-0.1077**)+ (0***-0.7976**) + (20***-0.00485**) + (0.0105***2.1059**)) / (1+ exp(**-4.3538** + (35***0.0299**) + (0.1167***2.5958**) + (0***-0.1267**) + (7.819***-0.1077**)+ (0***-0.7976**) + (20***-0.00485**) + (0.0105***2.1059**)))= 0.0194

PREDCON = exp(**-4.3538** + (20***0.0299**) + (0.1167***2.5958**) + (0***-0.1267**) + (7.819***-0.1077**)+ (0***-0.7976**) + (20***-0.00485**) + (0.0105***2.1059**)) / (1+ exp(**-4.3538** + (20***0.0299**) + (0.1167***2.5958**) + (0***-0.1267**) + (7.819***-0.1077**)+ (0***-0.7976**) + (20***-0.00485**) + (0.0105***2.1059**))) = 0.0124

Annex 2

Predicting probability of use on 100mx100m units using the logistic regression model

The logistic regression model response was a 1 if a den had been observed in the cell at any time during the 10 years of surveys, 0 otherwise. Cells with no search effort were not included in the analysis. The final model was of the form:

$\mathrm{Log}(P/(1-P)) = \exp(\mathbf{-0.5149} + (\mathrm{ELEV}*\mathbf{-0.0031}) + (\mathrm{SLOPE}*\mathbf{0.0603}) + (\mathrm{CSTD}*\mathbf{-0.0588}) + (\mathrm{PLND}*\mathbf{-0.1223}))$

An example from the dataset

UAID	PREDOBS	ELEV	SLOPE	CSTD	PLND
A1	0.57332	140	23.0077	1.98	0.28
A10	0.25827	200	5.7145	2.80	0.90

UAID: Unit ID preceded by an ‘A’ for available points or a ‘U’ for used points

PREDOBS: The predicted value of probability of use at the observed effort

ELEV: Elevation for the cell

SLOPE: Slope for the cell

CSTDIST: Distance from cell to shoreline

CSTD: CSTDIST/1000

PLNDIST: Distance from cell to 50m contour line, cells below 50m contour line get value of 0

PLND: PLNDIST/1000

Prediction for observation unit A1,

$\mathrm{PREDOBS} = \exp(XB)/(1+\exp(XB)) = \exp(\mathbf{-0.5149} + (140*\mathbf{-0.0031}) + (23.01*\mathbf{0.0603}) + (1.98*\mathbf{-0.0588}) + (0.28*\mathbf{-0.1223})) / (1+ \exp(\mathbf{-0.5149} + (140*\mathbf{-0.0031}) + (23.01*\mathbf{0.0603}) + (1.98*\mathbf{-0.0588}) + (0.28*\mathbf{-0.1223}))) = 0.573$

