Polar Bears

Proceedings of the 15th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 29 June-3 July 2009, Copenhagen, Denmark

Compiled and edited by Martyn E. Obbard, Gregory W. Thiemann, Elizabeth Peacock and Terry D. DeBruyn

Occasional Paper of the IUCN Species Survival Commission No. 43

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Published by: IUCN, Gland, Switzerland

Citation: Obbard, M.E., Thiemann, G.W., Peacock, E., and DeBruyn, T.D. (eds) (2010). *Polar Bears: Proceedings of the 15th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Copenhagen, Denmark, 29 June–3 July 2009.* Gland, Switzerland and Cambridge, UK: IUCN. vii + 235 pp.

Citation of chapters: Born, E.W., Sonne, C., and Dietz, R. (2010). Research on polar bears in Greenland 2005–2009. Pages 135-148 *in* M.E. Obbard, G.W. Thiemann, E. Peacock, and T.D. DeBruyn (eds.) *Polar Bears: Proceedings of the 15th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Copenhagen, Denmark, 29 June–3 July 2009.* Gland, Switzerland and Cambridge, UK: IUCN

ISBN: 978-2-8317-1255-0

Cover photo: Adult female polar bear accompanied by two yearlings, Hudson Bay coast near Churchill, Manitoba. (©Martyn E. Obbard, Ontario Ministry of Natural Resources)

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Rue Mauverney 28
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www.iucn.org/publications

Also available from: IUCN/SSC Polar Bear Specialist Group at: http://pbsg.npolar.no/en/index.html

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Nils Are Øritsland (1939–2006)

Nils Øritsland at Svalbard, 1969

Professor Dr Philos Nils Are Øritsland, a gifted scientist who contributed much original thought and research to polar bears, died unexpectedly on November 24, 2006 after a short illness. He participated actively in several meetings of the IUCN/SSC Polar Bear Specialist Group and continued collaborative studies with several members on a variety of research projects on polar bears right up to his untimely death. With his passing, the IUCN/SSC Polar Bear Specialist Group lost a highly valued colleague and friend, as have the polar bears as well.

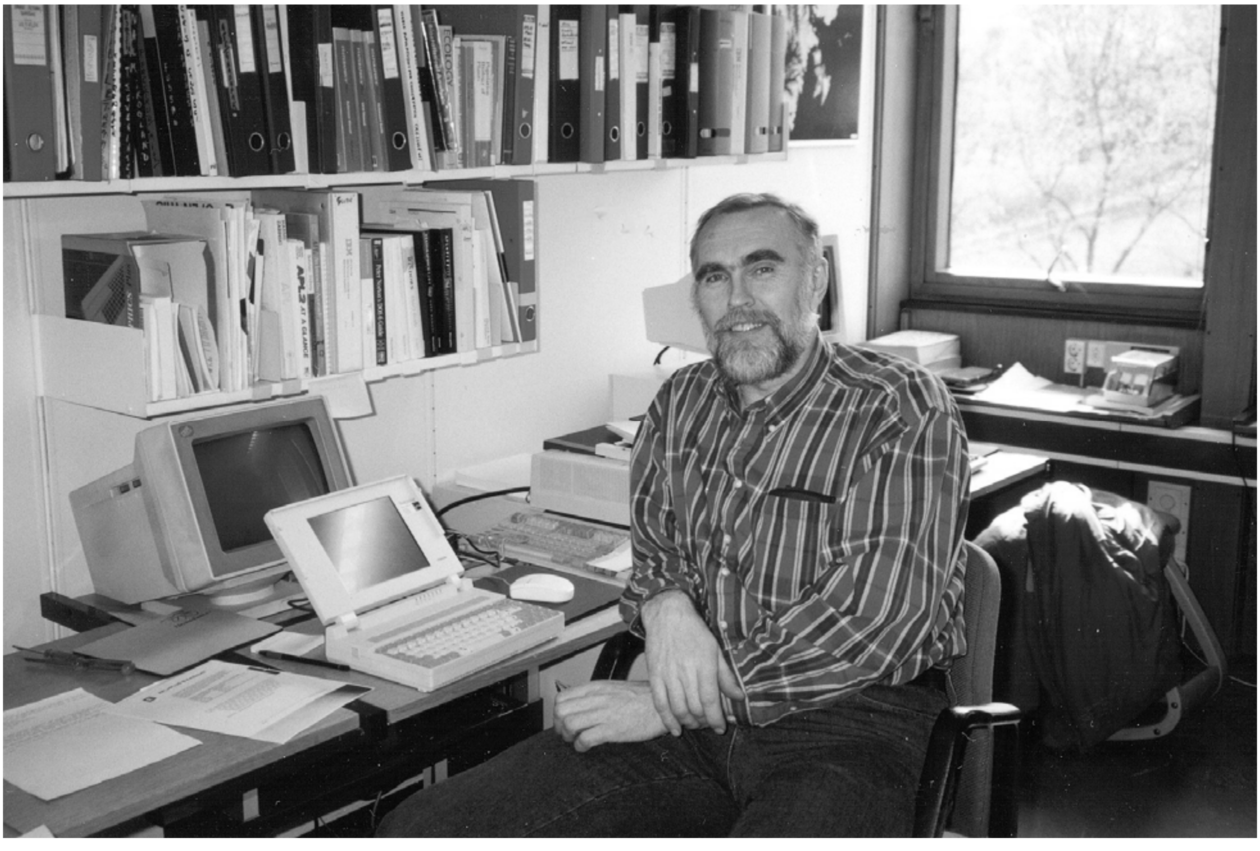
Throughout his early education and his later career, Nils Are was dedicated to Arctic research and in particular to studies of the energy balance of free-living animals, particularly polar bears and seals. As a young scientist, in 1968-69, along with another well-known Norwegian polar bear biologist, Thor Larsen, he spent a whole winter on an island in the remote archipelago of Halvmåneøya in Svalbard in the Norwegian Arctic in order to study polar bears. While there, he conducted a series of physiological experiments on heat balance in live bears, especially cubs, the results of which are still fundamental to all subsequent studies of heat balance in polar bears. Later, in 1971-1974, he performed a series of ingenious and original physiological experiments on heat balance in polar bears in Churchill, Canada. Included in his research during this period were some ground-breaking experiments on the effects of oil on polar bears. Although there was some controversy about the experiments at the time, over 30 years later his research on that topic remains the complete basis of our understanding of this significant environmental threat to wild polar bears.

Through most of his professional career, Nils Are was dedicated to Arctic research and continued to pursue his career through both the

University of Oslo and the Norwegian Polar Institute, focusing on the energetics of Arctic mammals. From 1974-84 he was the scientific leader of a multidisciplinary research program on reindeer under the UNESCO program "Man and Biosphere". The aim of the program was to understand the biological basis for the existence of the Svalbard reindeer. At the same time, he developed the Bioenergetics Group at the Zoophysiological Institute, University of Oslo, which continued to focus on all aspects of energy balance in mammals.

Nils Are received his Dr. Philos. degree in 1978 for a thesis entitled, "Some applications of thermal values of fur samples in expressions for *in vivo* heat balance". In 1986 he was honoured by the "Nansen reward" from the University of Oslo for outstanding research in the Arctic. In the period 1987–1992 he was Professor in Zoophysiology at the same place. Nils Are was director of the Norwegian Polar Institute from 1991 to 1993. He resigned when the Norwegian Parliament decided to move the institute from Oslo to Tromsø in 1993, though he continued to work there until the move was completed in 1999. Through the last years before he died, he consulted privately on the development of population models for the management of wildlife. Simultaneously, he continued to work closely with several of the members of the IUCN PBSG on the development of a comprehensive population and energetics model for polar bears, a work which, sadly, was never completed.

Nils Are was an unusually gifted scientist and a truly original thinker. He was also a totally honest man who remained unafraid to speak his mind, clearly and without rancour. One could not find a finer person to call a friend and colleague. He leaves behind a wonderful and close family as well as many scientific colleagues who continue to miss his insights, sense of humour, and simple good companionship very much. At the same time, we remain grateful for all that he did for us individually and for his field of science and, of course, for his long-term research that taught us so much about polar bears.



Nils Øritsland at the Norwegian Polar Institute

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 coordinate research and management of polar bears. Eight years following the First Scientific Meeting, the '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: "The Contracting Parties shall conduct national research programmes on polar bears, particularly research relating to the conservation and management of the species. They shall as appropriate coordinate such research with 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 15th Working Meeting of the IUCN/SSC Polar Bear Specialist Group that was held 29 June–3 July 2009 in Copenhagen, Denmark 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 (Seattle, Washington 2005), and identified priorities for future studies. The group confirmed the conclusion from previous meetings that the greatest challenge to conservation of polar bears is ecological change in the Arctic resulting from climatic warming. Declines in the extent of the sea ice have accelerated since the last meeting of the group in 2005, with unprecedented sea ice retreats in 2007 and 2008. Warming-induced habitat degradation and loss are already negatively affecting polar bears in some parts of their range, and unabated global warming will ultimately threaten polar bears everywhere. However, threats to polar bears will occur at different rates and times across their range. Subpopulations of polar bears face different combinations of human-induced threats meaning that conservation and management of polar bears will be even more challenging in the future.

These 15th Proceedings provide an overview of the ongoing research and management activities on polar bears in the circumpolar Arctic. Together with the previous 14 proceedings, they provide an historic record of the international effort in protecting, studying, and managing polar bears. The document addresses more recent concerns of threats arising as a consequence of increased human activities in both the Arctic and in regions far beyond the Arctic. Previous proceedings included a Status Report for each of the world's subpopulations, which focused largely on the known or unknown status as it related to harvest. In the Status Report of the 15th Proceedings, we provide a more comprehensive assessment of all threats to the status of each polar bear subpopulation.

A note on the use of the terms population and subpopulation

Following the usage adopted in the14th Proceedings, we use the term population for all the polar bears in the Arctic. This decision is based on their biology, as polar bears roam over large areas and genetic structuring is low even between areas far apart. However, in earlier issues and in several publications, population has been used to term more local management units. Here those are termed subpopulations. The boundaries between these subpopulations will always be based on current knowledge, thus boundaries may change as more complete knowledge on their ecology becomes available. This is especially so in less studied areas such as the Russian Arctic, where our view of what the real subpopulations or management units are, and to what degree they interact or are a part of the neighbouring nations' subpopulations, may change in the future.

The Editors:
M.E. Obbard
G.W. Thiemann
E. Peacock
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Agenda

Fifteenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group Copenhagen, Denmark 29 June–3 July 2009

Meeting Venue: Nordatlantens Brygge

Monday 29 June 2009

9:00 **1.0 Opening welcome and administrative issues (Andrew Derocher)**

1.1 Introductory welcome and remarks/comments from the hosts (E. Born & others)
1.2 Introduction of participants
1.3 Election of the meeting Chairperson
1.4 Election of Secretary for recording notes from the meeting
1.5 Review agenda (additions, deletions, or scheduling for topics), adoption of final agenda
1.6 Production, format, anticipated cost of published proceedings from the meeting (overview of publication of the 14th Working Meeting Proceedings – Aars; production of the 15th Proceedings – Obbard)
1.7 Presentation of ad hoc editors for compilation of Proceedings and the minutes of the meeting
1.8 PBSG website and future development – Vongraven
1.9 Election of group to draft the press release
1.10 Tabling or introduction of draft resolutions, formation of resolutions committee.

10:30 Break

2.0 Summary of research by nation including recent, ongoing and planned studies

2.1 Alaska:
Durner, Amstrup: Southern Beaufort Sea
Regehr: Demography of polar bears in the Southern Beaufort Sea
Rode: Chukchi Sea Project
Rode: Coastal Surveys and feeding studies
Other topics / speakers

12:00 Lunch

13:00 Reconvene

Eske Willerslev, University of Copenhagen: Polar bear genome and an international study

2.2 Canada
Lunn: Western Hudson Bay
Obbard: Southern Hudson Bay
Richardson: Beaufort Sea
Peacock: Nunavut
Derocher: University of Alberta
Thiemann: York University
Other topics / speakers

2.3 Greenland:
Born, Laidre, Sonne, Dietz
Other topics / speakers

2.4 Denmark:
Born, Sonne, Dietz

2.5 Norway
Aars: Barents Sea
Wiig:
Munro-Jenssen: ecotoxicology
Other topics / speakers

15:00 Break

2.6 Russia:
Belikov, Boltunov, Ovsyanikov
Other topics / speakers

19:00 IUCN/SSC Polar Bear Specialist Group Members meeting

Tuesday June 30

08:00 **3.0** **Summary of management by nation**

- 3.1 USA: DeBruyn
- 3.2 Canada: Lunn, Peacock, Obbard
- 3.3 Greenland: Greenland Home Rule, Winther Hansen
- 3.4 Norway: Vongraven, Ekker
- 3.5 Russia: Belikov, Boltunov, Ovsyanikov, Nikiforov

10:30 Break
Reconvene and continue with the above

12:00 Lunch

13:00 Reconvene and continue with the above

Wednesday July 1

08:00 **4.0** **Issues pertaining to the Agreement and the Range States Meetings**
Report from Meeting
Development of an Action Plan
PBSG as a Scientific Advisor for Meetings of the Range States

4.1 Status of populations by nation
USA: DeBruyn, Durner
Canada: Lunn, Peacock, Obbard
Greenland: Winther Hansen, Born
Norway: Vongraven, Ekker
Russia: Belikov, Boltunov, Ovsyanikov

4.2 Circumpolar Biodiversity Monitoring Program: Vongraven

12:00 Lunch

13:00 Reconvene and continue with the above

5.0 **Bilateral and Multilateral agreements, Memoranda of Understanding**
Russia–USA: Belikov, DeBruyn
Canada–USA: Lunn, Carpenter, Brower, DeBruyn

15:00 Break

Canada–Greenland: Peacock, Lunn, Greenland Home Rule
Norway–Russia: Ekker, Vongraven, Belikov

Thursday July 2

08:00 **6.0** **Conservation & environmental issues: contaminants, climate change, harvest, tourism, oil/gas/ mineral developments**

- 6.1 Toxic chemicals and heavy metals: Dietz, Sonne, Dietz, Nabe-Nielsen
- 6.2 Tourism issues: Vongraven, Ovsyanikov
- 6.3 Climate change: Amstrup, Durner, Derocher, Peacock and others
- 6.4 Oil/gas/minerals: Richardson and others
- 6.5 Harvest TBD
- 6.6 Shipping: Peacock, Wiig
- 6.7 Minimizing research impacts: Ovsyanikov
- 6.8 Human–bear interactions: DeBruyn, Vongraven
- 6.9 Hunting in Chukotka: Kotchnev

12:00 Lunch

13:00 Reconvene and continue with the above

7.0 Research priorities and cooperative projects – PBSG and others

8.0 Population inventory methods

8.1 DNA darting Peacock

15:00 Break

8.2 Aerial surveys: Aars
Aerial survey simulations: Nielson and others

8.3 Traditional Knowledge: Carpenter, Nirlungayuk

17:30 Social event – details will follow

Friday July 3

08:00 **9.0 Status report review of populations**

9.1 Tabling the draft status reports by nation (USA, Canada, Greenland, Norway, Russia)

9.2 Review, discuss, and recommendations for finalizing status report

10:30 Break

10.0 Resolutions

10.1 Tabling and discussion of draft resolutions

10.2 Review and discussion of resolutions

12:00 Lunch

13:00 Reconvene

11.0 IUCN Business

11.1 Issues handled by the Chair (2005-2009): Derocher

12.0 Evaluation and discussion of the future status of the PBSG

13.0 Adoption of the status report

15:00 Break

14.0 Adoption of resolutions presented by resolutions committee

15.0 Adoption of press release

16.0 Election of new chair of PBSG

17.0 Closing remarks

Minutes
of the 15th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Copenhagen, Denmark, 29 June-3 July 2009

Monday, June 29

1. Opening and administrative issues

Introductory remarks

The 15th Working Meeting of the IUCN/SSC Polar Bear Specialist Group (PBSG) was called to order by A. Derocher, Chair of the Group, at 09:00 in the Olivin Room, Nordatlantens Brygge in Copenhagen, Denmark. A. Derocher welcomed the delegates to Copenhagen, and invited Tove Søvndahl Pedersen, Head of the Greenland Representation in Denmark, to officially open the meeting.

Tove Søvndal Pedersen welcomed the delegates to Copenhagen and recognized the hard work of the PBSG and the ongoing commitment of all five signatory nations to the 1973 *Agreement on the Conservation of Polar Bears*. She discussed the importance of polar bears to Greenland Inuit and noted the recent developments of Greenland as a modern society, including the formation of the Greenland Self Governance just a few days earlier. She emphasized the need for user groups and scientists to share their understanding of polar bears and use this knowledge as the foundation of polar bear management. In closing, she thanked the PBSG for their continued hard work and expressed her confidence that the Group would continue to secure the conservation of polar bears.

Introduction of participants

There was a brief introduction of each participant, a list of which will be included in the Proceedings.

Election of meeting chairman and individuals to record the minutes

A. Derocher was elected meeting Chair and the following individuals volunteered to record the minutes for one day each: D. Lee (Monday), E. Regehr (Tuesday), E. Richardson (Wednesday), K. Rode (Thursday), and G. Thiemann (Friday). G. Thiemann would also be responsible for collecting and collating the minutes.

Review of the agenda

The meeting agenda was revised to include an afternoon break each day at 15:00. G. Nirlungayuk asked about press representatives and E. Born responded that a press release indicating that the meeting is taking place has been drafted by the Greenland Institute of Natural Resources. The final agenda was adopted.

Production, format, and anticipated cost of published proceedings from the meeting

A. Derocher said there will likely be great interest in the next proceedings and as a result, he has already coordinated the formation of an editorial group led by M. Obbard and joined by T. DeBruyn, E. Peacock, and G. Thiemann.

J. Aars was Senior Editor of the last proceedings and reviewed the costs and time involved. He noted that it cost £5,000 to publish 1000 copies and an additional £3,000 for shipping. Most of the editorial work was done by the PBSG members, which substantially reduced the costs of publication.

N. Lunn confirmed that Canada was committed to paying their share of costs for the proceedings. There were also commitments made by E. Born, J. Aars, S. Belikov, and T. DeBruyn on behalf of their jurisdictions. M. Obbard has contacted IUCN to inform them that the editors are organizing a publication of the proceedings. A. Derocher emphasized that he would like to see publication expedited because of the interest in the meeting.

PBSG website and future development

A. Derocher noted that D. Vongraven has continued to develop and maintain the PBSG website and expressed his deep appreciation for D. Vongraven's efforts.

D. Vongraven delivered a presentation that described the development of the website over the last 4 years including the adoption of a new logo for the group. The number of visitors to the website had increased dramatically. A. Derocher noted that new publications or other relevant activities could be publicized on the site. D. Vongraven demonstrated the content and functionality of the website, including: the ability to search over 1000 publications on polar bears, a database of Russian literature, information on each polar bear subpopulation, and descriptions of research techniques. He also presented some excellent tools developed by Periscopic® for visualizing and communicating data on the web. He solicited comments from the Group regarding their interest in having Periscopic® develop content for the PBSG site. This would involve a connection to some long-time data sets and a one-time cost of $50,000-70,000 USD.

N. Lunn indicated that he has received positive reviews of the PBSG website and would be willing to provide data from WH. A. Derocher pointed out that Periscopic® is associated with the IUCN and he too would be willing to contribute data to the site. R. Buchanan emphasized that the mission of Polar Bears International is research and education and would like to provide infrastructure and support for the website and other ventures (e.g., through volunteers). Ø. Wiig said there must an explanation of the uncertainties associated with data on the website and the Group agreed on this point. A. Derocher suggested a working group be formed to get this moving forward. E. Peacock, R. Dietz, G. Thiemann all expressed interest in providing data for the site. The Group discussed copyright issues for published work made available on the web and agreed on the need to clarify these issues.

Election of group to draft the press release

S. Amstrup, J. Aars, N. Lunn, G, Nirlungayuk, N. Ovsyanikov, and E. Peacock agreed to draft the press release. S. Amstrup would coordinate efforts. After general discussion of how to distribute the document, the Group decided to take advantage of an offer from Polar Bears International to provide information on various media connections that could be used to circulate the final draft to all media outlets.

Presentation of draft resolutions

No draft resolutions were provided prior to the meeting. The Group agreed that resolutions drafted during the course of the meeting could be circulated at any time.

S. Amstrup, A. Derocher, J. Justus, N. Ovsyanikov, S. Belikov, and G. Nirlungayuk agreed to serve on the resolutions committee.

2. Summary of research by nation including recent, ongoing, and planned studies

Presentations of research were delivered by each nation. Because detailed reports from each nation will be included in the Proceedings, only summaries are presented here.

United States

G. Durner summarized the USGS investigations into polar bear spatial ecology and physiology. He described the extensive spatial data recovered from one particular collar that showed the bear swimming more than 650 km in the Beaufort Sea. USGS will continue their research and development of resource selection functions (RSF) for polar bears and have plans to conduct a future population assessment of the Southern Beaufort Sea (SB) subpopulation. They will also re-examine the spatial delineation of subpopulations in the Beaufort and Chukchi Seas. These studies will continue to be driven by traditional mark-recapture and radio-tagging methods and will focus on explaining ecosystem change and the mechanisms that drive polar bear populations.

Questions centered on technical aspects of the methodology and how these data may reflect unprecedented changes in polar bear habitat and life history in SB. N. Ovsyanikov asked about the relationship between this research and broader issues of polar bear conservation. G. Durner responded that a basic understanding of polar bear ecology and physiology is required to understand how bears will respond to changes in environmental conditions and will facilitate appropriate management strategies. N. Ovsyanikov suggested the USGS perform a behavioural study to account for the possible impacts of capture and disturbance on the behaviour of collared bears, especially in relation to swimming.

E. Regehr presented the results of recent demographic studies on polar bears in SB. Declining sea ice conditions appeared to be related to declining vital rates for polar bears and indicated that the subpopulation is likely to decline severely in the next 100 years if sea ice loss continues as projected. E. Regehr mentioned a harvest risk analysis in preparation by the USFWS, to inform user groups of how different harvest scenarios may affect the future status of the subpopulation. He also presented results from recent surveys to count polar bears on Alaska's north coast during the ice-retreat season, introduced mark-resight studies planned for 2009-2013, and described plans to deploy ear-mounted and glue-on satellite telemetry tags on polar bears.

Questions were asked about which sea ice parameters might best capture shifts in polar bear habitat availability. G. Nirlungayuk pointed out the potential limitation of tracking only female bears and inquired about the rate of capture related mortality. E. Regehr responded that only 1 research-related mortality occurred over the last 6 years, during which *ca*. 1100 bears were handled. S. Amstrup commented that projections of polar bear habitat changes are based on general circulation models that incorporate a greenhouse gas forcing function. As these models are projected farther into the future, they actually become more accurate because the effects of short-term stochasticity are diminished. L. Carpenter suggested that the USFWS study design may fail to sample a substantial number of polar bears that remain on the ice far from shore. E. Regehr responded that the satellite telemetry data as well as directed flights into the pack ice do not support the idea of a separate group of offshore bears. G. Durner added that RSF models also indicate that SB bears primarily utilize the near shore ice.

K. Rode summarized the results of US-based studies on polar bears in the Chukchi Sea (CS) subpopulation. In support of the US-Russia Agreement on the Conservation and Management of the Alaska-Chukotka Polar Bear Population, the USFWS and USGS launched a polar bear capture study in the Chukchi Sea in 2008. The project goals include: (1) collection of data on body size, nutritional status, and other physiological parameters, (2) evaluation of movement and habitat use patterns in relation to sea ice availability, and (3) examination of the feasibility of capture-recapture or other techniques for estimating the size of the subpopulation. The study is planned to continue at least through 2011.

Discussion focused on the difficulty in drawing conclusions about the CS subpopulation because of the limited amount of data available to date. In response to a question from G. Durner, K. Rode commented that two bears appeared to den in the study area; one on Wrangel Island and the other on the Chukchi Peninsula. She also pointed out that there is good polar bear habitat and an abundance of seals in the Chukchi Sea area, but the region has been under-studied to date. N. Ovsyanikov expressed scepticism about the feasibility of a mark-recapture population estimate, given the number of bears that would likely need to be captured on the Russian side of the Chukchi Sea. K. Rode responded that the current capture program is not intended to be a mark-recapture population survey, but rather a preliminary attempt to collect information on body condition and distribution. Other methods, including aerial surveys, might provide useful information on population size.

Canada

N. Lunn noted that recent reorganization within Environment Canada has resulted in two separate groups within the department involved with wildlife – the Canadian Wildlife Service (CWS) and a newly created Wildlife Research Division, which is where the Marine Science/Polar Bear Program is now located. He recognized the significant contributions of Wendy Calvert and Ian Stirling both of whom are no longer with the Program. Wendy was reassigned and is currently working with the CWS Population Conservation group, whereas Ian has retired and is now a Research Scientist Emeritus.

N. Lunn summarized Environment Canada's ongoing, long-term research on the population ecology of polar bears in the Western Hudson Bay (WH) subpopulation in relation to climatic change and a pilot study using distance sampling aerial survey techniques to estimate abundance of polar bears in the WH subpopulation.

Specific questions were asked about the aerial survey methodology. In response, N. Lunn mentioned that the laser range finders (used to measure the distance from the aircraft to a bear on the ground) worked through closed windows but getting an accurate fix was difficult on bears farther than *ca*. 1500 m. The survey was done at an altitude of 500 feet AGL and few bears moved in response to the noise of the helicopter. This may have been a consequence of bears being used to regular air traffic over the area.

E. Richardson gave a presentation on the mating system of polar bears and male reproductive success in WH. The project was initiated by I. Stirling and includes a database of over 2400 bears that are genotyped at 26 microsatellite loci. Results were presented from a parentage analysis for the WH subpopulation using CERVUS 3.0 which indicated that polar bears have a polygynous mating system and significant variability in male reproductive success. It also appeared that a large number of cubs born in WH were sired by fathers outside of the subpopulation. This suggests that there may be more gene flow between polar bear subpopulations than was previously believed.

In response to a suggestion from J. Justus, E. Richardson said they will do additional analyses to examine the relatedness between genetic mothers and the foster mothers of adopted cubs. M. Branigan asked about adult males that had sired zero cubs and E. Richardson pointed out that it is not clear whether these males had died, left the population, or actually not produced any offspring. It is also possible that none of the male's cubs had been captured and sampled. K. Rode suggested that because so few multiple paternities were observed, a decline in the availability of males could negatively affect mating success in the population. S. Amstrup thought that paternity for very young adult male bears might be verified by comparing the body weights of those males with their female partners.

M. Obbard reported on a study of trends in body condition in the Southern Hudson Bay (SH) subpopulation that compared data from the 1984-86 period to data from 2000-05. Significant declines in body condition occurred for all age and sex classes with the magnitude of decline being greatest for pregnant females and subadults. Obbard also reported on capture-recapture analysis of 1984-86 and 2003-05 data; this analysis was conducted in conjunction with U.S.G.S. and West, Inc. No change in population size was detected between the early period (634 ± 244) and the later period (673 ± 277). However, there was evidence of declines in the point estimates of survival rates in all age and sex classes. Coupled with the declines in body condition this could suggest that the SH subpopulation is at a tipping point and abundance is likely to decline in the near future. M. Obbard also reported on a study in collaboration with M. Cattet that looked at the efficacy of hyaluronidase in improving chemical immobilization of polar bears. Hyaluronidase is a naturally-occurring enzyme that accelerates drug absorption from muscle or fat by catalyzing the hydrolysis of hyaluronic acid a component of the interstitial barrier. Treatment bears received smaller doses of immobilizing drug and had shorter induction times than control bears. Reduced induction times are important when chemically immobilizing fat animals; e.g., polar bears during the summer ice-free season in seasonal ice environments.

There was some discussion of whether different drugs should be compared by time to ataxia or complete immobilization. M. Obbard pointed out that bears darted with xylazine-zolazepam-tiletamine (XZT) cannot be safely approached when their head is still moving, therefore, all induction times were reported relative to full immobilization. A. Derocher pointed out that induction times for bears on land in summer are often longer than bears on ice in the spring. M. Obbard pointed out that some of the results were confounded by having a relatively inexperienced pilot and a batch of darts that was inconsistent in its quality; nevertheless the study results were promising.

Polar bear genetics: A proposed new study

E. Willerslev, Director of the Centre of Excellence in Geogenetics at the National History Museum of Denmark, gave a presentation to invite members and invited specialists to participate in a new study of polar bear genetic structure. The study would utilize the polar bear genome sequence that will shortly be completed by researchers in China. E. Willerslev's lab will utilize single nucleotide polymorphisms (SNPs) in the nuclear DNA of modern and ancient samples to examine temporal and spatial trends in polar bear genetic structure. This approach will provide insights into the effects of past climatic variation (e.g., the Holocene thermal optimum) on polar bear population dynamics and genetic diversity.

Questions focused on the methodology used to sequence the genome and the number of ancient samples that would be required for the study. S. Amstrup asked about the required age of the ancient samples and E. Willerslev replied that anything from 50-150 years old would provide useful information. Whether DNA can be extracted from very old samples (>100,000 yr) depends on the condition of the sample and the history of preservation. E. Born asked whether the study would have a whole-Arctic perspective and E. Willerslev indicated that a global analysis would be most interesting but will depend on sample availability from different regions. Additional questions centered on potential overlap between this project and another genetic study proposed by Dr. Beth Shapiro. Some members had already begun collaborating with Dr. Shapiro. It was decided that if Dr. Shapiro was planning to use a different approach (i.e., microsatellite analysis) to address similar questions, the two studies could be done in parallel. E. Willerslev was also enthusiastic about a broader collaboration. At the Chair's request, it was agreed that E. Willerslev would produce a short written proposal to be circulated to the Group.

Tuesday, June 30

PBSG members meeting

A. Derocher summarized the members meeting held the night before. He described how the PBSG was formulated and its historical limit of 20 members plus invited specialists. The members believe that although the current format is working well, given the recent increases in polar bear research, they decided to include 5 additional members. Currently, there are 3 members from each of the five polar bear nations, plus 5 additional members appointed by the chair. The Chair will now be able to appoint 10 members, thus increasing the total size of the PBSG to 25 members.

The members also discussed the polar bear Range States meeting. The PBSG was asked to serve as technical advisors to the Range States, and have now agreed to do so. However, the PBSG would remain an independent body under the IUCN.

The members discussed the timing of the next PBSG meeting and agreed that the group would continue to meet every 4 years, although the Chair could change this to 3 or 5 years if necessary. Canada will host the next meeting, tentatively scheduled for July 2013.

Canada (continued)

E. Richardson summarized research activities by the Canadian Wildlife Service in the Northern Beaufort Sea (NB) subpopulation and discussed the 2003-2006 capture-recapture effort and subsequent data analyses. The main finding was that the NB does not appear to have experienced a major change in population status since the 1980s. Details of this study are available in one of the USGS Administrative Reports released in 2007 (Stirling et al. 2007), and will eventually appear in a peer-reviewed scientific journal.

G. Nirlungayuk asked about the timing of the recent capture work relative to past and future studies. E. Richardson replied that some earlier work was done in the 1990s and the timing of future work would be decided by multiple jurisdictions. The CWS was not currently doing field work in NB. The interval between surveys was usually 8-10 years, which was unlikely to change unless there was a pressing management reason.

E. Peacock summarized research activities in Nunavut. She focused on results of the recent capture-recapture study in the Davis Strait (DS) subpopulation, details of which are available in a separate report. She also discussed radio-collaring and the use of aerial surveys in the Foxe Basin (FB) subpopulation, population delineation work in the Hudson Bay region, genetic studies, contaminants studies, investigations of the relationships between polar bears and sea ice, a study of social carrying capacity for polar bears in Davis Strait based on Inuit knowledge, and studies on foraging ecology.

E. Regehr asked whether inconsistent sampling methods could have affected survival estimates in DS, which appeared too low during the early years to support a population. Peacock responded that the increasing trend in survival in DS appeared to be real, although the point estimates for early years may have been biased low. G. Nirlungayuk and E. Peacock discussed issues about the genetic relatedness of polar bears in WH and DS and how trends in polar bear numbers might relate to trends in harp seal abundance in Davis Strait. Other questions related to the effect of migration on survival rate estimates and whether capture-recapture methods supported the genetic structure of polar bears in Davis Strait. E. Peacock responded that population delineation does suggest two different Davis Strait kernels. M. Obbard asked why she used the mean age of adult bears as a surrogate for density in DS rather than the mean age of all independent bears. E. Peacock responded that adult ages were more appropriate because captures were selective in some years. She also said that catch-per-unit-effort may be a better covariate for density than age, because age information is incorporated in the analyses elsewhere, which makes its use as a density covariate redundant. G. Nirlungayuk suggested that ringed seals may increasingly give birth to pups on the surface of the ice, as harp seals do, rather than in a snow den. A. Derocher commented that this has been observed in Svalbard, but these pups are heavily depredated by Arctic fox.

A. Derocher summarized ongoing research at the University of Alberta. He described a variety of research projects with collaborators throughout the Arctic, focusing on the Southern Beaufort Sea, Western Hudson Bay, and Foxe Basin subpopulations. He indicated the need to improve demographic models to include future ecological changes associated with changing sea ice conditions. He discussed P. Molnar's work on Allee effects as an example of model development from first principles when empirical data are lacking. The effects of climatic change on reproductive success can be examined using energetics models, and a model that describes the body condition of polar bears was recently published in the *Journal of Experimental Biology*. A. Derocher discussed movement analyses in SB, WH, and FB, and indicated that polar bear movement patterns are being affected by sea ice conditions. He discussed methods to obtain nutritional information from cementum annuli in polar bear teeth and indicated several recent publications on this subject. Finally, he discussed a study on blood urea concentration and nutritional status for polar bears in SB, available in a recent publication led by S. Cherry.

G. Nirlungayuk asked at what time of the year polar bears in SH begin to move inland. M. Obbard responded that polar bears in SH generally come off the ice in early to mid-July, about 3 weeks later than in WH. They also may return to the sea ice several weeks later than the bears in WH. Other questions related to the use of urea: creatinine ratios to examine polar bear fasting. M. Branigan asked whether data are available to look at blood nitrogen levels in SB, per S. Cherry's work, in years other than 2005 and 2006. She pointed out that survival rates in these years were low. Other discussion related to the use of litter size as a measure of reproductive success. E. Peacock commented that although P. Molnar's study, using capture data that are now 10 years old, did not detect an Allee effect in Lancaster Sound polar bears, the risk of an Allee effect may be increasing in this subpopulation.

G. Thiemann summarized his research at York University and described recent studies on polar bear foraging ecology using fatty acid signature analysis. He also discussed his work on the application of ecological data to the conservation of polar bears. He presented evidence that polar bears in Canada do not have a uniform conservation status and reviewed the ecological basis for considering five designatable units.

J. Justus asked why COSEWIC did not consider multiple designatable units for polar bears in Canada. G. Thiemann responded that COSEWIC's reasons were unclear, but their main argument was that genetic differences among groups were too small to warrant distinction. He also pointed out that, at the time of the COSEWIC decision, the guidelines indicated that factors other than genetics could be used to identify conservation units. N. Lunn clarified that the Government of Canada has not yet officially listed polar bears under the Species At Risk Act based on the COSEWIC recommendation. J. Aars asked about regional variation in the fatty acid signatures of prey species. G. Thiemann responded that although prey signatures varied regionally, differences among regions within a species were much smaller than variation among species. G. Nirlungayuk commented that it was important for the group to understand the reasons for COSEWIC's assessment of polar bears as a species of Special Concern, even if the group does not agree with this decision. He suggested that science and traditional knowledge indicate most polar bear populations have increased over the past 40 years.

Greenland/Denmark

E. Born summarized polar bear research in Greenland. The main subjects of investigation were new satellite telemetry tags, polar bear movements, a survey of traditional ecological knowledge, and contaminant studies. He presented preliminary results for ear-mounted and glue-on telemetry tags and discussed plans for hydrocarbon development off the coasts of Greenland. He summarized information on polar bear distribution, harvest levels, and climate change from a new study of TEK. Born then called for new information to be collected on polar bears in Baffin Bay and east Greenland, and mentioned logistical and financial challenges.

In response to a question from G. Nirlungayuk about the allocation and management of the Greenland quota, E. Born indicated that details would be provided in a later presentation.

R. Dietz presented an overview of work on contaminants in polar bears in Greenland and indicated that more details would be provided on Thursday. Dietz summarized the levels of various contaminants and their effects on organ histology, sexual organ morphology, bone density, and overall health. He asked whether polar bear researchers in Alaska and Russia were interested in collaborating to evaluate geographic variation in mercury concentrations. Questions from the group were reserved for the full presentation on Thursday.

Norway

J. Aars summarized polar bear research in the Svalbard region. He discussed recent capture-recapture studies, population delineation using radiotelemetry data, and an investigation of water use by polar bears. He described work by his graduate students on polar bear genetics and the determination of polar bear ages from cementum annuli in teeth. He discussed maternal denning and reproductive ecology on Svalbard and summarized a recent publication on the disturbance of polar bears by human activities. Finally, Aars discussed methods to evaluate body composition and talked about recent disease studies.

In response to comments by G. Thiemann and R. Dietz, Aars described the ultrasound methods his group had used to measure fat thickness in polar bears. S. Belikov asked whether the number of dens on northern Svalbard had changed in recent years. Aars responded that he does not know, but that he has found evidence for large annual variation in denning numbers related to ice conditions. S. Amstrup asked whether polar bears around Svalbard are starting to den farther north due to climatic change. Aars responded that they do not know because denning surveys were limited by weather and logistics, although they had found several new denning areas in 2009. He indicated that a graduate student was evaluating the use of telemetry data to determine denning.

B. Munro-Jenssen summarized other polar bear research in Norway, focusing on contaminants data collected under the International Polar year polar bear health project. Jenssen indicated that thyroid hormones were sensitive to persistent organic compounds and discussed relationships between contaminants and testosterone levels.

In response to a question from K. Rode, B. Munro-Jenssen indicated that the health effects of changes in thyroid hormone and testosterone levels were not yet known for polar bears, but that very low testosterone levels in Arctic foxes have been associated with delayed puberty. Other discussion focused on trends in PCB levels.