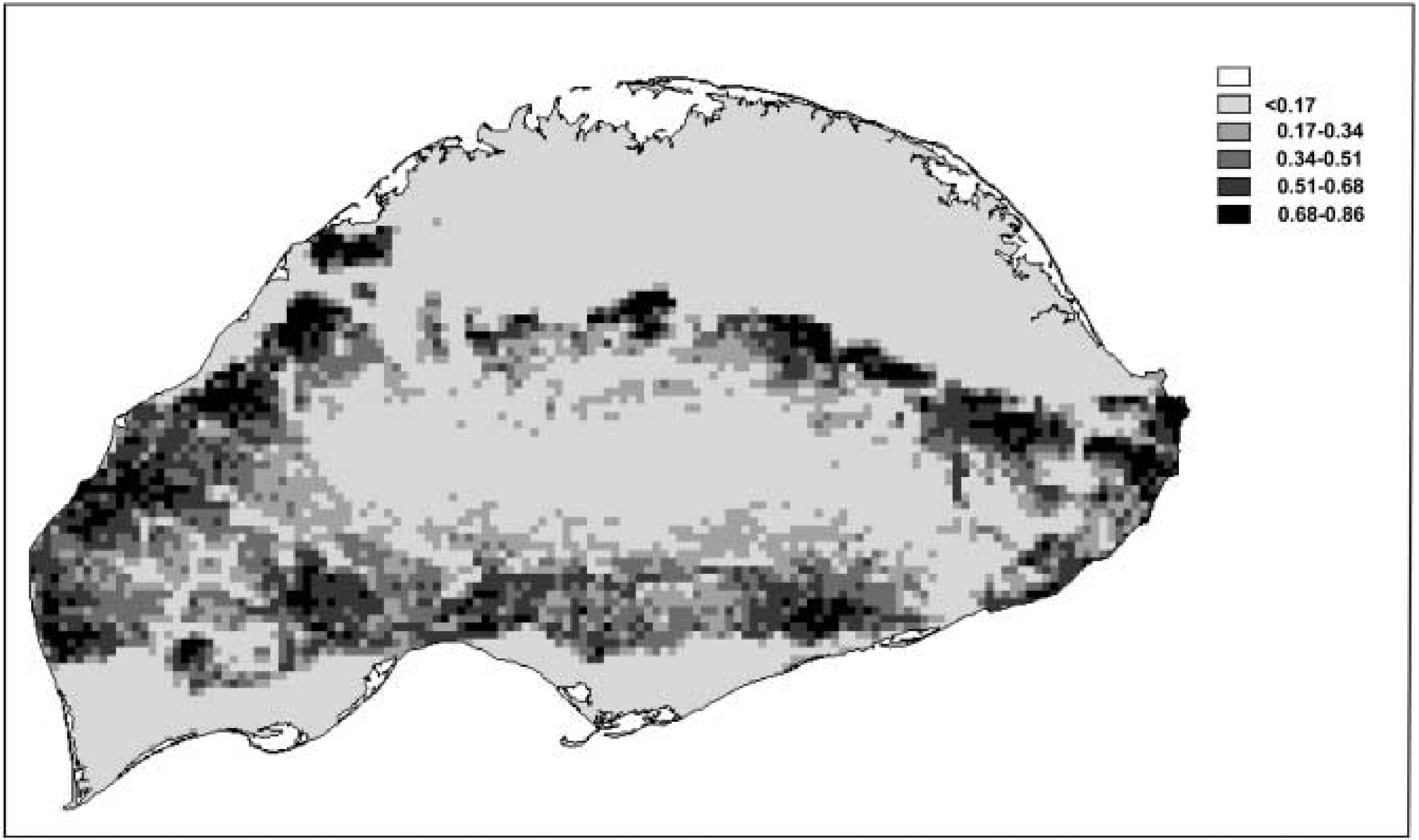

Fig. 22. Relative probability of use at 1x1km scale (effort = 100).