Russia

S. Belikov and A. Boltunov summarized polar bear research in Russia. They described collaborations with the USFWS aimed at understanding habitat use by polar bears in the Chukchi Sea and how movements may have been affected by recent sea ice loss. Boltunov discussed polar bear monitoring and management along the Chukotka coast. He discussed collaboration with the World Wildlife

Fund and the Russian Marine Mammals Council and described the use of opportunistic samples of polar bear hair and feces for genetic studies.

N. Ovsyanikov described polar bear research and monitoring on Wrangel Island. He mentioned his participation in ship-based polar bear surveys in the central Arctic in 2005 and 2007 and stressed that polar bear conservation should focus on protection from human disturbance. Ovsyanikov recommended the creation of protected areas, enforcement of wildlife regulations, sustainable harvest limits, effective non-lethal management of human-polar bear encounters, minimizing disturbance to polar bears on land during the ice-free season, and international cooperation in research and conservation.

Discussion focused on temporal and spatial trends in the distribution of polar bear dens. In response to a question from J. Herreman, A. Boltunov suggested that declining ice conditions may account for the low number of dens along the Chukotka coast. Polar bears would likely have to spend the entire summer on the coast in order to be there in fall to den. In response to a question from S. Amstrup, N. Ovsyanikov indicated that the number of dens on Wrangel Island has declined since the 1980s and 1990s. S. Amstrup also commented that family groups denning on sea ice over deep Arctic Basin waters may face reduced hunting opportunities when they emerge. G. Nirlungayuk inquired about the abundance of seals and walrus in the Arctic basin. N. Ovsyanikov replied that he had seen ringed seals but bearded seals were only located over the continental shelf. In response to a question from D. Lee, N. Ovsyanikov mentioned that annual variation in the abundance of walrus on Wrangel Island appears to be related to sea ice dynamics.

3. Summary of polar bear management by nation

United States

T. DeBruyn summarized polar bear management in Alaska and reviewed the major conservation agreements and legislation affecting polar bear management in the United States. This included the recent listing of polar bears as Threatened under the U.S. Endangered Species Act (ESA). He summarized harvest information from recent years.

M. Pederson and Ø. Wiig asked about the impact of the ESA listing on subsistence activities. T. DeBruyn indicated that neither the designation of critical habitat nor other aspects of the listing would likely affect subsistence activities. S. Amstrup asked whether critical habitat identified by the USFWS was limited to Alaska. T. DeBruyn indicated this was the case, and that most critical habitat consisted of sea ice over the continental shelf. M. Pederson suggested that people living in polar bear country should be more involved in the process. T. DeBruyn responded that USFWS would attempt to do this, and that the USFWS would present more accessible explanations of population models at upcoming management meetings. In response to a question from G. Nirlungayuk, T. DeBruyn described the implementation of polar bear patrols by the North Slope Borough and Alaskan communities. He also explained the Inupiat-Inuvialuit (I-I) user's agreement on subsistence harvest in the Southern Beaufort Sea. He pointed out that, because the Southern Beaufort Sea subpopulation is classified as depleted under the Marine Mammal Protection Act, the USFWS could assume regulation of the harvest and set quotas. The USFWS did not anticipate this happening, but rather would work closely with the user groups under the framework of the I-I agreement. Ø. Wiig enquired about progress toward setting a harvest quota in the Chukchi Sea. T. DeBruyn responded that the first step in setting a quota is the designation of a scientific advisory committee under the U.S.-Russia bilateral agreement. L. Carpenter asked for clarification about how the ESA listing and the potential uplisting of polar bears to CITES Appendix I could affect the ability of native people to trade in handicrafts made from polar bear parts. T. DeBruyn responded that he would find out the answer to this question.

Canada

N. Lunn summarized polar bear management in Canada. He reviewed the government entities responsible for polar bear management in Canada and presented information from each jurisdiction.

Ø. Wiig expressed disappointment at the lack of a management agreement between Canada and Greenland on the Baffin Bay subpopulation. He asked when quotas would be lowered for this subpopulation. J. Justus indicated that a public hearing had been held last year to inform people that scientific data indicated the subpopulation was declining due to overharvest. However, local residents responded that they were seeing more polar bears than ever in the region. J. Justus indicated that Nunavut did not have the authority to reduce quotas in Greenland, and that population simulations indicated the Baffin Bay subpopulation would continue to decline even if harvest in Canada was stopped. This is why Canada did not reduce the harvest for the next year. J. Justus emphasized that a co-management agreement was needed and that he was waiting for guidance from the new Minister of the Environment. E. Peacock indicated that new information had been submitted to the Nunavut Wildlife Management Board. Ø. Wiig asked what the sustainable harvest would be according to Peacock's analyses based on existing data. She responded about 90 polar bears per year, whereas the actual harvest was about 174 bears per year.

E. Born commented on the issue of reducing harvest quotas in Greenland and F. Ugarte asked what would be needed to estimate abundance for BB. E. Peacock responded that she has written a draft recommendation for an updated population assessment. She indicated that it would help if the PBSG drafted a resolution indicating that research in BB is a high priority. A. Derocher commented that the PBSG has not typically made this type of recommendation, but given the international importance of the issue it may be appropriate for a working group to consider drafting a resolution. Derocher asked Ø. Wiig to help consider the issue.

There was further discussion about the failure of Nunavut to reduce harvest quotas for the BB. Several members expressed concern about the quota of 105 polar bears alone in Nunavut, when the total sustainable harvest is likely 90. It was pointed out that Greenland had enacted a quota for this subpopulation in 2006 which reduced harvest on the Greenland side. J. Justus indicated that laypeople in Nunavut have the authority to make that decision, even if it does not make sense from a management perspective. Nunavut decided not to reduce the harvest for one year, based primarily on evidence that the harvest in Greenland alone is sufficient to reduce the population. The relevant board in Nunavut believed that the most important issue was to coordinate a reduced harvest between Nunavut and Greenland. J. Justus indicated that wildlife managers in Nunavut had recommended that the quota be reduced, but that this was not done. G. Nirlungayuk commented that Nunavummiut believe there is movement of polar bears between DS and BB, which may have influenced the decision not to reduce harvest in BB.

S. Belikov asked how Canada could list polar bears as a species of special concern despite evidence for separate designatable units. N. Lunn responded that the Government of Canada may not accept the COSEWIC recommendation and could send it back for further review. G. Thiemann challenged this response and said that given the Canadian government's public endorsement of the COSEWIC report, it seems unlikely that the Government would reject COSEWIC's recommendations. Lunn responded that it depends on the consultation process, and that he was simply pointing out that the Canadian government had not yet made a decision about the conservation status of polar bears.

Wednesday, July 1

Canada (continued)

A. Derocher gave a presentation on the recent COSEWIC status report, which identified polar bears as a species of Special Concern under the Species at Risk Act (SARA). He noted that the Canadian assessment of polar bears represented a less threatened conservation status the V*ulnerable* listing identified by the IUCN/SCC Red List or the T*hreatened* listing under the U.S. ESA. The official status of polar bears in Canada has not changed since 1991, despite growing concerns about the negative impacts of climate change. The most significant flaw in the COSEWIC report is the failure to rigorously account for the anticipated effects of climate change on polar bear populations.

A. Derocher pointed out that COSEWIC report used a generation time of 12 years in comparison with the 15 years used in the IUCN/SSC Red List Assessment and the ESA listing. Data from WH suggested that 15 years is a better estimate of generation time for polar bears and that a precautionary approach should have been used when assessing generation time. Recent collaborative work with G. Thiemann and I. Stirling identified regional differences in the conservation status of polar bears in Canada and integrated genetic and ecological data to identify 5 designatable units (DU) for polar bears in Canada. A. Derocher suggested that these recommendations were not seriously considered in the COSEWIC report, nor did the report substantively consider the data produced by the USGS in support of the ESA listing decision. A. Derocher presented a resolution recommending that the status of polar bears in Canada be re-assessed based on potential habitat loss (from projected sea ice declines) and that the issue of designatable units be revisited.

L. Carpenter commented that it was not appropriate for A. Derocher to criticize the COSEWIC report at the March 2009 meeting of the Parties to the 1973 Agreement. A. Derocher replied that there is strong disagreement between COSEWIC and Canada's polar bear scientists in regards to the status of the species and that he made the COSEWIC Chair aware of his position prior to the Meeting of the Parties. A. Derocher emphasized his respect for COSEWIC and their decision-making process, but felt that the report presented to COSEWIC was fundamentally flawed. S. Amstrup added that we know there are going to be major changes in Arctic ecosystems and any analysis that does not incorporate the very high probability of habitat loss is flawed. He added that polar bears face different conservation issues across the range and so it does not make sense to use a broad brush approach that ignores the immediate threats faced by some subpopulations. L. Carpenter noted that the Special Concern status does take into account various conservation issues and, if necessary, the status of polar bears could be revisited before the mandatory 10 year review.

Greenland

K. Winther Hansen presented information on polar bear management in Greenland. He indicated that polar bears are an important part of the Greenland culture and an important part of the modern economy. A recent Greenland Government Executive Order established a quota system to regulate the harvest of polar bears. The following protective elements were included in the executive order: only occupational hunters are allowed to hunt for polar bears, females with cubs of all ages are fully protected, disturbance of denning bears is prohibited, individuals cannot use large vessels, aircraft or other motorized vehicles for hunting, the use of poison is prohibited, and a firearm of minimum calibre of 7.62 mm is required for hunting polar bears. Enforcement in Greenland is based on a double reporting system in which local authorities issue hunting licenses and hunters report the catch immediately after a hunt using a standardized form. The current CITES scientific authority in Greenland is the Greenland Institute of Natural Resources. In April 2008, the CITES management authority issued a negative non-detrimental finding (NDF) which resulted in a ban on the export of polar bear products. Greenland is working on the development of a Memorandum of Understanding with Canada/Nunavut to promote cooperation on the harvest and management of shared subpopulations.

There were a number of questions regarding polar bear quotas and reporting of polar bear harvest in Greenland. J. Justus commented that simulation analyses in RISKMAN showed a harvest reduction to as few as 45 bears would be needed to stabilize the BB subpopulation and result in no net growth or decline in numbers. He questioned whether the Greenland government would consider a quota reduction to fewer than 45 bears. K. Winther Hansen could not comment on how quotas may be adjusted but indicated that their objective is a sustainable harvest. Other questions related to how the harvest was reported and K. Winther Hansen reiterated that licenses have to be stamped by local authorities and hunters are obliged to report their catch to the Ministry of Fisheries, Hunting and Agriculture. F. Ugarte reported that there are more sightings of polar bears near communities and people do not necessarily think that bears are in decline. He felt it is likely not realistic to have a quota of 45 at this point in time, but that it is still important to have a coordinated quota system in place. He emphasized the need for an updated status assessment and noted that because there are wildlife officers in the communities it is difficult to hide a harvested bear. Ø. Wiig and R. Dietz highlighted the importance of collecting samples from harvested bears to determine the sex and age distribution of the catch. In response to a question from S. Amstrup, K. Winther Hansen indicated that Greenland was starting to look at the potential impacts of future oil and gas development on polar bears.

Norway

D. Vongraven presented information on the management of polar bears in Norway. In 2006, a Norwegian Red List of threatened species was prepared in accordance with the IUCN criteria and the polar bear was listed as Vulnerable. In the same year, an integrated management plan for the Barents Sea was passed by the Norwegian Parliament to provide a framework for the sustainable use of natural resources. Currently, the northern part of the Barents Sea, including the area around Svalbard, is not open for development. There are currently 29 protected areas in Svalbard including a new National Park that was established in 2005. D. Vongraven indicated that tourism around Svalbard is increasing and the number of landing places for cruise ships has increased dramatically. Although there is no legal harvest of polar bears in Norway, a small number of bears are shot in defence of life and property. Six bears were shot from 2005 to May 2009. The Barents Sea polar bear subpopulation is estimated at 2,644 bears (95% CI:1,899-3,592). Given historical harvest records (~ 300 bears taken per year from 1870-1970) it is likely that the subpopulation was previously much larger or had a significant amount of immigration to sustain the number of bears were taken. The subpopulation is currently believed to be slowly increasing.

S. Belikov asked whether there will be any oil and gas development around Svalbard. D. Vongraven noted that the area is currently closed for development but at some point in the future there will likely be development.

Russia

S. Belikov reported that polar bears are listed in the Red Data Book of the Russian Federation, which reflects state policy for the protection and restoration of rare and endangered species in Russia. The Barents Sea and Kara Sea subpopulations are designated as Category IV (uncertain taxa), the Laptev Sea subpopulation is Category III (rare taxa) and the Alaskan Chukchi population is Category V (restoring taxa). It was noted that the U.S.-Russia Bilateral agreement was signed on October 16, 2000 and came into force on September 23, 2007. S. Belikov reviewed the protection of polar bears in National Protected Areas, State Nature Reserves and National parks. Polar bears in these reserves are provided absolute protection and S. Belikov highlighted the need for additional protected areas. In the past, the take of polar bears in Russia has been limited to catching cubs for public display and education (e.g., zoos and circuses). However, from 2005-2009 there were no authorizations given to catch cubs. It was reported that from 2005-2007 there were only 5 problem bears kills. The illegal take of polar bears in Russia is still difficult to estimate but anecdotal data suggest that illegal take remains around previous levels or may have slightly declined.

A. Boltunov reviewed a recent project that was initiated by WWF Russia and the Russian Marine Mammal Council that focused on coastal monitoring and management of polar bears in the Russian Arctic. The project includes the development of a community-based Polar Bear Patrol Program (Umpki Patrol) that involves the routine monitoring of the presence of bears, active collection of information on polar bears, education of local people as well as anti-poaching activity and action to prevent human-bear conflicts.

Ø. Wiig asked whether there were estimates of the number of bears that are poached each year. A. Boltunov noted that illegal take was difficult to assess. V. Nikiforov noted that the number of skins that show up on the black market and the internet suggest as many as 200 bears may be taken each year. It was asked whether the motivation for poaching has changed (e.g., to sell the gall bladder or skins) and it was reported that during the 1990s most bears were poached for meat. F. Ugarte asked whether the poachers were local people and A. Boltunov responded that although some poaching was done by local people, other poaching was related to organized criminal activity. There was general discussion of whether the establishment of a legal take of polar bears would help reduce poaching. Other questions related to the status of the Chukchi Sea subpopulation and the impacts of changing sea ice conditions. S. Belikov, A. Boltunov and N. Ovsyanikov all noted that changing sea ice dynamics are influencing the distribution of polar bears in the Chukchi Sea. However, there are insufficient data to determine whether these habitat changes are having an impact on the size of the subpopulation.

4. Issues pertaining to the Agreement and the Meeting of the Parties to the 1973 Argeement

A. Derocher gave a brief presentation on the Meeting of the Parties that was held in Tromsø, Norway, March 17-19, 2009. The parties of the 1973 Agreement met to discuss issues pertaining to polar bear management. It was agreed at the meeting that climate change is having a negative impact on polar bears and that action to mitigate this threat was beyond the scope of the International Polar Bear Agreement. The meeting recognized the need to use other national and international mechanisms to take appropriate action on climate change. The PBSG was invited to be the scientific advisory body to the range states and identify the elements needed in a Circumpolar Action Plan for Polar Bear Conservation and Management. The meeting saw a proposal from Norway to host a workshop intended to identify these elements. D. Vongraven and Ø. Wiig noted the importance of the PBSG responding to the request from the range states and suggested that a letter be sent to the range states to facilitate the organization of a workshop. It was suggested that A. Derocher and E. Born create a list of workshop participants. The next meeting of the Polar Bear Range States is scheduled to occur in Canada in 2011.

Status of subpopulations by nation

E. Peacock volunteered to take the lead on creating the Status Table and collecting information from each jurisdiction to populate the table. She reviewed the summary Status Table and highlighted the information contained within each column. There was considerable debate with respect to the structure and terminology used in the table. Most of the discussion focused around the last three columns: *observed or predicted trend*, *status*, and *estimated risk of future decline (10yrs)*. N. Lunn noted that much of this was covered in the 2005 meeting in Seattle and recommended that the group stick with the table format established at that meeting. E. Peacock reviewed the information in the table for each subpopulation to ensure that all the information was up to date and accurately reflected the status of each of the 19 subpopulations. Various corrections were made and the table was populated with the most recent information available.

Other Business

A. Derocher noted that past proceedings of the Polar Bear Specialist Group Meeting have been dedicated to individuals including Malcolm Ramsay and Gerald Garner in recognition of their contribution to polar bear research and management. He proposed that the proceedings from the 15th Working meeting be dedicated to Nils Øritsland and suggested that Ø. Wiig and E. Born work on the dedication and find a picture of N. Øritsland that could be incorporated in the Proceedings.

Thursday, July 2

Status table (continued)

Discussion continued on the types and format of data to be presented in the Status Table. Consensus was reached that the last three columns should be used to reflect the past, current, and likely future conservation status of each subpopulation.

5. Bilateral and Multilateral agreements and Memoranda of Understanding

These were addressed in the summaries of polar bear management by nation.

6. Conservation and environmental issues

Toxic chemicals

R. Dietz presented the results of analyses of toxic chemicals and heavy metals in polar bears throughout the Arctic. Correlations between mercury (Hg) in hair and other tissues suggest that hair is a good indicator of overall Hg burden. In general, polar bears at higher latitudes had higher levels of Hg than those at lower latitudes. In other mammals, biological effects of Hg appear at concentrations of 30 ppm. Although all polar bear subpopulations currently measured are below this limit, Hg is rapidly increasing and approaching 30 ppm in bears from the Lancaster Sound subpopulation. Hg increases started around 1850 and approximately 94% of Hg in Arctic fauna appears to come from anthropogenic sources. PCBs are lowest in polar bears in Alaska and western Canada and highest in Svalbard and eastern Greenland. Preliminary evidence suggests there may be a relationship between climate change and contaminant levels

C. Sonne presented data on the biological effects of contaminants on polar bears in East Greenland. Pollution loads may affect bone density, liver and renal function, and the size of sexual organs in polar bears. There is also evidence that Hg affects receptors in the brain stem associated with memory, learning, and neurotransmission. Further research is aimed at identifying the threshold levels that cause biological impairment and the development of a blood-plasma based study aimed at monitoring the contaminant loads and health status of polar bears across the circumpolar region.

Discussion focused on the need for controlled, captive studies into the biological effects of pollutants on Arctic wildlife. Much of the Hg in polar bears in Lancaster Sound appears to come from coal-fired power plants in China and the interaction between industrial development, climate change, and global circulation pathways requires further research.

J. Nabe-Nielsen presented a proposal for new research on the interaction between climate change and contaminants in polar bears. The project would utilize individual based models (IBMs) to examine the impacts of pollutants on polar bear movement patterns and population dynamics. The group discussed various confounding factors that would have to be incorporated into the models but agreed that IBMs could provide valuable insights into polar bear ecology.

Tourism issues

D. Vongraven presented information on the interaction between tourism activities and polar bears in Svalbard. Tourism there has increased dramatically since 1996 and there is an interest in making Svalbard one of the world's premiere ecotourism sites. The greatest risk to polar bears seems to be the prolonged impact rather than any immediate effects.

The Association of Arctic Expedition Cruise Operators have a list of rules for tour operators aimed at minimizing disturbance of polar bears, but they welcome additional input and suggestions from the PBSG. In contrast to this formalized protocol, the town of Churchill has no clear statements on the need to minimize disturbance of polar bears during tourism activities. The goals of Wapusk National Park are aimed at visitor safety, whereas Nunavut emphasizes hunting restrictions, firearm regulations, and safety. There is a need for common codes of conduct focused on minimizing disturbance. Although behavioural and physiological effects of disturbance have been documented, no population-level effects have been identified to date. Codes of conduct for tourism should be incorporated into future action plans for polar bear conservation.

The group agreed on the importance of monitoring tourism impacts in the future. E. Peacock identified tourism in Nunavut as an emerging issue with communities very concerned about the impact of tourism on wildlife. G. Nirlungayuk added that TK suggests human activity near polar bear dens results in abandonment. He also expressed concern that unregulated adventure expeditions (e.g., to the North Pole) can result in bear-human conflicts and bear mortality. D. Vongraven added that it would be helpful for the PBSG to provide guidelines related to tourism. R. Buchanan commented that PBI has funded a study on polar bear-human interactions and he has personally seen a great improvement in the interaction between tourism operators and polar bears near Churchill. Bear baiting is now strictly prohibited and has been largely eliminated, aside from some problems with individuals over-feeding dogs and thereby indirectly baiting polar bears. Manitoba Conservation is working on this problem. Tourists that come to Churchill leave very informed and enthusiastic to support scientific research.

N. Ovsyanikov presented information on the interaction between tourism and polar bears on Wrangel Island. The impact on polar bears may depend on the exact activities related to tourism, e.g. ship based sightseeing, eco-adventures, land-based traveling in polar bear country. For ship-based tourism, staff and guards may not be properly trained to manage landings without impacting polar bears. Some expedition leaders may even harass polar bears to move them into sight of tourist groups. Restrictive guidelines for the entire Arctic region should be developed in order to minimize tourism-related disturbance of polar bears. Training in the appropriate use of non-lethal deterrents should be mandatory for all tourism operators and educational materials should be developed for clients. N. Ovsyanikov distributed polar bear safety guidelines developed for Wrangel Island.

M. Obbard commented that there are guidelines and principles developed for other bear species that may be applicable for polar bears. A. Derocher and J. Justus described a DVD developed by the Safety in Bear Country Society that describes how to avoid and handle conflicts with polar bears in the wild. T. DeBruyn commented that it is crucial to mitigate bear-human conflicts before they arise because once bears have learned behaviour, and potentially passed it on to offspring, it is difficult to make changes. A. Derocher emphasized the need to establish a working group to address issues of polar bear-human conflicts and the following individuals volunteered to participate: N. Ovsyanikov, J. Justus, T. DeBruyn, M. Branigan, S. Medill (nominated by E. Peacock), G. York, R. Buchanan, T. Smith (by G. Durner), M. Obbard, D. Vongraven, J. Herreman, D. Vincent-Lang.

Climate change

S. Amstrup presented the results of new research aimed at modeling changes in the amount and distribution of polar bear habitat under various climate change scenarios. He emphasized the fact that, despite natural year-to-year variability in air temperatures, the climate will continue to warm as a result of increasing greenhouse gases (GHGs). Although the exact degree of warming attributable to GHGs is still debated, continued increases in GHG level will assuredly result in warmer temperatures and a seasonally ice-free Arctic. Recent research by the USGS has examined whether this trend is reversible under various GHG emission scenarios. They found that global mean temperature was linearly related to changes in polar bear habitat and there was no evidence of a "tipping point" of irreversible habitat loss. If GHG emissions, and therefore rising temperatures, are mitigated, polar bear habitat can be conserved. In modeling runs, the probability of polar bear extinction was much lower in the GHG mitigation scenarios in the seasonal ice and divergent ecoregions (see Durner et al. 2009, *Ecological Monographs* 79: 25-58). In the archipelago and convergent ice ecoregions, GHG mitigation scenarios suggest possible increases in the number of bears. In the end, global management of GHGs can have significant, positive effects on polar bear conservation and the forecasts made in the USGS reports are not unavoidable.

Discussion focused on the importance of communicating these findings to a broad audience of stakeholders, policy makers, and the general public. E. Regehr pointed out that the models linking habitat to polar bear abundance assume a direct, linear relationship between polar bear density and optimal habitat. This is a very simple assumption that may not always hold true. S. Amstrup responded that the USGS is working towards refining the relationship between polar bear abundance and habitat availability.

Oil and gas development

E. Richardson gave a presentation on the potential impacts of resource development on polar bear maternity denning habitat in the Mackenzie Delta. The Mackenzie gas project (MGP) has planned 3 gas fields near the mouth of the Mackenzie River and a 1200 km pipeline to southern markets. The SB subpopulation of polar bears is known to den in the area of proposed development. Environment Canada conducted helicopter surveys of polar bear denning areas in March 2007-2009 and conducted 46 local knowledge interviews with people from Inuvik, Aklavik and Tuktoyaktuk. Four major denning areas were identified along the Beaufort Sea coast. A fine scale habitat model was developed and used to identify potential polar bear denning habitat.

Questions were asked about the application of the model to oil and gas development activities and the applicability of the model to other areas. E. Richardson commented that the study provides pre-development data and is not likely applicable to other areas because of the locally-specific conditions that influence den site selection. E. Peacock commented that changes in harvest management, specifically the prohibition of hunting denning females, may have changed the local knowledge of polar bear denning.

Harvest

A. Derocher pointed out that no one had come forward to discuss issues of polar bear harvest. D. Lee pointed out that he had planned to briefly discuss some parts of harvest in a separate presentation during the session on traditional knowledge. A. Derocher invited him to present those findings in the current session.

D. Lee presented the results of RISKMAN simulations and provided information on how decisions were made regarding the Nunavut harvest of polar bears in the Baffin Bay subpopulation. He mentioned that the decision-making process was complex, but the 2005 quota was based on the assumption that Greenland was taking 15-20 bears. This assumption turned out to be false. Nunavut has a unique management system that corrects for over-harvesting of females by adjusting the allowable harvest in future years. E. Peacock added that although the total allowable harvest in Nunavut for Baffin Bay is 105, because of the flexible harvest system, the actual catch can vary. This reflects a broader trend throughout Canada in that actual harvest levels are below total allowable.

Shipping

E. Peacock presented information on the potential impacts of shipping activity on polar bears in Nunavut. The ecosystems biologist for the Government of Nunavut, Hillary Robison, is responsible for environmental assessments regarding shipping. However, there is a lack of information available to make environmental assessments. The 2009 Arctic Marine Shipping Assessment identified the release of oil as one of the most significant environmental threats related to shipping. Areas that may be most impacted by shipping include Bering Strait, Hudson Strait, and Lancaster Sound. The Northwest Passage is not expected to become viable until 2020. There are numerous exploration permits throughout Nunavut, particularly in M'Clintock Channel. There is a proposal related to the Baffinland Iron Mines Inc. Mary River project that would have an icebreaker move through Foxe Basin every 32 hours throughout the year. Local communities are concerned about the impacts of this activity and some hunting and trapping organizations have been successful at moving the shipping route. There is also a proposed marine protected area around Igloolik in Foxe Basin. Currently, the only data that exist to be incorporated into environmental assessments related to polar bears are general habitat use areas and basic information on seasonal ice preferences. There is a desperate need for more ecological data to inform environmental assessments in a rapidly developing Arctic region.

The discussion focused on the need for additional information and the difficult balance between economic development, sustainable resource use, and conservation. E. Peacock mentioned that the boundaries of the proposed marine protected area are still being considered and shipping activities related to the Mary River project are expected to begin in 2010/2011. Collar data from polar bears in the area could be used to examine pre- and post-development movement patterns. S. Amstrup commented that such extensive ice breaking activity could create a feedback loop that causes greater reductions in available sea ice. E. Peacock mentioned that the environmental assessment has not yet been completed but the proposal will not be reviewed at the federal level.

Ø. Wiig presented information on conservation and environmental issues related to shipping. One of the key findings of the Arctic Climate Impact Assessment was that reduced sea ice is very likely to increase marine transport and access to resources. Ø. Wiig, S. Belikov, G. Garner, and N. Ovsyanikov developed an environmental assessment 15 years ago to evaluate shipping effects on marine mammals, including polar bears. Potential impacts included: physical disturbance, noise, waste, and pollution. In developing an Action Plan outline for the Range States, the PBSG should draw on the Arctic Council assessment of Arctic shipping. There is a need to develop appropriate monitoring and research strategies to better understand the impacts of this emerging conservation issue.

Minimizing research impacts

N. Ovsyanikov gave a presentation describing the need to minimize the impacts of research on polar bears. He specifically recommended that researchers: use non-chase-based capture methods, seek out better immobilizing drugs and delivery methods that reduce dart trauma and are fully reversible, use local anaesthetic during specific procedures (e.g., tooth extraction), allow the animal to sufficiently recover before leaving it alone, minimize the number of procedures, and develop alternative assessment methods where possible.

The Group agreed on the need to continuously improve the techniques used during capture work. M. Obbard encouraged researchers to be conscious of how people perceive our efforts and to seek out improved chemical immobilization protocols. G. Nirlungayuk, S. Amstrup, and L. Carpenter pointed out that it is critical for local people to understand why researchers need specific types of information and samples. E. Regehr suggested the Group might benefit from a workshop designed to share capture protocols and identify best practices. The Chair supported this suggestion and the Group agreed to investigate the possibility of holding a workshop associated with the International Bear Association Meeting in Ottawa in 2011.

Bear-human interactions

N. Ovsyanikov presented information on polar bear-human interactions on Wrangel Island. Tens of polar bear-human encounters happen on Wrangel Island every year and all field researchers are exposed to encounters with polar bears. Effective encounter management is based on methodology developed in early 1990s and involves the use of non-lethal deterrent tools including shotguns with rubber slugs, long wooden sticks, noise based deterrents, special flares, pepper spray, and psychological contra-pressure on an agitated bear (e.g., aggressive human behaviour).

T. DeBruyn presented details of an information management system for documenting polar bear-human interactions. One of the tasks that emerged from the Tromsø Range States meeting was the development of a database to organize and analyze historic polar bear-human interaction data. These data could describe three types of bear interactions: bear sightings, bear-human interactions (encounters and incidents), and natural history and management data. The database can be queried and includes narratives about each incident. There are options to map data and identify hotspots of potential interactions. The database could be used to track unusual natural history events (e.g., bear starvation, drowning) and to develop a central public educational website. USFWS would like to provide access to the database via the PBSG website and have jurisdictions enter some of their information to determine the breadth of information and how it fits in the current database. After improving the database, USFWS would send it back to the jurisdictions to populate with their data.

Questions were asked about which software platform would be most appropriate and how best to protect sensitive information. T. DeBruyn mentioned that Tom Smith was involved in the construction of the original database. At the close of the session, all PBSG members and invited specialists were invited to attend a bear-human interaction workshop November 15-18, 2009 in Canmore, Alberta.

Status table (continued)

Discussion of the Status Table continued with E. Peacock summarizing the changes recommended by the status table working group. The previously-labelled *trend* column was relabelled *current trend* and a new column titled *trend in sea ice* was added. The *status* and *estimated risk of future decline* columns were maintained and their definitions are the same as the previous table. Specifically, s*tatus* is expressed relative to historical data and *estimated risk of future decline* is based on quantified projections, including RISKMAN analyses or other PVAs. It was agreed that additional details on how the table was populated would be provided in the *comments* column or in the text of the status reports.

There was considerable discussion over whether to categorize the Davis Strait subpopulation as declining or stable, given that a recent capture-recapture study indicated that the subpopulation may be declining from a recent peak in abundance, possibly as a result of density-dependent or ice factors. E. Peacock emphasized that although there is strong evidence to indicate Davis Strait is currently in decline, given the recent trajectory of the subpopulation it may be categorized as stable, depending on the temporal window used for the *current trend* column. S. Amstrup and E. Born felt the most recent data should be used and the subpopulation should be listed as declining. A. Derocher noted that the Group has traditionally deferred to the management agency to determine how to populate the *current trend* field.

Further discussion focused on the type of data used to inform the *trend in sea ice* column. A. Derocher emphasized the need to provide a citable data source for the field. Given the difficulty in obtaining and documenting the various sources of information, S. Amstrup suggested that the *trend in sea ice* column could be dropped from the table and details on habitat trends provided in the text. E. Born and M. Obbard felt the column contained important information and in areas where data were available, the field should be populated. There was further discussion about what sort of sea ice data should be considered (e.g., % concentration, thickness, summer extent, ice-free days, etc.) and how those details should be communicated (e.g., footnotes). When discussion resumed the following day, consensus was reached on deleting the *trend in sea ice* column. A. Derocher expressed hopes that all conservation issues (including climate-related habitat loss) would be discussed in the text of the status reports in a concise, organized, and standardized way.

Friday, July 3

A. Derocher re-convened the meeting and thanked the Greenland Institute of Natural Resources for hosting a wonderful dinner the previous evening.

7. Research priorities and cooperative projects

A. Derocher pointed out that these topics were well-covered in the individual research and management presentations.

8. Population inventory methods

DNA darting

E. Peacock began the discussion and reported having success with biopsy darting in Nunavut. Researchers there have been using *Pneu-Dart*® equipment. Skin and hair samples, and possibly even subcutaneous fat, can be collected relatively non-invasively when the dart breaks the skin of the bear and then falls to the ground. Darts with longer shafts and those placed in the neck and upper back of the bear tended to release most easily. Locating the dart on the ground can be difficult and it helped to paint the shaft of the dart bright orange to make it more visible.

J. Aars described the experiences of Norwegian researchers using DNA-darting. They tried it on a small number of bears using the same *Cap-chur*® darts they use for immobilizations. Those darts were fitted with a special tip consisting of a small cylindrical cutting blade with small barbs inside to hold the tissue. The Norwegians used a long stick with a magnet on the tip to retrieve the dart from the ground without needing to land the helicopter. J. Aars suggested that DNA sampling techniques could be usefully incorporated into traditional mark-recapture methodologies.

A. Derocher reported that he and M. Branigan have used the *Pneu-Dart*® equipment on grizzly bears with good result and R. Dietz said that his group has used floating darts to sample walruses. E. Peacock added that handling the samples in the field was easy and the whole tip could be sent to the genetics lab for sample preparation and analysis. S. Amstrup asked about replication of DNA protocols to ensure that individuals were properly identified. E. Peacock replied that there was generally plenty of tissue to ensure quality control and potentially enough tissue to do both genetic and stable isotope analyses.

Aerial surveys

J. Aars delivered a presentation on using line transect surveys to estimate polar bear population size in the Barents Sea. This work was published in *Marine Mammal Science* (2009, 25: 35-52) and the details are available there. In Svalbard, standard capture-recapture data are not suitable for population estimates because the subpopulation area is greater than the study area. Challenges of line transect methods include the need for good area coverage, large number of detections, exact or at least unbiased distances, g(0) – the probability of detecting a polar bear directly under the aircraft – close to 1, short duration of study to avoid changes in distribution, and knowledge of population boundaries. In areas that could not be reached by helicopter because of poor weather, researchers used fixes from satellite telemetry to make inferences about polar bear density. The total estimate for the area was 2,644 polar bears and overall, the method seemed to work well for this study area.

A. Derocher asked whether detection rates differed for family groups and J. Aars replied that they did not see any differences. E. Regehr inquired about sensitivity and sample size analyses and J. Aars replied that these sorts of tests could not be done because they could not evaluate g(0). They felt that g(0) was likely very close to 1 in some places whereas in others it felt like they could be missing some bears. K. Rode and S. Amstrup asked if densities and population estimates could be extrapolated to a larger area based on habitat characteristics. J. Aars relied that they are looking at these sorts of issues but warned that extrapolation could be risky because habitat use could change over space. To confidently extrapolate, one would need to survey a very large area or use many sub-sampled areas. N. Ovsyanikov suggested that aerial surveys may be more efficient if combined with satellite tracking data and L. Peacock pointed out that a good aerial survey can be expensive with not much cost savings versus a standard capture-recapture program.

Aerial survey simulations

R. Nielson gave a presentation on the potential use of aerial line transect surveys to estimate polar bears abundance in the Chukchi Sea. They developed an RSF for polar bears in the Chukchi Sea and then ran modeling simulations that incorporated the RSF and empirical data from satellite telemetry. These simulations incorporated a probability function that estimated the likelihood of detecting a polar bear at a given distance from the survey aircraft. These repeated simulations examined the efficacy of aerial surveys in the pelagic Chukchi Sea and suggested that real-life ship-based surveys could provide valuable insights into population size and dynamics. Survey requirements would include a valid RSF surface, collared bears in the survey area, access to near real time sea ice data, land-based survey, and 2 crews per helicopter to keep the survey going.

K. Rode asked whether a change towards more marginal habitat use might affect the survey technique. R. Nielsen replied that bears may not be behaving differently over time if they continue to look for the best available habitat. If high-quality habitat becomes more concentrated and polar bear density becomes more uniform, then these techniques should work well. S. Belikov asked whether different techniques should be used for bears on land and ice. R. Nielsen replied that surveying land is easier and that a standard line transect or total count approach will work because you can cover the whole area. J. Aars commented that using 2 aircraft crews is a good idea because it is relatively inexpensive. He also suggested that detection probability might get smaller at low densities. In response to a query by Ø. Wiig, R. Nielsen said that the Alaskan polar bear researchers are working with their Russian colleagues to try to get real-life aerial surveys running in the Chukchi Sea as soon as possible.

During an audio-visual-related break in R. Nielsen's presentation, A. Derocher pointed out that resolutions coming from the meeting are from the PBSG in the sense that they reflect the opinions of the Group. Non-members are invited to submit resolutions, but the members are the ones to decide which ones are adopted. Following R. Nielsen's presentation, S. Amstrup invited anyone with a draft resolution to email it to him. The text would be presented on the overhead screen and discussed in the afternoon.

Traditional knowledge

G. Nirlungayuk provided an overview of Nunavut Tunngavik Inc. and the Nunavut Land Claim Agreement. He discussed the long oral history of Inuit and polar bears and the fact that Inuit are sceptical about the effectiveness and impacts of polar bear capture programs. He presented a new book titled *Inuit, Polar Bears and Sustainable Use*, which is in pre-publication at Canadian Circumpolar Institute Press. He discussed the results of a workshop involving D. Lee, G. Nirlungayuk, and 5 Inuit hunters. Workshop participants found that prior to the harvest quota system of polar bear management, Inuit encountered few bears between Arviat and Chesterfield Inlet. Since the quota system was introduced, more bears have been observed in communities along the western coast of Hudson Bay. Changes in the behaviour of polar bears have also been reported and may be associated with increased bear-human interactions and habituation to anthropogenic foods. These behavioural changes have made some Inuit feel unsafe bringing their children into traditional hunting areas. Changes in the distribution of polar bears may have been associated with the closing of the Churchill dump, which prompted polar bears to move north and could account for the observed population declines in Western Hudson Bay. Although Inuit are unable to provide exact population numbers, they have valuable insights into population trends and changes in the environment. People in northern communities want to see more consideration of Traditional Knowledge and the history of interaction between people and polar bears.

Ø. Wiig commented that it is difficult to integrate TK into scientific studies and this should not be seen as a lack of respect for Inuit. According to the terms of the International Agreement, polar bears should be managed according to the best scientific evidence. G. Nirlungayuk responded that TK is verifiable because you can go to individuals and confirm what they have seen. It may be difficult to integrate TK and science, but you can do science and see if Inuit are correct.