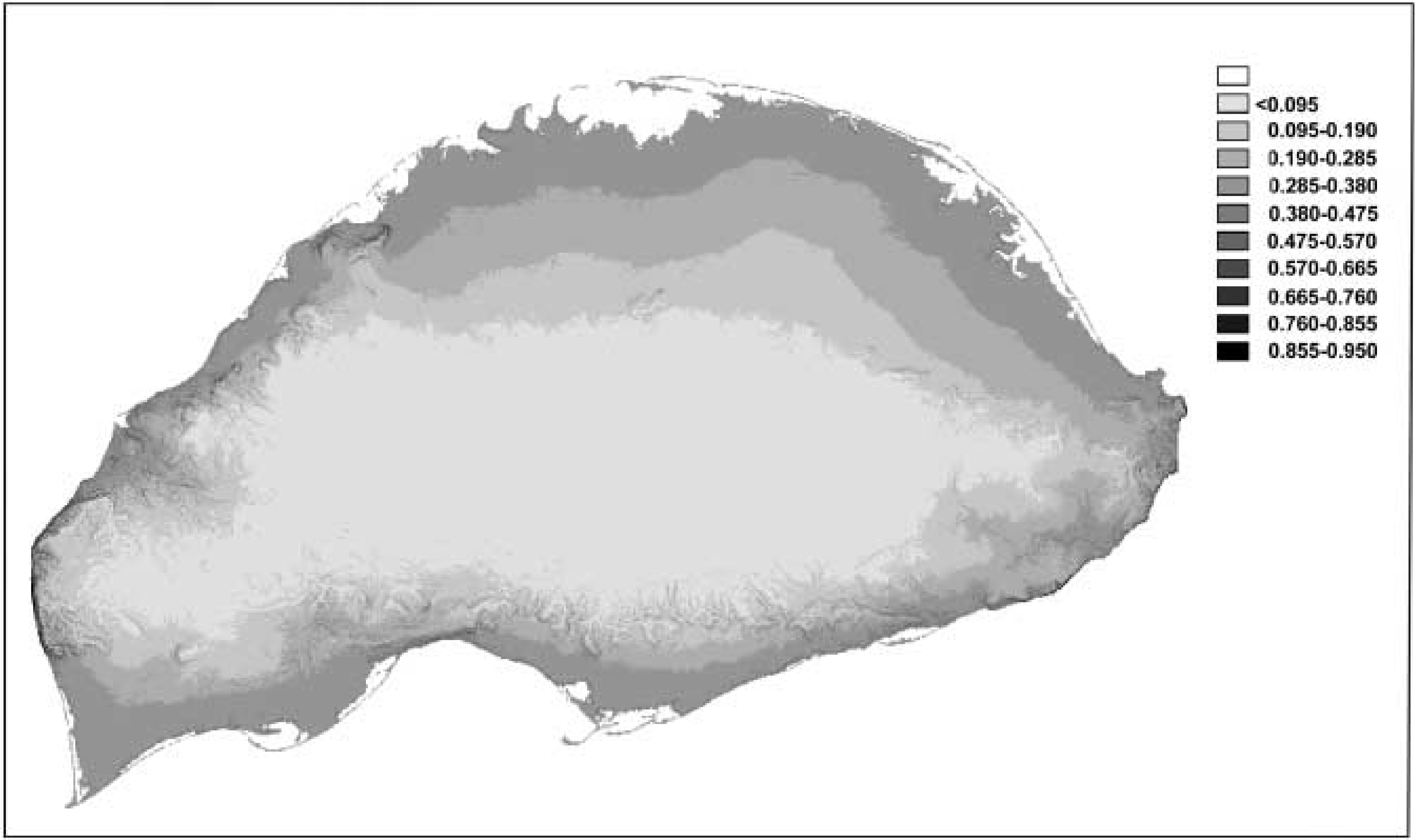

Fig. 23. Relative probability of use at 100x100m scale.