E. Peacock commented that an important way of utilizing TK is to incorporate it into the design of scientific studies. Biologists in Nunavut collaborate frequently with their Inuit colleagues to develop scientific studies. E. Born commented that research in Greenland must be presented to and in principle be approved by the Organization of Hunters and Fishermen in Greenland before studies begin. E. Peacock added that consideration of IQ is mandated to be a part of studies in Nunavut and Inuit values (e.g., human relationships with bears) must be incorporated into all research programs.

M. Obbard pointed out that one of the difficulties of integrating TK with scientific knowledge is the uncertainty of anecdotal observations and how much they can be extrapolated to broader trends. L. Carpenter and M. Branigan added that local observations were integrated into a RISKMAN analysis of grizzly bear populations in NWT.

9. Review and adoption of resolutions

The Group reviewed 11 proposed resolutions. The following 3 resolutions were presented and discussed but were not adopted:

Support For Sustainable Harvest of Polar Bears – This resolution recommended that the Group support the sustainable harvest of polar bears by local subsistence users. The Group concluded that this did not warrant a new resolution as support for sustainable harvest is already explicitly stated in the International Agreement.

Population Estimates to Include Local Knowledge and Inuit Qaujimajatuqangit – This resolution recommended that Signatory Nations to the Agreement place high priority on obtaining and exchanging all available information and especially local knowledge and Inuit Qaujimajatuqangit. The Group reached consensus that the primary goals of the resolution were covered by the International Agreement. Incorporation of TK and IQ is already required for polar bear studies in NWT and Nunavut, so the group saw no need for an additional resolution.

Basic Requirements for Sound Conservation Management – This resolution recommended the systematic cooperation and inclusion of Inuit, Inuvialuit, and Inupiat in all aspects of polar bear management and research. The Group identified this resolution as being very similar to the one discussed just previous (Population Estimates to Include Local Knowledge and Inuit Qaujimajatuqangit) and consensus was reached that this resolution should not be adopted.

The following resolutions were discussed and adopted by consensus:

Resolution 1 – Effects of global warming on polar bears

Resolution 2 – Recommendations for renewed cooperative research in Baffin Bay

Resolution 3 – On the 2008 status report on polar bears by the Canadian Committee on the Status of Endangered Wildlife in Canada (COSEWIC)

Resolution 4 – Need for polar bear monitoring and capture

Resolution 5 – On minimizing human-polar bear interactions

Resolution 6 – On the conservation of the Chukchi Sea polar bear subpopulation

Resolution 7 – International study to understand the effects of climate change on pollution levels and the effects of pollution in polar bears

Resolution 8– Recommendations for the collection of scientific samples from harvested polar bears

The full text of the Resolutions would be posted on the PBSG website as soon as possible (http://pbsg.npolar.no/en/meetings/resolutions/15.html)

10. IUCN business: Issues handled by the Chair

A. Derocher reported no significant issues.

11. Future status of the PBSG

The future direction of the PBSG, including membership issues and the role of the Group relative to the Range States, was discussed at the members meeting.

D. Vongraven presented details of the Circumpolar Biodiversity Monitoring Program (CBMP) and invited the Group to participate in the development of a monitoring plan for polar bears. CBMP is based in Whitehorse, YT and is chaired by Mike Gill. The program is affiliated with the Conservation of Arctic Flora and Fauna (CAFF). CBMP is interested in hosting a workshop to develop a monitoring plan for polar bears and they have funds to support a post-doctoral student to produce a background paper. If these activities go forward, CBMP will need some support from the Group. D. Vongraven expressed his support for this project and invited other members to participate. A. Derocher added that CBMP is offering help, support, and assistance to move polar bears into a conservation and monitoring network and the Group reached consensus that this idea is worth pursuing further.

12. Adoption of the status report

The Status Report was adopted, pending circulation of the final draft to meeting participants for review and approval. N. Lunn asked for an estimated timeline for production of the final status report. E. Peacock said she could complete a draft by August 1, 2009 but other members may need to assist her in obtaining all final approvals. A. Derocher and N. Lunn volunteered to coordinate the process.

13. Adoption of the press release

After some discussion and revision, the press release was adopted and posted on the PBSG website.

14. Election of new PBSG Chair

J. Aars nominated Erik Born to serve as the new Chair of the PBSG. E. Born suggested the floor be open to other nominees. After no other nominations were made, Erik Born accepted the position of Chair of the IUCN/SSC Polar Bear Specialist Group.

The new Chair led the Group in thanking A. Derocher for his dedication and outstanding service as PBSG Chair.

15. Closing remarks and adjournment

The outgoing Chair thanked all of the participants for a stimulating, collegial, and productive meeting. He directed special thanks to Louise Holst Hemmingsen for her assistance as the meeting secretary. The Group expressed their sincere thanks to the Greenland Institute of Natural Resources and to the Greenland Government for their hospitality in Copenhagen.

The 15th Working Meeting of the IUCN/SSC Polar Bear Specialist Group was adjourned at 15:53 on 3 July, 2009.

2009 Status Report on the World's Polar Bear Subpopulations

Status and distribution

Polar bears are neither evenly distributed throughout the Arctic, nor do they comprise a single nomadic population, but rather occur in 19 relatively discrete subpopulations (Figure 1). There is uncertainty about the discreteness of the less studied subpopulations, particularly in the Russian Arctic and neighbouring areas, due to restricted capture and genetic data. The total number of polar bears worldwide is estimated to be 20,000 – 25,000. The following subpopulation summaries are the result of discussions of the IUCN/SSC Polar Bear Specialist Group held in Copenhagen, Denmark 29 June – 3 July, 2009, and updated with results that became available up to March 2010 The information on each subpopulation is based on the status reports given by each nation. We present estimated subpopulation sizes and associated uncertainty in those estimates, recent and predicted human-caused mortality, subpopulation trends, and rationale for our determinations of status. Where data allowed, or the approach was deemed appropriate, results of quantitative modelling estimating the likelihood of future population decline are presented.

Status table structure

Subpopulation size

Table 1 presents subpopulation sizes and uncertainty in the estimates as ± 2 standard errors of the mean, 95% CI, or ranges. These estimates are based on scientific research using mark-recapture analysis or aerial surveys. The year of the estimate is presented to give an indication of the age of the data on which this estimate is based. For some subpopulations, scientific data were not available and population estimates were extrapolated from professional knowledge, simulations based on an earlier population estimate, or the minimum size necessary to support local and/or aboriginal traditional knowledge (TEK) of population trends. Although these data are presented in addition to or in some cases as an alternative to dated scientific estimates, methods other than mark-recapture analysis or aerial surveys have unknown and in most cases inestimable errors.

Human-caused mortality

For most subpopulations, particularly those in North America and Greenland, harvesting of polar bears is a regulated and/or monitored activity. In many cases, harvesting is the major cause of mortality for bears. In most jurisdictions, the total numbers of bears killed by humans in pursuit of subsistence and sport hunting, and in defence of life or property are documented. Where data allow, we present the five-year mean of known human-caused mortality for each subpopulation. We also present the anticipated removal rate of polar bears in each jurisdiction based on hunting quotas and average harvest rates.

Status and current trend

Qualitative categories of trend and status are presented for each polar bear subpopulation (Table 1). Status is an assessment of whether a subpopulation is not reduced, reduced, or severely reduced from historic levels of abundance, or if there is insufficient data to estimate status (data deficient). Current trend is an assessment of whether the subpopulation is currently increasing, stable, or declining, or if there is insufficient data to estimate trend (data deficient).

Subpopulation viability analysis

For some subpopulations, recent quantitative estimates of abundance and parameters of survival and reproduction are available to determine likelihoods of future subpopulation decline using stochastic subpopulation viability analysis (PVA) or quantitative predictions based on both simulated habitat and demographic change (Hunter *et al.* 2007). Apart from the modeling used for the southern Beaufort Sea (Hunter *et al.* 2007), we used the PVA model RISKMAN (Taylor *et al.*

2001a) to estimate risks of future declines in polar bear subpopulations given demographic parameters and uncertainty in data. The model and documentation detailing the model's structure are available at www.nrdpfc.ca/riskman/riskman.htm. Publications based on the RISKMAN model include McLoughlin *et al.* (2003), Howe *et al.* (2007) and Taylor *et al.* (2002, 2005, 2006, 2008ab, 2009). RISKMAN can incorporate stochasticity into its model at several levels, including sampling error in initial subpopulation size, variance about vital rates due to sample size and annual environmental variation (survival, reproduction, sex ratio) and demographic stochasticity. RISKMAN uses Monte Carlo techniques to generate a distribution of results, and then uses this distribution to estimate subpopulation size at a future time, subpopulation growth rate, and proportion of runs that result in a subpopulation decline set at a predetermined level by the user. We adopted the latter to estimate persistence probability. Our approach to variance in this simulation was to pool sampling and environmental variances for survival and reproduction. We did this because: 1) variances for reproductive parameters often did not lend themselves to separating the sampling component of variance from environmental variance; and 2) we were interested in quantifying the risks of subpopulation decline including all sources of uncertainty in the data (*i.e.,* pooling sampling error with environmental error presents more conservative outcomes of subpopulation persistence).

For each subpopulation model, the frequency of occurrence of subpopulation declines and/or increases after 10 years was reported as the cumulative proportion of total simulation runs (2,500 simulations). We chose to conduct model projections using these criteria because we do not advocate using PVA over long time periods in view of potential significant changes to habitat resulting from climate change. Individual runs could recover from 'depletion', but not from a condition where all males or all females or both were lost. Required subpopulation parameter estimates and standard error inputs included annual natural survival rate (stratified by age and sex as supported by the data), age of first reproduction, age- specific litter production rates for females available to have cubs (*i.e.,* females with no cubs and females with 2- year-olds), litter size, the sex ratio of cubs, initial subpopulation size, and the sex, age, and family status distribution of the harvest. Input data may be found in Tables 1–3. The standing age distribution was always female- biased, likely due to long-term harvesting of males in subpopulations for which simulations were performed (Table 1). Because we wished to err on the side of caution, for all simulations we used the stable age distribution expected for the subpopulation at the anticipated annual removal rate as the initial age/sex distribution (i.e. initializing the subpopulation at the stable age distribution produced more conservative outcomes compared to that of the existing standing age distribution). The harvest selectivity and vulnerability array was identified by comparing the standing age distribution of the historical harvest of subpopulations to the total mortality, stable age distribution. Harvest was stratified by sex, age (cubs and yearlings, age 2–5, age 6–19, and age >20) and family status (alone, or with cubs and yearlings, or with 2-year-olds). We ran harvest simulations using natural survival rates, upon which anticipated annual removal rates (*i.e.,* human-caused mortality from all sources) were added.

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

Arctic Basin (AB)

The Arctic Basin subpopulation (AB) is a geographic catchall to account for polar bears that may be resident in areas of the circumpolar Arctic that are not clearly part of other subpopulations. Polar bears occur at very low densities here and it is known that bears from other subpopulations use the area (Durner and Amstrup 1993). As climate warming continues, it is anticipated that this area may become more important for polar bears as a refuge but a large part of the area is over the deepest waters of the Arctic Ocean and biological productivity is thought to be low. Polar bears with cubs have recently been observed from icebreakers in this region (see *Research in Russia*, this volume).

Barents Sea (BS)

Status and delineation

The size of the Barents Sea (BS) subpopulation was estimated using aerial survey techniques to be approx. 2,650 (95% CI, approx. 1900 – 3600) in August 2004 (Aars *et al.* 2009). This suggests that earlier estimates based on den counts and ship surveys (Larsen 1972) were too high. This suggestion is further supported by ecological data that indicate the subpopulation grew steadily the first decade after protection from hunting in 1973, and then either continued to grow or stabilized. Studies on individual movement using satellite telemetry and mark-recapture have been conducted in the Svalbard area since the early 1970s (Larsen 1972, 1985, Wiig 1995, Mauritzen *et* *al.* 2001, 2002) and continue (see *Research in Norway,* this volume). Studies show that some polar bears associated with Svalbard are very restricted in their movements but bears from BS, specifically, range widely between Svalbard and Franz Josef Land (Wiig 1995, Mauritzen *et al.* 2001). Continuing research confirms there is some spatial substructure between bears in northern and southern Svalbard. Some bears of the pelagic-type from northern Svalbard, move north to the Arctic Ocean in the summer, and return to northern Svalbard in the winter, whereas bears from southern Svalbard follow retreating ice to the east. Subpopulation boundaries based on satellite telemetry data indicate that BS is a natural subpopulation unit, albeit with some overlap to the east with the Kara Sea subpopulation (Mauritzen *et al.* 2002). Although overlap between BS and the East Greenland subpopulation may be limited (Born *et al.* 1997), low levels of genetic structure among all these subpopulations indicates substantial gene flow (Paetkau *et al.* 1999). There is also some preliminary evidence that home ranges of bears from the east Greenland subpopulation overlap with those of bears from Svalbard in Fram Strait (see *Research in Norway*, this volume).

Habitat and foraging

Denning occurs on several islands both on Franz Josef Land (Belikov and Matveev 1983) and Svalbard (Larsen 1985). Derocher *et al.* (submitted) found that the number of dens on Hopen Island negatively correlates with the annual date of freeze-up, indicating a potential for impacts of warmer climate on population growth in BS. Durner *et al.* (2009) found BS to be one of the most vulnerable subpopulations to the reduction in sea ice habitat.

Harvest management

BS is currently unharvested with the exception of bears killed in defence of life and property (Gjertz and Persen 1987, Gjertz *et al.* 1993, Gjertz and Scheie 1998). BS was overharvested, but a total ban on hunting in 1973 in Norway and in 1956 in Russia allowed the subpopulation to increase (Larsen 1986, Prestrud and Stirling 1994).

Human-bear conflicts

There have been no human fatalities due to polar bears from 2005 – 2009 and no increase in the number of polar bear-human conflicts on Svalbard. In Russia, conflicts with polar bears occasionally occur in a settlement on the Novaya Zemlya archipelago; polar bears in the area attracted by dumps in outskirts of the town.

Contaminants

High levels of polychlorinated biphenyls (PCBs) have been detected in samples of polar bears from BS, which raises concern about the effects of pollutants on polar bear survival and reproduction (Skaare *et al.* 1994, Bernhoft *et al.* 1997, Norstrom *et al.* 1998, Andersen *et al.* 2001, Derocher *et al.* 2003). Recent studies suggest a decline and stabilization of some pollutants (Henriksen *et al.* 2001) while new pollutants have been discovered (Wolkers *et al.* 2004). Haugestøl (2009) examined relationships between persistent organic pollutants (POPs) in the plasma of male polar bears and testosterone; the results confirm those previously reported by Oskam *et al.* (2004) that POPs have a negative effect on the plasma testosterone of polar bear males. Plasma levels of PCB-OHs were significantly lower in 2008 as compared to 1997-98 (Bertinussen 2009). Bertinussen (2009) also found significant changes in the thyroid hormone status of the bears from 1997 – 2008, indicating that the thyroid health of the animals has improved. However, it is also possible that the changes are due to selection of animals that are resistant to thyroid related effects of POPs.

Development

The northern part of the BS is not open for oil and gas developments, and the immediate risk from petroleum activities in areas where there are polar bears are only from acute oil spills from tourist, fishing or research vessels, or ice breakers with conventional fuel.

Tourism

Tourism is, and will continue to be, one of the main commercial activities on Svalbard, and tourism activities are increasing, both in winter and summer (see *Management in Norway*, this volume). There is an increased concern that polar bears are disturbed in sensitive areas and periods, although possible negative impacts of disturbance from tourism and other activities are unknown. At the present time tourism is not allowed in that part of the subpopulation that lives in Russia.

Protected areas

There are a total of 29 protected areas on Svalbard (115,600 km^2, ~77% of Svalbard). There are seven national parks, six nature reserves, 15 bird sanctuaries and one geological reserve. Management plans, a means to promote conservation goals for polar bears, are being developed for all the larger areas. In the Russian Arctic, polar bears in BS and their habitats are protected in the following protected areas: Russian Arctic National Park, Franz Josef Land State Sanctuary (Federal), Nenetskiy Federal Strict Nature Reserve, and the Vaigach State Sanctuary (Regional).

Research and monitoring needs

A capture program on polar bears to study demographic changes, in combination with studies on toxicology and health based on samples from the animals, is conducted every year in Svalbard. A study on maternity denning has been conducted yearly since 2007. A line transect survey across the entirety of BS, like the one conducted in 2004, was planned to be repeated in 2009 or 2010, but at the moment it is not clear when a similar study will be conducted. Monitoring of levels of contaminants is also of high priority. It is also important to develop program to study the impacts of global climate change to polar bears.

Baffin Bay (BB)

Status and delineation

Based on the movements of adult females with satellite radio-collars and recaptures of tagged animals, the Baffin Bay (BB) subpopulation of polar bears is bounded by the North Water Polynya to the north, Greenland to the east and Baffin Island, Nunavut, Canada to the west (Taylor and Lee 1995, Taylor *et al.* 2001a). A distinct southern boundary at Cape Dyer, Baffin Island, is evident from the movements of tagged bears (Stirling *et al.* 1980) and from polar bears monitored by satellite telemetry (Taylor *et al.* 2001a). A study of microsatellite genetic variation did not reveal any significant differences between polar bears in BB and neighboring Kane Basin, although there was significant genetic variation between polar bears in BB and those in Davis Strait (Paetkau *et al.* 1999). An initial subpopulation 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. However, work in the early 1990's showed that an unknown proportion of the subpopulation is typically offshore during the spring and, therefore, unavailable for capture. A second study (1993 – 1997) was carried out during September and October, when all polar bears were ashore in summer retreat areas on Bylot and Baffin islands (Taylor *et al.* 2005). Taylor *et al.* (2005) estimated the number of polar bears in BB at 2,074 ± 226 (SE). The current (2004) abundance estimate is less than 1,600 bears based on simulations using vital rates from the capture study (Taylor *et al.* 2005) and up-to-date pooled Canadian and Greenland harvest records.

Traditional ecological knowledge

Dowsley and Wenzel (2008) studied TEK of the BB subpopulation through semi-directed interviews. While they found significant differences in the responses among communities in Nunavut regarding whether there had been any change in the size of the subpopulation and numbers of bears in town, the majority of respondents in each community reported an increase. No respondent indicated a decrease in the subpopulation or a decrease in the numbers of bears in communities. Respondents also observed receding of the floe-edge towards land, and a decrease in the amount of land-fast ice in the region. Comments from the public at the Nunavut Wildlife Management Board (NWMB) April 2008 public meeting, including hunters and trappers and Nunavut Tunngavik Incorporated (NTI) support the findings of Dowlsey and Wenzel (2008).

Born *et al.* (2008, 2009a) interviewed 72 polar bear hunters residing in northwest

Greenland and hunting in BB and Kane Basin. The majority of the informants noted an increased occurrence of bears closer to the coast (*i.e.,* in areas usually used for hunting). About 31% of the answers specified that the reason for this change was an increase in the number of polar bears, whereas 16% of the answers specified it was due to a decrease in sea ice cover. The hunters in the Qaanaaq area (*i.e.,* bordering the Northwater Polynya to the east) were more inclined to believe that a decrease in sea ice cover explained the increase in coastal occurrence of polar bears, whereas the informants in the Upernavik area further south primarily believed it was an increase in the total number of bears. It was not clear from the results when the change in bear density occurred. However, several informants expressed the opinion that polar bears were scarce during the 1960s and 1970s. During recent years, perhaps beginning in the 1990s, the hunters noted marked environmental changes. Most pronounced, and of greatest importance to hunting, was the decrease in sea ice cover. This change, most pronounced in the southern parts of the Upernavik district, was mentioned by some of the informants as an additional reason for the increased catch of bears since the early 1990s (a boat has a larger range and can cover more ground faster than a sled). About 24% of the informants said that polar bears demonstrated physical changes (*e.g.,* had become thinner either as a result of increased competition or access to less food due to a decrease in sea ice). Thinner bears were most frequently reported in the Qaanaaq than in the Upernavik area. The reason for the regional difference is not clear.

Harvest management

Our simulations indicate that there is a 100% likelihood of any decline after 10 years after 2004 (from simulated estimate of 1,546) based on vital rates measured in 1997. The five-year mean combined Greenland and Canadian harvest is a 212 bears per year. However due to Greenland quotas invoked in 2006, the current legal maximum combined harvest is 176 bears per year. Vital rates (Taylor *et al.* 2005) are among the highest measured for polar bears; it is therefore unlikely that productivity has increased since 1997. As a result the current simulations likely do not underestimate a decline, if the subpopulation is demographically closed.

In December 2004, based on information from hunters that polar bear numbers in BB had increased substantially, the Government of Nunavut (GN) raised BB polar bear quotas from 64 to 105 bears. The mark-recapture and population growth rate estimate for BB used a Greenland annual removal from BB of 18 – 25 bears for the period 1993–1997 derived from recovery probabilities of marked bears (Taylor *et al.* 2005). However this was a considerable underestimate compared with the officially reported harvest in Greenland of polar bears taken from the BB population being approximately 70 bears per year (Born 1998, 2002, Taylor *et al.* 2005, Born and Sonne 2006). In 2006, Greenland invoked a quota system, reducing the Greenlandic harvest in BB from 73 in 2007 to 68 in 2009. Based on information on sex and age of each kill (n = 211) reported by the hunters during 2006 – 2008 the proportion of independent female polar bears in the Greenlandic catch from BB is estimated at 0.33 (see *Management in Greenland,* this volume).

In April 2008, the NWMB held a public hearing in Pond Inlet, Nunavut to consider a change to the quota for the three Nunavut communities that harvest from BB. The GN presented data from a TEK study (Dowsley and Wenzel 2008), the population inventory (Taylor *et al.* 2005), and up-to-date harvest data indicating a decline in the subpopulation due to overharvest. A decision was made by the NWMB and GN not to reduce the quota (105 bears per year for Nunavut) for 2008/09, primarily because a Greenland-Canada MOU was still outstanding and TEK suggesting an increase of polar bears in the area. In October 2009 the governments of Canada, Nunavut and Greenland signed a MOU for cooperative management of the Baffin Bay and Kane Basin population to ensure sustainable use of these stocks. A new public hearing regarding reducing the harvest in Nunavut was held in Iqaluit, Nunavut in September 2009; on 5 March 2010, NWMB and the GN agreed to reduce the Nunavut harvest of polar bears in BB by 10 bears per year over the next four years.

In 2008, Greenland failed to find a Non-Detriment Finding (NDF) under the Convention on International Trade of Endangered Species (CITES) for the export of hides from BB (and other subpopulations in Greenland), because it could not be asserted that the combined Greenlandic-Canadian catch from BB is sustainable, and because there is no trade-system in place in Greenland that will help to distinguish the origin of polar bear products. Late 2009 Canada issued a NDF for the export of polar bear products from the Baffin Bay population. In 2009, the European Union banned the import of polar bear hides from BB (and Kane Basin), based on the data suggesting an unsustainable harvest.

Habitat and foraging

Date of spring-time sea ice break up is occurring 2 – 3 weeks earlier than in 1980 (Stirling and Parkinson 2006). TEK confirms these scientific data, and adds that freeze-up is also later than the earlier 1990s and the extent of land fast ice has also declined (Dowsley and Wenzel 2008; Born *et al.* 2008, 2009a). Population and habitat modeling have predicted substantial declines in the abundance of polar bears in BB (Amstrup *et al.* 2008).

Contaminants

Dietz *et al.* (2006) found that mercury concentrations from hair of polar bears harvested in northwest Greenland have increased at ca. 2%/year between 1892 – 1991; the concentration from 1985 – 1991 was >14 times higher than baseline levels. Recent investigations suggest that this increase have continued up until 2008 (Dietz et al 2008bc, 2009, *in prep.*). The authors suggested that mercury concentrations in polar bears did not decline in BB and Kane basin, as they have in eastern Greenland, because of increasing emissions from Asia.

Concentrations of PCBs and DDT in BB were lower than in polar bears from the East Greenland and Svalbard regions but comparable to Western Hudson Bay and higher than the other Canadian and Alaskan populations (Verreault *et al.* 2005). Among the perfluoroalkyl contaminants (PFCs), perfluorooctanesulfonic acid (PFOs) had the highest concentrations in polar bear livers (Smithwick *et al.* 2005). Concentrations of PFOs in BB livers were among the lowest together with polar bears from the Chukchi Sea. Concentrations of polybrominated diphenylethers (PBDEs) concentrations in polar bears from BB were intermediate compared to the other Arctic regions (Muir *et al.* 2006).

Development

In 2006 the waters off West Greenland between 67° and 71° N (*i.e.,* the Disko West area) were opened for hydrocarbon exploration and licenses for exploration were granted several oil companies in 2008. The area includes the northeastern part of Davis Strait and the southeastern part of BB, with Disko Island as the most prominent landscape on the Greenland coast. A strategic environmental impact assessment (SEIA) of expected activities in the Disko West area indicated that a potential oil spill may impact a portion of the BB polar bear population in a worst case scenario (Mosbech *et al.* 2007). To obtain updated information for an environmental impact assessment (EIA), a polar bear study in the area was initiated in 2009 (see *Research in Greenland* this volume).

In 2006, a process was initiated to prepare the eastern parts of BB between ca. 71° and ca. 77 °N for hydrocarbon licensing. A preliminary SEIA evaluated the impact on polar bears of oil exploration and exploitation (Born and Dietz 2009, Boertmann *et al.* 2009). The overall conclusions of the SEIA were that activities in connection with oil exploration probably would have little to moderate effect on the polar bears and that the risk of an oil spill having long term impact on critical polar bear habitat and the population was moderate (Boertmann *et al.* 2009).

Tourism

Auyuittuq and Sirmilik National Parks on eastern Baffin Island, Canada attract visitors mainly for hiking and climbing; non-aboriginal visitors are not allowed to bring firearms into national parks in Canada. Currently, tourism does not pose a threat to polar bears in BB. In 2007/08, sport hunters took 25% of the harvested polar bears in the Canadian portion of the BB harvest. In Greenland, the tourist industry is increasing greatly in importance. There are no statistics on the number of tourists and their distribution in Greenland, but by far the major part of the tourist activity in West Greenland is outside the range of BB. Cruise ships bring an increasing number of tourists to Greenland. The cruise ships focus on the coastal zone and they often visit very remote areas that are otherwise almost inaccessible, and seabird and marine mammals are highlights on these trips (Boertmann *et al.* 2009a). There is no sport-hunting for polar bears in Greenland.

Human-bear conflicts

There has been an increased number of defence kills in Nunavut communities in BB since the 1970s (R^2 = 0.23; p = 0.002; Government of Nunavut data). This increase could have resulted from changing distribution of bears due to changes in ice habitat, though also may be confounded with variation in reporting. Since the introduction of quotas in Greenland there has been an increase in number of polar bears that were killed in self-defence in BB (see Table 3, *Management in Greenland*, this volume).

Protected areas

There are two Canadian National Parks on Baffin Island, which protect on-shore summer time and denning habitat from development: Auyuittuq and Sirmilik National Parks. Polar bear hunting is permitted. The Melville Bay Nature Reserve in NW Greenland was created in June 1980, in part to protect polar bear denning areas. The reserve consists of an outer zone (I) where hunting is permitted and an inner zone (II), in which all hunting is prohibited. Those travelling between the Qaanaaq and Upernavik areas must also avoid zone II. It is however permitted to pursue a wounded polar bear into zone II, as long as the hunter can prove that the shot that wounded the bear was fired while the animal was outside of zone II (Born 1995b).

Research and monitoring needs

A reanalysis of the mark-recapture-recovery data is being undertaken to incorporate the 10 years of recovery of harvested marked bears since the end of the mark-recapture study in 1997 (Taylor *et al.* 2005), to provide updated abundance and survival estimates. During the interview survey in 2006 (Born *et al.* 2008, 2009a) it was indicated approximately 50% of tagged bears harvested in NW Greenland remain unreported (E.W. Born, unpublished data). This significant violation of an assumption for the estimation of natural from total survival would have resulted in negatively biased natural survival estimates (Taylor *et al.* 2005). A preliminary pilot study to test aerial survey methods in regions of high topography on Bylot Island, Canada occurred in September of 2009 (S. Stapleton, unpublished data); while 68 polar bears were observed (average litter size, 1.55, n = 11 litters), biologists concluded that the high-topography coast of Baffin Island was not conducive to conducting an autumn aerial survey, when bears are on-land. An aerial survey to assess subpopulation size of BB on the spring-ice is tentatively planned for spring 2011, with a pilot study planned to occur in spring 2010. To provide information on seasonal area occupancy prior to and during the aerial survey, satellite transmitters will be deployed on polar bears in eastern BB, March-April 2010. Research on the effects of oil/gas development on polar bear movements is on-going using satellite transmitters deployed on polar bears in the spring of 2009 near Disko Island, Greenland. We suggest it is also necessary to assess any changes in subpopulation delineation among BB, Kane Basin and Lancaster Sound, as a result of ice-habitat change.

Chukchi Sea (CS)

Status and delineation

Reliable estimates of subpopulation size or status based upon mark-recapture or other techniques (*e.g.,* aerial survey) are not available for CS. This subpopulation is believed to be declining based on reported high levels of illegal killing in Russia combined with continued legal harvest in the United States, and observed and projected losses in sea ice habitat.

Cooperative studies between the US and Russia in the late 1980s and early 1990s revealed that polar bears in CS, also known as the Alaska-Chukotka subpopulation, 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 these telemetry studies, the western boundary of the subpopulation was set near Chaunskaya Bay in northeastern Russia. The eastern boundary was set at Icy Cape, Alaska, which is also the western boundary of the southern Beaufort Sea subpopulation (Amstrup and DeMaster 1988, Garner *et al.* 1990, Amstrup *et al.* 1986, 2004a, 2005). Movement data have been used to determine probabilistic distributions and zones of overlap between CS and Southern Beaufort Sea subpopulations. This information can be used to more accurately describe sustainable harvest levels once defensible estimates of abundance are developed (Amstrup *et al.* 2004a, 2005). An on-going capture-based research program started in 2008 off the US coast of CS by the US Fish and Wildlife Service and the US Geological Survey will provide updated information on bear movement patterns and distribution.

Traditional ecological knowledge

Natives in communities throughout the range of the polar bear in the Chukchi and Bering Seas have provided valuable information on the distribution, movement patterns, habitat use, and behavior for years. Kalxdorff (1997) coordinated collection of TEK on polar bear habitat use in Alaska and Kochnev *et al.* (2003) reports on local knowledge of Chukotkan Native peoples. Hunters in Alaska reported the irregular occurrence of some dens on St. Lawrence Island, Little Diomede Island, and in areas south of Point Hope. Native hunters in Chukotka reported regular use of areas around capes throughout the eastern Chukotkan coastline for maternal denning. Reports of denning in Russia by Natives support scientific studies documenting that the maternal denning for CS occurs primarily in Russia. Hunters reported the occurrence of polar bears along the Chukotkan coast primarily in fall and winter. In the fall, bears are reported to actively feed on whale and walrus (*Odobenus rosmarus*) carcasses. Congregations of as many as 80-100 polar bears at feeding sites can occur. Polar bears have only occasionally been observed hunting for seals from land in the fall and winter.

Habitat and foraging

Data on habitat of polar bears in CS are telemetry data collected between 1985 – 1995 (Durner *et al.* 2006, 2009). TEK and observational studies report foraging on whale and walrus carcasses on the Chukotkan coastline and Wrangel Island in the fall and winter (Kochnev *et al.* 2003, Ovsyanikov *et al.* 2008). Marine mammal carcasses are frequently available along the US coastline between July and September (Kalxdorff 1998, Fischbach *et al.* 2009). Kalxdorff (1988) found carcasses to be particularly abundant between Wales and Point Hope with increasing densities in the North. The majority of carcasses were seal species and walrus and though as many as 22 whale carcasses were observed in September 1997. The formation of new and larger walrus haul-outs in recent years has resulted in potentially increased availability of walrus carcasses to polar bears on land in both Russia (Ovsyanikov *et al.* 2008) and in the US. On the sea ice, polar bears have access to bearded (*Erignathus barbatus*), ringed (*Pusa hispida*), ribbon (*Histriophoca fasciata*) and spotted seals (*Phoca largha*) in CS, though bearded seal and ringed seal appear to be most abundant.

Harvest management

Russia has maintained a moratorium on harvest of polar bears since 1956. However, starting in the late 1990s, illegal killing began to increase and is currently believed to be 150 – 200 polar bears per year. In addition to this removal from the population, a legal, unlimited harvest occurs by Inupiat in western Alaska. In the absence of accurate information on population size and trend, it is not currently possible to identify a sustainable level of harvest for this population. Average annual harvest levels in Alaska have declined by approximately 50% between the 1980s and the 1990s (Schliebe *et al.* 2006) and remain depressed today. The cause(s) of this decline is unknown, but could include reduced effort or reduced availability resulting from changes in polar bear distribution or abundance. Measures are being taken by regional authorities in Chukotka to reduce poaching activity, including the prosecution of two poachers in 2006, which was the first prosecution in 30 years.

Implementation of the Russia-US Bilateral Agreement on the Conservation and Management of Polar Bears is designed to ensure a scientifically based sustainable management program is instituted. Management will include active involvement of Native hunters' organizations from Alaska and Chukotka. In 2009, a Bilateral Commission was formed, including a Native and federal representative from each country. The first meeting of the Commission occurred in September, 2009, and the first meeting of the scientific advisory commission occurred in March 2010.

Human-bear conflicts

The number of defence of life killings occurring on the US side of the CS has increased in recent years. Efforts are being made to establish polar bear patrols to minimize bear-human conflicts in communities where polar bears are frequent visitors. In addition, outreach efforts have increased in coastal communities in an effort to prepare communities for more frequent interactions with polar bears that may result with changing sea ice conditions, particularly in the during fall/summer open water periods. In Russia, the Umky patrol was initiated in the fall of 2007 to minimize bear-human conflicts on the Chukotkan coastline and to gather data on seasonal abundance and distribution of bears in this area (see *Research and Management in Russia*, this volume).

Contaminants

Norstrom *et al.* (1998) reported concentrations of PCBs, CHLs, DDEs, and DIELs in CS polar bears as being among the lowest of any studied polar bear populations. Andersen *et al.* (2001) further supported lower concentrations of PCBs in polar bears from the Chukchi-Bering Seas compared to bears from Franz Josef Land, the Kara Sea, and Svalbard. Smithwick *et al.* (2005) found lower levels of perfluoroalkyl substances in the liver and blood of bears in the Chukchi-Bering seas than those of polar bears in Southern Hudson Bay, East Greenland, and Svalbard. The one exception is β-HCH which occurs at some of the highest concentrations reported in the Arctic (Evans 2004). Suspected sources of the high concentrations of β-HCH in the North Pacific Ocean are from China and Southeast Asia (Li *et al.* 1998). Kannan *et al.* (2005) also suggested differences in local sources of exposure to organochlorine pesticides, PCBs, PBDEs, and perfluorinated acids between bears sampled from the Alaskan portion of CS and the Southern Beaufort subpopulations. Mercury levels tended to be lower in bears sampled from the CS compared to the Southern Beaufort Sea, whereas copper concentrations showed the reverse trend.

Development

In 2006, oil/gas exploration activities in the US expanded into CS. Exploration activities had not occurred in CS since the operations of the Shell oil company (1991 – 1996). The oil/gas industry is currently operating in the marine and terrestrial regions of the Alaskan portion of the CS, while exploration for large-scale coal deposits has also occurred in the terrestrial coastal regions of western Alaska. To address development issues in the region of CS with regards to polar bears, the US Fish and Wildlife Service (USFWS) has implemented its regulatory authority through the incidental take program (for management details see *Management in USA*, this volume). Currently, the oil and gas industry has been the only "citizen group" to request incidental take authorization for polar bears in the Chukchi Sea. The USFWS administers an incidental take program through Letters of Authorization (LOAs) that allow for polar bear managers to work cooperatively with oil/ gas operators to minimize impacts of their activities on polar bears. To address this increased oil/gas industry interest in CS, the USFWS issued incidental harassment authorizations (IHAs) in 2006 and 2007 as an interim measure prior to the development of incidental take regulations (ITRs) for the region.

Oil and gas activities continued in the Chukchi Sea region during 2008. In February of 2008, the Minerals Management Service held a lease sale of a 29.7 million acre area off the northwest Alaskan coast in the Chukchi Sea. ITRs were promulgated in June 2008. Three companies were issued LOAs to conduct seismic exploration activities during the open water period (June to November). Interactions between polar bears and humans are minimal during the open-water season when activities occur. Recently, two cargo ships began a traverse of Russia's Northeast Passage marking the first time commercial ships have attempted this route without the aid of icebreakers. Thus, the potential for increased shipping exists within the range of polar bears in the Chukchi and Bering Seas.

Tourism

Tourism is a minimal issue for polar bears on the US side of CS. Some bear viewing occurs in Barrow, at the eastern boundary of the range of this population. Polar bear patrols and efforts by local authorities, including the North Slope Borough, work to mitigate potential effects. There is a regulated ship-based tourist industry on Wrangel Island, Russia.

Protected areas

There are no protected areas designated for polar bears on the US side of the Chukchi Sea. However, polar bears have been protected under the Marine Mammal Protection Act since 1973 throughout their range in the US since 2008. This protects bears from sport harvest and includes measures to mitigate interactions between bears in areas of industrial activity. Polar bears in Russia have access to a number of protected areas (see *Management in Russia,* this volume), one of the most important being the Nature Reserve on Wrangel Island.

Research and monitoring needs

Currently, there are no data available to estimate the population size, vital rates, or population trend for polar bears inhabiting the Chukchi and Bering Seas. Coordinated research between the US and Russia is needed to better understand this subpopulation. In September 2009, the first meeting of a Bilateral Commission established under the US-Russia Bilateral Agreement for the Conservation and Management of polar bears will be held. This agreement outlines the establishment of a Scientific Advisory Group, delegated by the Commission, to advise research and management of this population. This agreement will aid in facilitating coordinated research. In addition to the need for information on population size and trend, information is needed on the number of bears taken illegally in Russia, the response of this population to loss of sea ice habitat, and current distribution and habitat use patterns. Ongoing research in this population include observational studies on Wrangel Island and the Chukotkan coast (see *Research and Management in Russia*, this volume) and a US-based capture effort that began in 2008 (see *Research in the United States*, this volume) to study population ecology and status, and movement, habitat and health of polar bears.