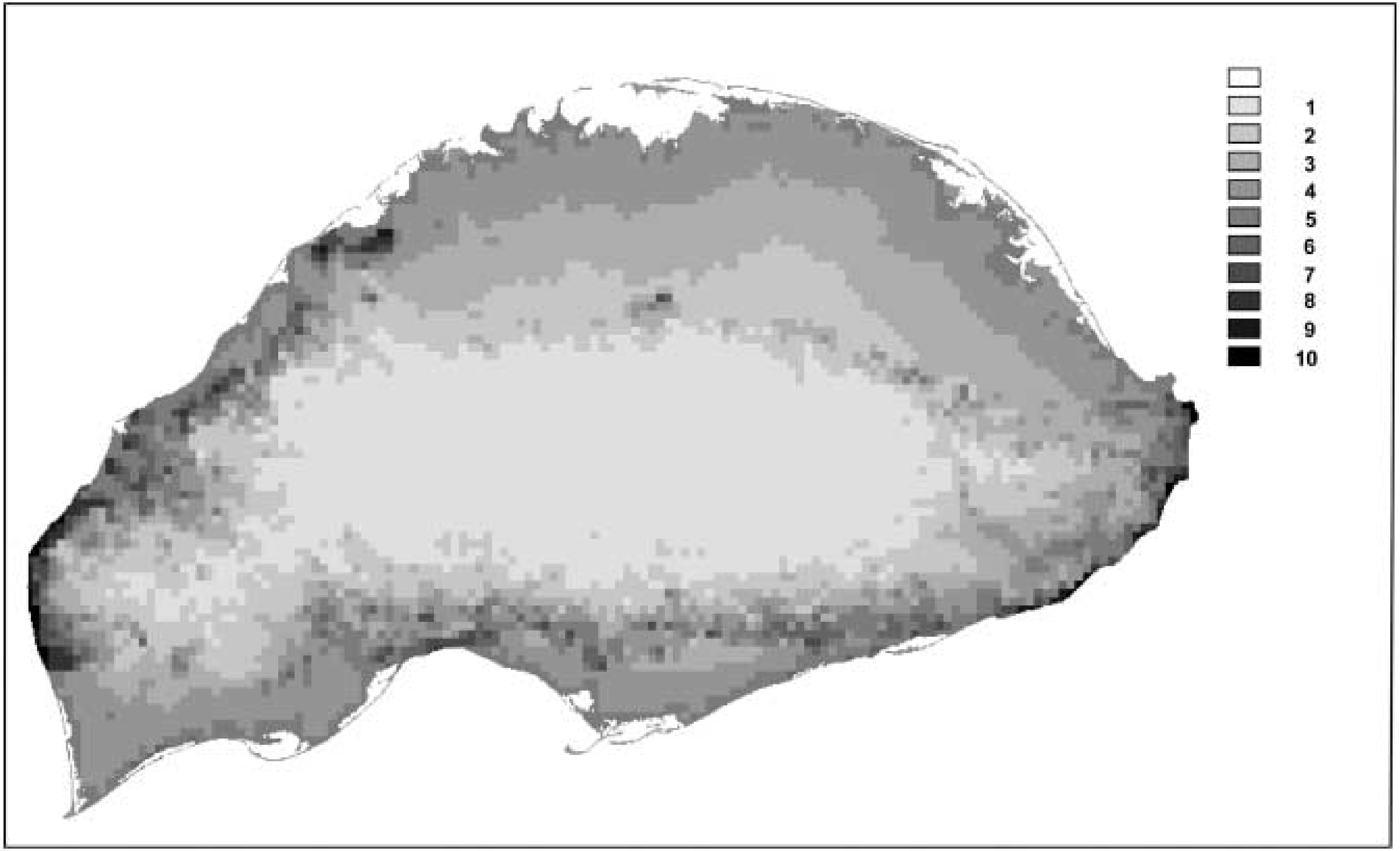

Fig. 24. Maximum categories of probability of use of 100x100m cells for 1x1km units.

Polar bear co-management in Alaska: Co-operative management between the US Fish and Wildlife Service and the native hunters of Alaska for the conservation of polar bears

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Co-management of marine mammals in Alaska began with the listing of bowhead whales as an endangered species in the early 1970s. Bowhead whales had been heavily hunted by commercial whalers for their blubber and baleen until they became protected under the Endangered Species Act. The National Marine Fisheries Service, the agency charged with managing whales, had announced that as few as 750 whales remained in the waters of the Bering Sea and Arctic Ocean.

Bowhead whales have been and continue to be a vital part of the subsistence diet and culture of the Inupiat and Yupik Peoples of Alaska. The listing of the bowhead whales under the ESA caused NMFS to announce that limits would have to be imposed on the subsistence harvest of the whales. The whaling captains felt that the NMFS count underestimated the population of whales by a factor of ten. In 1977 the whaling captains formed the Alaska Eskimo Whaling Commission (AEWC) to represent Alaska Natives and to fight for their right to continue whaling. Soon thereafter NMFS signed a co-management agreement with the AEWC.

The intent of the agreement was the conservation of bowhead whales by determining an accurate population count, establishing enforceable quotas and improving the humane take of the whales. As a result of the co-operative efforts of NMFS and AEWC the population of bowhead whales is now estimated at more than 8,000 and native people of Alaska have been granted acceptable quotas by the International Whaling Commission. According to reports by the Marine Mammal Commission the ratio of struck and lost whales has been dramatically reduced by improved methods and weaponry.

Alaska has two populations of polar bears, one in the Bering and Chukchi Seas that it shares with Russia and one in the Southern Beaufort Sea that it shares with the Northwest Territories of Canada. While sport hunting of polar bear had been stopped by the International Polar Bear Agreement in 1973, subsistence hunting by indigenous people was allowed to continue in Alaska and Canada. Under the U.S. Marine Mammal Protection Act of 1972, taking of marine mammals was prohibited except for subsistence purposes by coastal native people. Native people have the right to take an unlimited number of marine mammals provide the take was non wasteful and that the animals were not listed as threatened or depleted. Polar bear in Alaska have never been listed.

During the 1980s the people of the North Slope Borough of Alaska and the Inuvialuit of the Northwest Territories of Canada became concerned that the potential for over-harvesting the polar bear of the Southern Beaufort Sea population was a real threat. While neither the Department of Wildlife Management of the North Slope Borough or the Inuvialuit Game Council had the legal authority to manage the harvest of polar bear they felt that some action was needed to protect this population of polar bear.

In 1986 the "North Slope Borough/Inuvialuit Game Council Agreement on the Conservation and Management of the Southern Beaufort Sea Polar Bear Population" was developed and signed. On the Alaska side compliance was entirely voluntary. The agreement established annual quotas of 40 bears for each side of the border for a total of 80 bears each year and sought to protect females and females with cubs.

The Agreement has been an outstanding success. For the first ten years after the Agreement was signed a total of 680 bears have been taken out of a cumulative 800 bears that have been on the quotas. The ratio of females taken has been reduced to 25% compared to 40% during the same period out of the Bering/Chukchi population.

The Agreement is overseen by a Joint Commission, which has members representing the Inuvialuit Game Council and the North Slope Borough Department of Wildlife Management. The Joint Commission meets annually to review harvest data, compliance with the quotas, results of research and to adjust the quotas if necessary. Two years ago the quotas were raised by four animals annually, not to increase the harvest but to facilitate the allocation of quotas between the villages of the Inuvialuit of Canada.

The Southern Beaufort Sea population continues to thrive. The population estimate has recently been revised upward to be as high as 2,500 from the 1,800–2,000 that has historically been used.

The Bering/Chukchi Seas polar bear population

Alaska shares a population of polar bear in the Bering and Chukchi Seas. Hunting of polar bear was banned in the Soviet Union in 1956 by a decree that listed them in the "Red Book" as depleted. In 1989 the FSU reclassified polar bear as a recovered species and notified the U.S Fish and Wildlife Service that it wished to share in the harvest of the Bering/Chukchi population.

Even though Alaska Natives had continued to harvest bears from this population, indicators such as age-sex structure of the harvest, suggested that the population was healthy if not thriving. With the possibility of additional harvest by natives of Chukotka, the U.S. Fish and Wildlife Service met with representatives of Alaska Native Organizations that would be affected such as the Eskimo Walrus Commission, the North Slope Borough, Kawerak and Maniiliq Associations. The Native organizations were informed that if Russia shared in the harvest it meant splitting the harvest equally which meant numbers and quotas.

The Native organizations responded that since they were the only legal hunters of this population they wanted to be an equal partner in any negotiations with Russia to develop a polar bear agreement. They further stated that if quotas were to be established they wanted to set these quotas themselves through a Native-to-Native agreement with the Native hunters of Chukotka modeled after the North Slope-Inuvialuit Agreement in the Southern Beaufort Sea.

In June 1994 the Alaska Nanuuq Commission (ANC) was formed. The tribal councils of the villages in North and Northwest Alaska in the range of the polar bear passed resolutions authorizing the Alaska Nanuuq Commission to represent them on matters concerning the conservation and sustainable subsistence use of polar bear. The resolutions authorized the ANC to enter into agreements with local, regional, state, national governments or agencies, non-governmental organizations or other native organizations for the purpose of polar bear conservation.

In 1994 the Alaska Nanuuq Commission began meeting with Native organizations in Chukotka to discuss the development of a Native-to-Native agreement. At about this time the late Mollie Beattie, the Director of U.S. Fish and Wildlife Service established the Native American Policy for the Service. The policy stated that on matters concerning management of fish and wildlife on native and tribal lands a government-to-government relationship would be honored between the U.S. Fish and Wildlife Service and the tribes. The policy further stated that where the USFWS had management authority, co-management with affected Native Americans would be established whenever possible.

As a result of this policy Alaska natives, as represented by the Alaska Nanuuq Commission, became an equal partner with the U.S. Fish and Wildlife Service in the negotiation and finalization of the U.S./Russia Polar Bear Treaty that was signed on October 16, 2000 in Washington D.C. The treaty creates a Joint Commission with representatives of the governments of the U.S. and Russia as well as representatives of Alaska Natives and the Natives of Chukotka. The Joint Commission will establish harvest limits and will establish policy guidelines for management of this population. The treaty also allows for a Native-to-Native Agreement to implement the treaty.

When Russian Ambassador to the U.S., Yuri Ushakov, signed the treaty he noted that this was the most democratic treaty that Russia had ever signed. Not only is co-management of polar bears in Alaska a legacy of Mollie Beattie's Native American Policy, but the potential for co-management in Russia through the polar bear treaty is also a result. During the negotiation of the treaty, the Alaska Nanuuq Commission and the USFWS insisted that representatives of Chukotka's Native Peoples be part of the Russian delegation.

In 1997 a grass roots movement in Chukotka representing the native villages and hunters formed the Union of Marine Mammal Hunters. Three commissions were established, a Bowhead Whale Commission, a Pacific Walrus Commission and a Polar Bear Commission. The Union struggled under the repressive regime of Chukotka Governor Nazarov and was forced to change its name when Nazarov formed a competing organization with the same name. The Union is now the Association of Traditional Marine Mammal Hunters of Chukotka. A Beluga Whale Commission has also been added to the Association.

Fortunately a new governor has been elected in Chukotka who has promised support for the Association and its efforts to become involved in the management of marine subsistence resources.