Davis Strait (DS)

Status and delineation

Based on the recapture or harvest of previously tagged animals and of adult females with satellite collars, the Davis Strait (DS) polar bear subpopulation occurs in the Labrador Sea, eastern Hudson Strait, Davis Strait south of Cape Dyer, and along an as yet undetermined portion of south-west Greenland (Stirling *et al.* 1980, Stirling and Killian 1980, Taylor and Lee 1995, Taylor *et al.* 2001a). A genetic study of polar bears (Paetkau *et al.* 1999) indicated significant differences between bears from southern DS and both Baffin Bay and Foxe Basin; Crompton *et al.* (2008) found that individuals from northern portions of DS and those from Foxe Basin share a high degree of ancestry. The initial subpopulation estimate of 900 bears for DS (Stirling *et al.* 1980, Stirling and Killian 1980) was based on a subjective correction from the original mark-recapture calculation of 726 bears, which was felt to be too low because of possible bias in the sampling. In 1993, the estimate was again increased to 1,400 bears and to 1,650 in 2005. These increases were to account for the bias as a result of springtime sampling, the fact that the existing harvest appeared to be sustainable and not having negative effects on the age structure, and TEK which suggested that more bears were being seen over the last 20 years. The most recent inventory of this subpopulation was completed in 2007; the new subpopulation estimate is 2,142 (95% log-normal CI, 1811 – 2534). Using new recruitment and natural survival estimates (Tables 3, 4), the 10-year mean un-harvested geometric population growth rate is 0.98 ± 0.001 (Peacock 2009; see *Research in Canada*, this volume). DS is currently declining based on survival rates calculated from data collected up to the conclusion of the mark-recapture study in 2007. Ecological covariates associated with survival suggest that the decline may be as a combined result of short-term and local density dependence, stabilization of harp seal (*Pagophilus groenlandicus*) numbers and declining ice conditions.

Traditional ecological knowledge

Research to gather traditional and public knowledge has been conducted in communities that harvest from DS in Nunavut: Pangnirtung, Iqaluit and Kimmirut. In 2006, Kotierk (unpublished data) found that 61% of the surveyed public responded that there were 'many' or 'the most ever' bears in Davis Strait (see *Research in Canada*, this volume).

Habitat and foraging

Davis Strait is a seasonal-ice subpopulation, with the ice-free period extending from approximately August through November. Annual ice cover in DS is highly variable and rarely reaches 50% (Stirling and Parkinson 2006). Ice breakup has become earlier since 1991 (Stirling and Parkinson 2006). Using a 34-year mark-recapture-recovery dataset, Peacock (2009) evaluated the impact of total concentration of summer-time ice on polar bear survival; *Ice* as a second-order variable first appears in a Burnham survival model of $\Delta AIC = 0.69$. Total survival of polar bears increases as mean summer ice concentration declined from 35% to 20% (from 1974 – mid 1990's); as mean summer ice concentrations have now decreased from 20% to less than 10%, the relationship with total survival and summer-time ice concentration is negative. Davis Strait is unique in terms of prey diversity available to polar bears (Thiemann *et al.* 2008); harp seals comprise 50 (northern DS) to 90 (southern Labrador)% of polar bear diet (Iverson *et al.* 2006). Peacock (2009) found the most important temporal covariate affecting polar bear survival was the abundance of harp seals. The abundance of seals primarily affected subadult survival ($\beta = 2.96 \pm 1.3$ (SE), subadults, $\beta = 0.31 \pm 0.44$ non-subadult); as harp and hooded seals increased in the North Atlantic population, polar bear survival increased. Population and habitat modeling have predicted substantial declines in the abundance of polar bears in the seasonal-ice eco-region, which includes DS (Amstrup *et al.* 2008).

Harvest management

In December 2004, the GN and NWMB increased Nunavut's polar bear quota in DS by 12 as a result of the increase in the estimate. Total annual harvest is 46 for Nunavut, 2 for Greenland, 6 for Nunatsiavut (Newfoundland & Labrador); there is no quota in Nunavik (Quebec). In January of 2006, Greenland established a quota system. An annual quota of 2 bears was established for southern Greenland. Canadian jurisdictions will be reassessing harvest rates in the near future, based on the new population data.

Contaminants

Concentrations of ΣPCBs and DDT in polar bears from southern Baffin Bay and DS were lower than found in bears from the East Greenland and Svalbard regions, comparable to Western Hudson Bay and higher than in the other Canadian and Alaskan populations. The opposite trend was observed for ΣHCHs (Verreault *et al.* 2005).

Development

There is renewed interest in oil exploration offshore along the west coast of Greenland where DS polar bears occur during winter and spring in the eastern edge of the Davis Strait pack ice. Currently some oil companies have licenses for exploration in the area: (http://www.bmp.gl/petroleum/current_licences.html).

Tourism

Tour ships conduct summertime landings on Akpatok Island (Nunavut) in Ungava Bay, where high densities of polar bears summer occur; operations are assessed by the Department of Environment, GN, on a case-by-case basis. Ship-based tourism occurs in the Torngat National Park region of Labrador. Sport-hunting can occur in the Nunavut region of DS, however is uncommon. Tourism is likely not a problem in the region of Greenland where polar bears from the DS subpopulations sometimes are taken; polar bears usually occur in the eastern part of the DS pack ice at a time of the year where there are no tourist activities.

Protected areas

The Torngat Mountains National Park occurs in northern Labrador, which protects polar bear onshore and denning habitat from development.

Research and monitoring needs

There is no new research planned for the DS subpopulation, although harvest of recovered marks in the population will continue to be frequent, and population models will be updated.

East Greenland (EG)

Status and delineation

Although various studies have indicated that more or less resident groups of bears may occur within the range of polar bears in East Greenland (EG; Born 1995a, Dietz *et al.* 2000, Sandell *et al.* 2001), the EG polar bears are thought to constitute a single subpopulation with only limited exchange with other subpopulations (Wiig 1995, Born *et al.* 2009b). Satellite-telemetry has indicated that polar bears range widely along the coast of eastern Greenland and in the pack ice in the Greenland Sea and Fram Strait (Born *et al.* 1997, 2009b, Wiig *et al.* 2003; see *Research in Greenland*, this volume). Although there is little evidence of genetic difference between subpopulations 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 EG and the Barents Sea subpopulation is minimal (Wiig 1995, Born *et al.* 1997, 2009b, Wiig *et al.* 2003). No inventories have been conducted in recent years to determine the size of the polar bear subpopulation in eastern Greenland.

Traditional ecological knowledge

In 1999, 52 hunters living in eastern Greenland (30 in the Scoreby Sound areas, 22 in the Ammassalik area further south) were interviewed about polar bear distribution and occurrence, and about the polar bear hunt (Sandell *et al.* 2001). Groups of bears showing site fidelity were thought to exist in both the Scoresby and Ammassalik areas. Observations of maternity dens were sporadic and overall, information about such dens was scarce. Generally, the hunters had not noted any changes in distribution or 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 variation in the extension and seasonal distribution of ice. However, in both areas it had been noted that the ice conditions had deteriorated since the mid-1990s. Polar bears are hunted mainly by use of dog sleds. However, since the early 1980s hunting with skiffs powered with 50-70 horsepower out-board engines had become increasingly important, reflecting the decline in sea ice resulting in a longer boating season (Sandell *et al.* 2001).

Habitat and foraging

During the last decades, the ice in the east Greenland area has diminished both in extent and thickness (Parkinson 2000). It has been predicted that this trend will continue in this century (Rysgaard *et al.* 2003). The effects of arctic warming on EC polar bears have not been documented. However, considering the effects of climate change on polar bears in other parts of the Arctic (*e.g.,* western Hudson Bay), these environmental changes cause concern about how polar bears in EG may be negatively affected. Durner *et al.* (2009) forecasted that optimal polar bear habitat in EG will decrease substantially during the next 50–100 years.

Harvest management

On January 1st, 2006, quotas came into effect for EG and other subpopulations by Greenland Government Executive Order No. 21. The annual quota for the East Greenland population was 55 in 2006 and 54/year for the period 2007 – 2009 (30 in Scoresby Sound, 20 in Tasiilaq and 4 in Southwest Greenland; Anonymous 2006). The catch of polar bears taken in southwestern Greenland, south of 62 °N, must be added to the catch statistics from EG because polar bears arrive in the southwestern region with the drift ice that comes around the southern tip from eastern Greenland (e.g. Sandell *et al.* 2001). In 2008, the quota for EG was raised to 64 (see *Management in Greenland*, this volume). Between 1993 (first year of instituting a new catch recording system) and 2005 the catch from the EG subpopulation has fluctuated and averaged approx. 61 polar bears per year with no clear trend (range: 46–84; see

Management in Greenland, this volume). However, at the beginning of the 20th century the Greenlanders catches from the EG population were much larger, averaging more than 100 bears per year (Vibe 1967, Sandell *et al.* 2001, Rosing-Asvid 2006). Since the early 1900s the catch of polar bears from the EG has decreased significantly (Sandell *et al.* 2001, Rosing-Asvid 2006). It is not clear whether this decrease represents an over-exploitation (in a period with increase in the human population in East Greenland and increased use of modern and more effective hunting methods) with an associated decrease in the EG population, or reflects natural fluctuations in ice conditions and prey and therefore abundance of polar bears within the hunting areas (Sandell *et al.* 2001, Rosing-Asvid 2006, Born *et al.* 2009b). Based on information on sex and age of each kill (n =155) reported by the hunters during 2006-2008 the proportion of adult (=independent) female polar bears in the catch in eastern Greenland is estimated at 0.34 (see *Polar Bear Management in Greenland*, this volume).

Human-bear conflicts

After the introduction of quotas in 2006, defence kills have been reported from EG (see *Management in Greenland*, this volume).

Contaminants

Polar bears in EG have relatively high body burdens of organic pollutants (Norstrom *et al.* 1998, Dietz *et al.* 2004, 2007) and levels of these pollutants seem to have increased between 1990 and 1999–2001 (Dietz *et al.* 2004). Several studies indicate that organic pollutants may have negatively affected polar bears in this region. Dietz *et al.* (2006) found that mercury increased in concentration from 1892 – 1973, but after 1973, concentrations have decreased. However, levels remain at about 11 times higher than historic levels indicating that the source of mercury is 90% anthropogenic.

PFCs were examined in liver from East Greenland polar bears sampled in19 different years during 1984–2006 (Dietz *et al.* 2008a). The study revealed significant annual increases of eight different PFCs. Among the PFCs, PFOS had the highest concentrations in polar bear livers (Smithwick *et al.* 2005). Concentrations of PFOS in livers in polar bears from EG were among the highest together with the southern Hudson Bay bears. PBDEs were found to be the highest in EG polar bears (Muir *et al.* 2006).

Development

In 2006, the Bureau of Minerals and Petroleum of Greenland initiated a decision process for the KANUMAS East area, which comprises the waters off Northeast Greenland. Interest in the KANUMAS East area increased substantially when it was evaluated that there might be substantial oil, natural gas, and natural gas liquid resources in the seas of Northeast Greenland. A preliminary SEIA of activities related to exploration, development and exploitation of hydrocarbons in the sea off Northeast Greenland between 68° and 81° N concluded that impacts on the polar bear population from disturbing activities during development and production in the KANUMAS East assessment area likely will be moderate because there will only be a moderate overlap with activities because these will be relatively local (Boertmann *et al.* 2009b). There is also oil exploration activities offshore in Southwest Greenland in areas where polar bears from the EG population sometimes arrive with the pack ice coming around the southern tip of Greenland from East Greenland: (http://www.bmp.gl/petroleum/current_licences.html).

Tourism

The national strategy of tourism in Greenland (2008–2010) planned a 10% increase per year in the number of cruise tourists, a trend, which is very apparent in Scoresby Sound (ca. 70° 30´ N) in East Greenland (Boertmann *et al.* 2009b). The most important asset for the tourist industry in East Greenland is the unspoiled, authentic and pristine nature, which is particularly abundant in the areas north of Scoresby Sound *i.e.,* in the National Park of Northeast and North Greenland (Boertmann *et al.* 2009b) which is an important area for EG polar bears (Born *et al.* 2009b). Both land-based tourism and tourist ships have increased in numbers in the area in recent years. With the expected increase in cruise tourism and with more open water in the summer time, cruise ship activity will most likely intensify in EG, in terms both of number of ships and people, but also in terms of visiting more and more remote sites (Boertmann *et al.* 2009b).

Protected areas

The world's largest national park "The National Park in North and Northeast Greenland" was established in 1974. The park covers ca. 972.000 km^2 between 71° and 83°40' N and 12° and 63°W. It is permitted for permanent residents of Central East and Northwest Greenland with a hunting license to hunt polar bears in the national park under certain restrictions (Aastrup *et al.* 2005). An estimated 15 – 20 polar bears were shot in the national park in the early 1980s by hunters coming from the Scoresby Sound area but apparently hunting of polar bears in the park has since decreased (Sandell *et al.* 2001, Aastrup *et al.* 2005).

Research and monitoring needs

In connection with development of an EIA, a study was initiated to determine polar bear movement and habitat choice in NE Greenland in 2007 (see *Research in Greenland*, this volume). Furthermore, an aerial survey is planned to determine the abundance of polar bears in EG.

Foxe Basin (FB)

Status and delineation

Based on 12 years of mark-recapture studies (primarily within Hudson Bay), tracking of female bears with VHF radio and satellite collars in western Hudson Bay and southern Hudson bay, the Foxe Basin (FB) subpopulation appears to occur in Foxe Basin, northern Hudson Bay, and the western end of Hudson Strait (Taylor and Lee 1995). During the ice-free season, polar bears are concentrated on Southampton Island (the number of bears on the island was estimated at 240 independent bears in August 2008; S. Stapleton, unpublished data, Peacock *et al.* 2008) and along the Wager Bay coast; however, significant numbers of bears are also encountered on the islands and coastal regions throughout the Foxe Basin area (Peacock *et al.* 2008; see *Research in Canada,* this volume). A total subpopulation estimate of 2,119 ± 349 was developed in 1996 (Taylor *et al.* 2006c) from a mark-recapture analysis based on tetracycline biomarkers. The marking effort was conducted during the ice-free season, and distributed throughout the entire area. TEK suggests the subpopulation of polar bears has increased (GN consultations in villages in Foxe Basin 2004 – 2009); the subpopulation estimate was increased to 2,300 bears in 2005. Survival and recruitment rates required for PVA assessment are unavailable, and the rates observed from adjacent populations vary considerably. During a comprehensive summertime aerial survey in 2009 (based on distance sampling and double-observer estimation) covering 43,000 km, 814 bears were observed (S. Stapleton, unpublished data, Peacock *et al.* 2009); abundance estimates will be developed shortly.

Harvest management

Harvest levels in Nunavut were reduced in 1996 to permit slow recovery of this subpopulation. After consultations in 2005, the Nunavut quota was increased to a level consistent with a population level of 2,300 bears (105 per year), and the increasing trend observed by Inuit. It is unknown if harvest levels are sustainable. There are no quotas in Quebec; reported harvest in northern Quebec averages 2 bears per year.

Habitat and foraging

Fragmentation of ice has increased, and total concentration and ice-floe size has decreased in FB over the last 25 years (Sahanatien and Derocher 2009). Stirling and Parkinson (2006) predict eventual population decline based on past and predicted changes in ice habitat for polar bears.

Development

There is planned increased shipping through foraging areas to Steensby Inlet port in northeastern FB for Mary River Iron Ore Mine on Baffin Island. There is proposed mining development near denning areas southwest of Wager Bay (Peregrine Diamonds).

Tourism

Twenty-one percent of the 2007/08 Nunavut harvest was from sport-hunting, mainly from the hamlet of Coral Harbour.

Protected areas

Ukkusiksalik National Park in Nunavut protects from development an area of summertime polar bear concentration; currently there are few tourists to this National Park. There is a proposed federal Marine Protected Area for northwest FB; boundaries and restrictions are under discussion.

Research and monitoring needs

A new population inventory is necessary to determine population growth and status and whether the harvest is sustainable. This is especially important because of known changes in ice habitat (Sahanatien and Derocher 2007), predicted changes in polar bear habitat (Stirling and Parkinson 2006), and planned development. A population inventory for FB was proposed in 2008 and 2009, but was not permitted due to lack of support of Inuit communities for research requiring capture and handling of polar bears. A second comprehensive aerial survey will be conducted in 2010 to continue to develop the distance-sampling technique for polar bears on land.

Gulf of Boothia (GB)

Status and delineation

The population boundaries of the Gulf of Boothia (GB) subpopulation are based on genetic studies (Paetkau *et al.* 1999), movements of tagged bears (Stirling *et al.* 1978, Taylor and Lee 1995), movements of adult females with satellite radio-collars in GB and adjacent areas (Taylor *et al.* 2001a), and interpretations by local Inuit hunters of how local conditions influence the movements of polar bears in the area. An initial subpopulation estimate of 333 bears was derived from the data collected within the boundaries proposed for GB, as part of a study conducted over a larger area of the central Arctic (Furnell and Schweinsburg 1984). Although population data from this area were limited, local hunters reported that numbers remained constant or increased since the time of the central Arctic polar bear survey. Based on TEK, recognition of sampling deficiencies, and polar bear densities in other areas, an interim subpopulation estimate of 900 was established in the 1990s. Following the completion of a mark-recapture inventory in spring 2000, the subpopulation was estimated to number 1,523 ± 285 bears (Taylor *et al.* 2009). Natural survival and recruitment rates were estimated at values higher than the previous standardized estimates (Taylor *et al.* 1987). Taylor *et al.* (2009) concluded that the subpopulation was increasing in 2000, as a result of high intrinsic rate of growth and low harvest. However, harvest rates have increased to a 5-year mean of 60 bears per year, from 40 bears per year reported in Taylor *et al.* (2009). In this report, we changed the status of the population from *increasing* to *stable* to reflect the increase in the harvest rate and because populations cannot continue to increase without stabilization.

Traditional ecological knowledge

Keith *et al.* (2005) report that the GB polar bear subpopulation has increased since the mid 1980's.

Habitat and foraging

Barber and Iacozza (2004) found no trends in ringed seal habitat or sea ice conditions from 1980 to 2000. In general, summer pack ice in GB appears to offer high habitat quality and prey availability (Taylor *et al.* 2009).

Harvest management

GB is under the sole jurisdiction of Nunavut, Canada. The NWMB increased quotas in GB in 2005 from 40 bears per year to 74 bears per year, based on TEK of increasing numbers of bears and the new capture data.

Research and monitoring needs

Taylor *et al.* (2009) recommend increased monitoring of GB, and all polar bear subpopulations, due to unidirectional environmental change. There is no scheduled new mark-recapture inventory of polar bears in GB.

Kane Basin (KB)

Status and delineation

Based on the movements of adult females with satellite collars and recaptures of tagged animals, the boundaries of the Kane Basin (KB) subpopulation include the North Water Polynya (to the south of KB), and Greenland and Ellesmere Island to the west, north, and east (Taylor *et al.* 2001a). Polar bears in KB do not differ genetically from those in Baffin Bay (Paetkau *et al.* 1999). The size of the subpopulation was estimated to be 164 ± 35 (SE) for 1994 – 1997 (Taylor *et al.* 2008a). The intrinsic natural rate of growth for KB polar bears is low at 1.009 (SE, 0.010) (Taylor *et al.* 2008a), likely because of large expanses of multi-year ice and low population density of seals (Born *et al.* 2004). Taylor *et al.* (2008a) suggested that KB might act as a sink because of unsustainable rates of harvest, relatively unproductive habitat, and lack of genetic differentiation with BB.