In order to help the Association become established and to gain credibility the Alaska Nanuuq Commission received a three year contract from the National Park Service to study polar bear habitat use in Chukotka by interviewing knowledgeable hunters on their observations of polar bear hunting areas, migration routes and denning sites. The ANC signed an agreement with the Association for them to conduct the study and to provide technical assistance and training. A similar study on the Alaska side of the population had been conducted by USFWS biologist Susanne Kalxdorff who published the report in 1997 titled “Collection of Local Knowledge Concerning Polar Bear Habitat Use in Alaska”. In order to insure consistency Ms Kalxdorff provided training in the techniques and methodology she had used in Alaska to the investigators from the Association. The program is now in its third year and the report is expected to be published by late fall. The program will also produce calendars and posters in Russian to promote polar bear conservation in Chukotka and to inform the Russian public on the U.S/Russian Polar Bear Treaty.

Polar bear co-management

The development of the Native-to-Native Agreement was based on the NSB/Inuvialuit Agreement and its success. However there will be some critical differences. First the NSB/Inuvialuit Agreement is voluntary; the Native-to Native Agreement will be enforceable.

The U.S./Russia treaty is in conflict with the MMPA in that it calls for quotas or “Management before depletion” which is in violation of Section 101 (b) which allows unlimited non-wasteful harvest of marine mammals by coastal natives. Alaska Natives have tenaciously clung to this section of MMPA as a basic subsistence right. While the Joint Commission described earlier will determine sustainable harvest limits it will fall to the Native-to-Native Agreement to assign to the regions or villages. The acceptance of quotas by the villages of Northwest Alaska will determine the success of the Native-to-Native Agreement. Both the Alaska Nanuuq Commission and the Association of Traditional Marine Mammal Hunters of Chukotka favor starting with low level quotas at the start and to adjust as the effects of the harvest on the population is observed.

The second issue is enforcement. In the NSB Agreement on the Alaska side, enforcement is done by community pressure and sometimes by direct intervention by the Department of Wildlife Management. It is anticipated that the first line of enforcement will be through ordinances adopted by village councils. Where enforcement by the village is not possible then assistance by federal enforcement agencies will be requested. At the same time the federal agencies may enforce where village enforcement is absent.

The third issue is the perceived level of poaching in Chukotka. While hunting is still not legal in Russia there have been reports from villages of Northern Chukotka of significant numbers of bears being taken. The economic situation in Chukotka has resulted in residents turning to polar bear, both for meat and for cash or goods from the sale of hides. The Association is beginning to address this problem by developing processes to use in the future to determine the legality of hides that are sold.

Both the ANC and the Association want to cooperatively set research priorities with their respective management agencies and governments. These research priorities will reflect the concerns of the Native Peoples of Alaska and Chukotka and include contaminants and their effect on the health of animals and on the people who consume them. Global warming and its effect on the environment and habitats is also of great concern.

Co-management also provides for a process to include traditional knowledge into the research and management and is the only way to include the user groups in polar bear conservation.

Appendices

Appendix 1

Agreement on the Conservation of Polar Bears and their Habitat

The Governments of Canada, Denmark, Norway, the Union of Soviet Socialist Republics, and the United States of America,

Recognizing the special responsibilities and special interests of the States of the Arctic Region in relation to the protection of the fauna and flora of the Arctic Region;

Recognizing that the polar bear is a significant resource of the Arctic Region, which requires additional protection;

Having decided that such protection should be achieved through coordinated national measures taken by the States of the Arctic Region;

Desiring to take immediate action to bring further conservation and management measures into effect;

Have agreed as follows:

ARTICLE I

1. The taking of polar bears shall be prohibited except as provided in Article III.
2. For the purpose of this Agreement, the term "taking" includes hunting, killing and capturing.

ARTICLE II

Each Contracting Party shall take appropriate action to protect the ecosystems of which polar bears are a part, with special attention to habitat components such as denning and feeding sites and migration patterns, and shall manage polar bear populations in accordance with sound conservation practices based on the best available scientific data.

ARTICLE III

1. Subject to the provisions of Articles II and IV, any Contracting Party may allow the taking of polar bears when such taking is carried out:
   (a) for bona fide scientific purposes; or
   (b) by that Party for conservation purposes; or
   (c) to prevent serious disturbance of the management of other living resources, subject to forfeiture to that Party of the skins and other items of value resulting from such taking; or
   (d) by local people using traditional methods in the exercise of their traditional rights and in accordance with the laws of that Party; or
   (e) wherever polar bears have or might have been subject to taking by traditional means by its nationals.
2. The skins and other items of value resulting from taking under sub-paragraphs (b) and (c) of paragraph 1 of this Article shall not be available for commercial purposes.

ARTICLE IV

The use of aircraft and large motorized vessels for the purpose of taking polar bears shall be prohibited, except where the application of such prohibition would be inconsistent with domestic laws.

ARTICLE V

A contracting Party 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.

ARTICLE VI

1. Each contracting Party shall enact and enforce such legislation and other measures as may be necessary for the purpose of giving effect to this Agreement.
2. Nothing in this Agreement shall prevent a Contracting Party from maintaining or amending existing legislation or other measures or establishing new measures on the taking of polar bears so as to provide more stringent controls than those required under the provisions of this Agreement.

ARTICLE VII

The Contracting Parties shall conduct national research programs on polar bears, particularly research relating to the conservation and management of the species. They shall as appropriate coordinate such research with the research carried out by other Parties, consult with other Parties on the management of migrating polar bear populations, and exchange information on research and management programs, research results and data on bears taken.

ARTICLE VIII

Each Contracting Party shall take actions as appropriate to promote compliance with the provisions of this Agreement by nationals of States not party to this Agreement.

ARTICLE IX

The Contracting Parties shall continue to consult with one another with the object of giving further protection to polar bears.

ARTICLE X

1. This Agreement shall be open for signature at Oslo by the Governments of Canada, Denmark, Norway, the Union of Soviet Socialist Republics, and the United States of America until 31st March, 1974.

2. This Agreement shall be subject to ratification or approval by the signatory Governments. Instruments of ratification or approval shall be deposited with the Government of Norway as soon as possible.

3. This Agreement shall be open for accession by the Governments referred to in paragraph 1 of this Article. Instruments of accession shall be deposited with the Depository Government.

4. This Agreement shall enter into force ninety days after the deposit of the third instrument of ratification, approval or accession. Thereafter, it shall enter into force for a signatory or acceding Government on the date of deposit of its instrument of ratification, approval, or accession.

5. This Agreement shall remain in force initially for a period of five years from its date of entry into force, and unless any Contracting Party during that period requests the termination of the Agreement at the end of that period, it shall continue in force thereafter.

6. On the request addressed to the Depository Government by any of the Governments referred to in paragraph 1 of this Article, consultations shall be conducted with a view to convening a meeting of representatives of the five Governments to consider the revision or amendment of this Agreement.

7. Any Party may denounce this Agreement by written notification to the Depository Government at any time after five years from the date of entry into force of this Agreement. The denunciation shall take effect twelve months after the Depository Government has received this notification.

8. The Depository Government shall notify the Governments referred to in paragraph 1 of this Article of the deposit of instruments of ratification, approval, or accession, for the entry into force of this Agreement and of the receipt of notifications of denunciation and any other communications from a Contracting Party specially provided for in this Agreement.

9. The original of this Agreement shall be deposited with the Government of Norway, which shall deliver certified copies thereof to each of the Governments referred to in paragraph 1 of this Article.

10. The Depository Government shall transmit certified copies of this Agreement to the Secretary-General of the United Nations for registration and publication in accordance with Article 102 of the Charter of the United Nations.

[The Agreement came into effect in May 1976, three months after the third nation required to ratify did so in February 1976. All five nations ratified by 1978. After the initial period of five years, all five Contracting Parties met in Oslo, Norway, in January 1981, and unanimously reaffirmed the continuation of the Agreement.]

Appendix 2

Annex E, Resolution on Special Protection Measures, and a recent related resolution from the PBSG

Annex E, Resolution on Special Protection Measures

The conference,

Being convinced that female polar bears with cubs and their cubs should receive special protection;

Being convinced further that the measures suggested below are generally accepted by knowledgeable scientists to be sound conservation practices within the meaning of Article II of the Agreement on the Conservation of Polar Bears;

Hereby requests the Governments of Canada, Denmark, Norway, the Union of Soviet Socialist Republics and the United States of America to take such steps as possible to:

1. Provide a complete ban on the hunting of female polar bears with cubs and their cubs; and,
2. Prohibit the hunting of polar bears in denning areas during periods when bears are moving into denning areas or are in dens.

Clarification of the need for special protection measures for female polar bears

(Resolution from the 1997 PBSG Meeting)

The IUCN Polar Bear Specialist Group

Recognising that the RESOLUTION ON SPECIAL PROTECTION MEASURES appended to the 1973 Agreement for the Conservation of Polar Bears urges a complete ban on hunting females with cubs and their cubs; and

Recognising the requirement for sound conservation measures identified in the Agreement for the Conservation of Polar Bears; and

Recognising that the polar bear is a significant cultural, nutritional, and economic resource for local subsistence users; and

Recognising that adult females have relatively greater reproductive value compared to other sex and age groups; and

Acknowledging that harvest management practices that accommodate the occasional take of dependent young for cultural reasons are consistent with sound conservation practices so long as the mother continues to be protected; therefore

Recommends special protection for adult females and emphasizes that harvest management practices that select for males and young animals may aid in offering protection for adult females.

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Appendix 4

Numbers allocated to each country for eartags and tattoos used in polar bear research and management

Number series	Letter[1]	Country	Year assigned
1–249	A	USA	1968
250–499	N	Norway	1968
500–749	X	Canada	1968
750–999	C	USSR	1968
1000–1999	A	USA	1969
2000–5999	X	Canada	1971–76
6000–6999	A	USA	1976
7000–7499	D	Denmark	1976
7500–7999	N	Norway	1976
8000–8499	C	USSR	1976
8500–9999	X	Canada	1980
10000–19999	X	Canada	1984
20000–22999	A	USA	1984
23000–23999	N	Norway	1984
24000–24999	D	Denmark	1984
25000–25999	C	USSR/Russia	1984
26000–29999	N	Norway	1997
30000–39999	X	Canada	1997

[1] A unique letter has been assigned to each country for use on eartags and in tattoos in combination with the above number series

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. Constant, 1985, 58pp. (Out of print)
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3. *Biology and Conservation of River Dolphins*. Edited by W.F. Perrin, R.K. Brownell, Zhou Kaiya and Liu Jiankang, 1989, 173pp. (Out of print)
4. *Rodents. A World Survey of Species of Conservation Concern*. Edited by W.Z. Lidicker, Jr., 1989, 60pp.
5. *The Conservation Biology of Tortoises*. Edited by I.R. Swingland and M.W. Klemens, 1989, 202pp. (Out of print)
6. *Biodiversity in Sub-Saharan Africa and its Islands: Conservation, Management, and Sustainable Use.* Compiled by Simon N. Stuart and Richard J. Adams, with a contribution from Martin D. Jenkins, 1991, 242pp.
7. *Polar Bears: Proceedings of the Tenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group.* 1991, 107pp.
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10. *Polar Bears: Proceedings of the Eleventh Working Meeting of the IUCN/SSC Polar Bear Specialist Group, January 25–28 1993, Copenhagen, Denmark*. Compiled and edited by Øystein Wiig, Erik W. Born and Gerald W. Garner, 1995, 192pp.
11. *African Elephant Database 1995*. M.Y. Said, R.N. Chunge, G.C. Craig, C.R. Thouless, R.F.W. Barnes and H.T. Dublin, 1995, 225pp.
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16. *The Live Bird Trade in Tanzania*. Edited by N. Leader-Williams and R.K. Tibanyenda, 1996, 129pp.
17. *Sturgeon Stocks and Caviar Trade Workshop. Proceedings of a workshop held on 9–10 October 1995 Bonn, Germany by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the Federal Agency for Nature Conservation*. Edited by Vadin J. Birstein, Andreas Bauer and Astrid Kaiser-Pohlmann. 1997, viii + 88pp.
18. *Manejo y Uso Sustentable de Pecaries en la Amazonia Peruana*. Authors: Richard Bodmer, Rolando Aquino, Pablo Puertas, Cesar Reyes, Tula Fang and Nicole Gottdenker, 1997, iv + 102pp.
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21. *African Antelope Database 1998.* Compiled by Rod East and the IUCN/SSC Antelope Specialist Group, 1999, x + 434pp.
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A volunteer network comprised of some 7,000 scientists, field researchers, government officials and conservation leaders from nearly every country of the world, the SSC membership is an unmatched source of information about biological diversity and its conservation. As such, SSC members provide technical and scientific counsel for conservation projects throughout the world and serve as resources to governments, international conventions and conservation organizations.

SSC Occasional Papers cover a broad range of subjects including conservation of groups of species in a particular geographical region, wildlife trade issues, and proceedings of workshops. IUCN/SSC also publishes an Action Plan series that assesses the conservation status of species and their habitats, and specifies conservation priorities. The series is one of the world's most authoritative sources of species conservation information available to natural resource managers, conservationists and government officials around the world.

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