Traditional ecological knowledge

An interview survey conducted in 2006 showed that until 2006 (*i.e.,* before quotas) more than 1/3 of the polar bears taken by Greenlanders living in the Qaanaaq area were hunted in northern Smith Sound and eastern KB. Due to the reduction of sea ice there has been a decrease in dog sled hunting trips to these areas and an increase in the proportion of polar bears that are taken from skiffs since the 1990s. It was the impression that bears have come closer to inhabited and regularly used hunting areas. Several interviewees were of the opinion that this represents an increase in the KB population, whereas other suggested that it might reflect a change in distribution related to the decrease in sea ice (Born *et al.* 2008, 2009a).

Harvest management

Before 1997, KB was essentially un-harvested by Inuit in Canadian territory because of its distance from Grise Fiord, the closest Canadian community, and because conditions for travel in the region are typically difficult. However, KB has occasionally been harvested by hunters from Grise Fiord since 1997, and continues to be harvested from Greenland. Hunting of polar bears from the KB population along eastern Ellesmere Island and in the western parts of KB had been a very long tradition for the Inuit living in Northwest Greenland (Rosing-Avid and Born 1990) until it became prohibited for hunters from Greenland to hunt polar bears on Canadian territory after the introduction of quotas in 1967 (Killian *et al.* 1988). However, the eastern part of KB Smith Sound is still an important polar bear hunting ground for Greenlanders living in the Qaanaaq area of Northwest Greenland (Rosing-Asvid and Born 1990, Born *et al.* 2008, 2009a).

The five-year Canadian-Greenlandic mean harvest of 11 bears per year is not sustainable in simulations using up-to-date recruitment and survival rates (Table 1). Greenland initiated a quota system in January 2006. In 2006, Greenland invoked a quota system, reducing the Greenlandic harvest from KB from 10 in 2007 to 6 in 2009. Co-management discussions between Greenland and Canada are continuing. Based on information on sex and age of each kill in Greenland, (n = 16) reported by the hunters during 2006 – 2008 the proportion of adult (*i.e.,* independent) female polar bears in the catch from KB is estimated at 0.31 (see *Management in Greenland*, this volume).

In 2008, Greenland failed to find a Non-Detriment Finding (NDF) under CITES for the export of hides and other polar bear products from KB (and other subpopulations in Greenland), because it could not be asserted that the combined Greenlandic-Canadian catch from KB is sustainable, and because there is no trade-system in place in Greenland that will help to distinguish the origin of polar bear products. In 2008, the European Union banned the import of polar bear hides from KB (and Baffin Bay).

Habitat and foraging

Although the KB region has ringed seals and areas with favourable polar bear habitat (Taylor *et al.* 2001a) it is thought to be extreme and generally low quality habitat for polar bears (Taylor *et al.* 2008a) . It is unknown how habitat will change in the future.

Kara Sea (KS)

Status and delineation

This subpopulation includes the Kara Sea (KS) and overlaps in the west with the Barents Sea subpopulation in the area of Franz Josef Land and Novaya Zemlya archipelagos. Data for KS and the Barents Sea, in the vicinity of Franz Josef Land and Novaya Zemlya, are mainly based on aerial surveys and den counts (Parovshivkov 1965, Belikov and Matveev 1983, Upenski 1989, Belikov *et al.* 1991, Belikov and Gorbunov 1991, Belikov 1993). Telemetry studies of movements have been done throughout the area, but data to define the eastern boundary are incomplete (Belikov *et al.* 1998, Mauritzen *et al.* 2002).

Habitat and foraging

During the last decades, the extent of ice in KS has diminished (Parkinson 2000). It has been predicted that this trend will continue in this century (Parkinson 2000). The effects of this trend on KS polar bears have not been documented. However, considering the effects of climate change on polar bears in other parts of the Arctic (*e.g.,* Western Hudson Bay), these environmental changes cause concern about how polar bears in KS may be negatively affected.

Harvest management

Reported harvest activities have been limited to defence kills and an unknown number of illegal kills; these are not thought to be having an impact on the size of the subpopulation.

Human-bear conflicts

The risk of human-bear conflicts in KS is comparatively high in the ten settlements situated on the coast and on islands.

Contaminants

Contaminant levels in rivers flowing into this area raise concerns about the possibility of environmental damage. Recent studies clearly show that polar bears from KS have some of the highest organochlorine pollution levels in the Arctic (Andersen *et al.* 2001, Lie *et al.* 2003).

Development

There are plans to start oil and gas production in the southern part of KS in near future. This potentially increases pollution of habitats and polar bears.

Protected areas

The following protected areas are situated in the range of the subpopulation: Gydanskiy State Nature Reserve (Federal), Great Arctic State Nature Reserve (Federal) and the Severozemel'skiy State Sanctuary (Federal).

Research and monitoring needs

KS is practically unstudied. The most urgent needs are for studies of seasonal distribution and movements, population structure and contaminant burden.

Lancaster Sound (LS)

Status and delineation

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 subpopulation is distinct from the adjoining Viscount Melville Sound, M'Clintock Channel, Gulf of Boothia, Baffin Bay and Norwegian Bay subpopulations (Taylor *et al.* 2001a). Survival rates of the pooled Norwegian Bay and LS populations were used in the PVA to minimize sampling errors; the subpopulation estimate of 2,541 ± 391 is based on an analysis of both historical and current mark-recapture data to 1997 (Taylor *et al.* 2008b). This estimate is considerably larger than a previous estimate of 1,675 that included Norwegian Bay (Stirling *et al.* 1984). Taylor *et al.* (2008b) estimated survival and recruitment parameters (Tables 3, 4) that suggest this subpopulation has a lower renewal rate than previously estimated.

Harvest management

A highly skewed harvest towards males exacerbates the risk of decline. The harvest sex ratio results from a high proportion of sport hunters seeking trophy animals. As a result of the recent listing of the polar bear as *threatened* under the US *Endangered Species Act* (*US ESA*) and subsequent ban on the import of polar bear trophies into the United States (effective December 2008), the highly skewed harvest towards males is expected to be reduced. Indeed in 2008/09, the harvest was 39% female.

Molnar *et al.* (2007) used polar bear capture data from LS to explore the potential of an Allee Effect as a result of sex-ratio and sex-selective harvesting.. The authors did not find a likelihood of an Allee Effect in LS polar bears; however, they outlined scenarios that could result in an increased chance of an Allee Effect. Two scenarios – an increased harvest and an increasing male biased sex ratio of the harvest – have occurred in the ten years since the period of dataset used by the authors. The possible effects of those changes have not been evaluated. McLoughlin *et al.* (2005) have also assessed the conservation risks of male-selective harvesting of polar bears.

Habitat and foraging

The central and western portion of the area occupied by LS is characterized by high biological productivity and high densities of ringed seals and 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 LS subpopulation are low. As break-up occurs, polar bears move west to summer on the multi-year pack ice of the Queen Elizabeth Islands.

Tourism

Sport hunting has been an important economic activity for hamlets in Nunavut that harvest from LS. It is expected that sport-hunt tourism will decline further with the 2008 ban on imports of hides into the USA. In 2007/08 and 2008/09, 23% and 9%, respectively, of the harvest was attributed to sport hunting, down from 40% in 2006/07. Overall harvest declined to 74 in 2007/08 from 94 in 2006/07, but back to 94 in 2008/09.

Human-bear conflicts

Defence kills represented 10% of the polar bear harvest in LS (11 of 85 in 2008/09). On average, defence kills are common in the communities that harvest from LS, most notably in Resolute Bay.

Laptev Sea (LP)

Status and delineation

The Laptev Sea subpopulation (LP) area includes the western half of the East Siberian Sea and most of the Laptev Sea, including the Novosibirsk and possibly Severnaya Zemlya islands (Belikov *et al.* 1998). The 1993 estimate of subpopulation size for LP (800 – 1,200) is based on aerial counts of dens on the Severnaya Zemlya in 1982 (Belikov and Randla 1987) and on anecdotal data collected in 1960–80s on the number of females coming to dens on Novosibirsk Islands and on the mainland coast (Kischinski 1969, Upenski 1989).

Habitat and foraging

The western and northern parts of the area occupied by LP have higher biological productivity elsewhere in the region. Consequently it is assumed that densities of polar bears and ringed seals are distributed in correspondence with these biological productivity characteristics. In the western part of the subpopulation range, the ice massif (Taimyrskiy) remains even in late summer, which provides polar bears with platform for hunting. In the central and eastern parts of the range, sea ice retreats north of the continental shelf. Thus the Novosibirsk Islands Archipelago plays an important role as seasonal terrestrial habitat for polar bears.

Harvest management

Reported harvest activities in this subpopulation are limited to defence kills and an apparently small but unknown number of illegal kills. The current levels of harvest are not thought to be having a detrimental impact on the subpopulation.

Development

The main economic activity in the area of LP is the Northern Sea Route. However, the negative impact of this activity to polar bears is presumably low.

Protected areas

The protected areas in LP are: Taimyrskiy State Nature Biosphere Reserve (Federal); Ust-Lenskiy State Nature Biosphere Reserve (Federal); Severozemel'skiy State Sanctuary (Federal); and a number of wildlife refuges in Sakha (Yakutia) Republic (Regional).

Research and monitoring needs

LP is practically unstudied. The most urgent are studies of seasonal distribution and movements, population structure and contaminant burden.

M'Clintock Channel (MC)

Status and delineation

The current population boundaries for the M'Clintock Channel (MC) subpopulation 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.* 2001a). 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. An estimate of 900 bears was derived from a 6-year study in the mid 1970s within the boundaries proposed for the MC subpopulation, as part of a study conducted over a larger area of the central Arctic (Furnell and Schweinsburg 1984). Following the completion of a mark-recapture inventory in spring 2000, the subpopulation was estimated to number 284 ± 59.3 (Taylor *et al.* 2006a). Natural survival and recruitment rates (Tables 3,4) were estimated at values lower than previous standardized estimates (Taylor *et al.* 1987).

Traditional ecological knowledge

Hunters in Taloyoak and Gjoa Haven (HTO's, personal communications, 2009) have observed increasing numbers of bears in their hunting areas.

Harvest management

The GN implemented a moratorium on hunting for the 2001/02 and 2002/03 hunting seasons. The current annual quota for MC is 3 bears.

Research and monitoring needs

Local villages in MC have requested an updated population inventory, based on TEK of increasing population numbers.

Northern Beaufort Sea (NB)

Status and delineation

Studies of movements and abundance estimates of polar bears in the eastern Beaufort Sea have been conducted using telemetry and mark-recapture at intervals since the early 1970's (Stirling *et al.* 1975, Demaster *et al.* 1980, Stirling *et al.* 1988, 1997, Lunn *et al.* 1995). As a result, it was recognized that there were separate populations in the North and South Beaufort Sea areas (NB and SB) and not a single population as was suspected initially (Stirling *et al.* 1988, Amstrup *et al.* 1995, Taylor and Lee 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 subpopulation estimate of 1,200 (Stirling *et al.* 1988) for NB was believed to be relatively unbiased at the time but the northwestern coast of Banks Island was not completely surveyed in the 1980s because of perceived conflicts with guided sport hunters in the area. The northern region of the NB subpopulation was surveyed in 1990 – 92, but the densities encountered were low and the marked to unmarked ratio was the same as for the southern portion of the subpopulation. There was no indication that the subpopulation estimate of 1,200 should be increased. A recently completed mark-recapture survey suggested that the size of the NB subpopulation has remained stable at approximately 1,200 bears, probably because ice conditions have remained stable and the harvest has been maintained at sustainable levels (Stirling *et al.* 2007). Although there are fluctuations in the amount of ice remaining in NB by late summer, to date there is no significant trend though it appears the total area of sea ice may be beginning to show a decline Analyses using data from satellite tracking of female polar bears and spatial modeling techniques indicate the boundary between NB and SB may need to be adjusted, probably expanding the area occupied by bears from NB and retracting that of SB (Amstrup *et al.* 2004a, Amstrup *et al.* 2005). See summary of the southern Beaufort Sea subpopulation for more details regarding the NB-SB boundary.

Harvest management

Currently a combined (Nunavut and Northwest Territories) total allowable harvest is 65 bears per year, but the actual average harvest over the last five years is 29. In Nunavut (quota of 12/year), harvest has declined based on increasing difficulty of residents of Kugluktuk to reach areas where there are bears, because of changing ice conditions. Final results and management recommendations will be available when the population boundary with SB is re-evaluated.

Habitat and foraging

Aerial surveys of ringed seals and studies of ringed seal habitat and variation in reproductive productivity of ringed seals have been conducted (Smith and Stirling 1975, 1978, Stirling *et al.* 1982). The area is productive for seals, particularly in landfast areas and along the floe edge, both of which are preferred hunting areas for polar bears (Stirling *et al.* 1993). Besides ringed seals, bearded seals are important prey species in this area (Stirling and Archibald 1977, Thiemann *et al.* 2008).

Human-bear conflicts

Occasional bears have harassed hunters in their camps and villages but, in general, to date, this has not been a serious problem.

Protected areas

Some denning habitat is protected in Aulavik National Park on the northern coast of Banks Island, Northwest Territories.

Research and monitoring needs

A re-assessment of the population size should be conducted in 10-15 years because it is possible that if there is a significant decline in the amount of sea ice and development of a trend toward earlier breakup and later freeze-up there could be a negative effect on polar bears.

Norwegian Bay (NW)

Status and delineation

The Norwegian Bay (NW) subpopulation is bounded by heavy multi-year ice to the west, islands to the north, east, and west, and polynyas to the south (Stirling *et al.* 1993, Stirling 1997; Taylor *et al.* 2008b). From data collected during mark-recapture studies, and from satellite radio-tracking of adult female polar bears, it appears that most of the polar bears in this subpopulation are concentrated along the coastal tide cracks and ridges along the north, east, and southern boundaries (Taylor *et al.* 2001a). The current (1993 – 97) estimate is 203 ± 44 (SE; Taylor *et al.* 2008b). Survival rate estimates for the NW subpopulation were derived from pooled Lancaster Sound and NW data because the subpopulations are adjacent and the number of bears captured in NW was too small to generate reliable survival estimates.

Harvest management

The harvest quota for the NW subpopulation was reduced to 4 bears (3 males and 1 female) in 1996.

Habitat and foraging

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.

Southern Beaufort Sea (SB)

Status and delineation

Research on polar bears in the SB has been ongoing since 1967 (Amstrup *et al.* 1986, Stirling 2002). Radio-telemetry and mark-recapture studies through the 1980s indicated that polar bears in the region comprised a single subpopulation, with an eastern boundary between Paulatuk and Baillie Island, Northwest Territories, Canada, and a western boundary near Icy Cape, Alaska (Amstrup *et al.* 1986, Amstrup and DeMaster 1988, Stirling *et al.* 1988). Analyses of more recent satellite relocations using probabilistic models indicate that, rather than exhibiting distinct boundaries, there are areas of overlap between the SB and adjacent subpopulations (Amstrup *et al.* 2004b; Amstrup *et al.* 2005). At Barrow, Alaska, USA in the west, 50% of polar bears are from the SB subpopulation and 50% are from the Chukchi Sea (CS) subpopulation. At Tuktoyaktuk, Northwest Territories, Canada, in the east, 50% of polar bears are from the SB subpopulation and 50% are from the northern Beaufort Sea (NB) subpopulation. Based on this analysis, polar bears in the vicinity of the current eastern boundary near Pearce Point, Northwest Territories, are rarely members of the SB subpopulation. To address this issue, user groups, scientists and resource managers are discussing a western shift of the SB-NB boundary. One proposal has been to move it to 133° W longitude but a line further east is also under consideration. A decision on the potential boundary shift is expected in 2010, at which time the abundance and status of the SB and NB subpopulations will be re-evaluated. A similar boundary shift, or a change in the way harvest is allocated among subpopulations, may be required on the western side of the SB subpopulation where it borders the CS subpopulation (Amstrup *et al.* 2005). Sound management requires that current scientific information be used to define biologically relevant polar bear subpopulations. This presents an increasing challenge, as sea ice loss and increased variability in sea ice extent have the potential to affect polar bear movements and distribution, including the breakdown of historic subpopulation boundaries (Derocher *et al.* 2004).

The size of the SB subpopulation was first estimated to be approximately 1,800 animals in 1986 (Amstrup *et al.* 1986). Survival rates of adult females and dependent young were estimated from radio-telemetry data collected from the early 1980s to the mid-1990s (Amstrup and Durner 1995). Through the 1980s and early 1990s, observations suggested that the SB subpopulation was increasing. Amstrup *et al.* (2001) found that the SB subpopulation may have reached as many as 2,500 polar bears in the late 1990s. However, that estimate was not considered reliable due to methodological difficulties, and management decisions continued to be based on a population size of 1,800. Results from an intensive mark-recapture study conducted from 2001-2006 in both the USA and Canada indicated that the SB subpopulation included 1,526 (95% CI = 1,211 – 1,841) polar bears in 2006 (Regehr *et al.* 2006). This suggests that the size of the SB subpopulation declined between the late 1990s and 2006, although low precision in the previous estimate of 1,800 precluded a statistical determination. Subsequent analyses of the 2001-2006 data using multistate and demographic models indicated that the survival and breeding of polar bears during this period were affected by sea ice conditions, and that population growth rate was strongly negative in years with long ice-free seasons, such as 2005 when Arctic sea ice extent reached a record low (Hunter *et al.* 2007, Regehr *et al.* 2010). Thus, the SB subpopulation is currently considered to be declining due to sea ice loss. If the region continues to lose polar bear habitat as forecasted by global climate models (Durner *et al.* 2009), it is likely that the SB subpopulation will face extirpation in the next 100 years (Hunter *et al.* 2007).

Harvest management

Polar bears in the SB are harvested for subsistence in the US, and for both subsistence and sport in Canada. Recognition that the SB subpopulation is shared by the two countries prompted development of the "Polar Bear Management Agreement for the Southern Beaufort Sea" (Agreement) between the Inupiat hunters of Alaska, as represented by the North Slope Borough, and the Inuvialuit hunters of Canada, as represented by the Inuvialuit Game Council. The Agreement allows for the cooperative management of polar bear harvest. The

Agreement included provisions to protect polar bears in dens and females with cubs, and stated that the annual sustainable harvest would be shared between the US and Canada. Historically, harvest has been considered to be below sustainable levels based on the best scientific information available (Treseder and Carpenter 1989, Nageak *et al.* 1991). An evaluation of the Agreement after its first 10 years (Brower *et al.* 2002) concluded that it had been successful in ensuring that the total harvest, and the harvest of adult females, was within sustainable limits. The evaluation also noted that increased harvest monitoring and continued restraint in harvesting females were necessary to continue meeting the provisions of the Agreement.

Recent radio-telemetry data indicate that most polar bears near the current eastern and western subpopulation boundaries are actually members of adjacent subpopulations (Amstrup *et al.* 2005). Management initiatives to address this issue are being considered (see *Status and delineation* for details). More importantly, recent evidence suggests that the level of harvest in the SB may not be sustainable. The current harvest limit of 80 polar bears per year is based on two assumptions: (1) the subpopulation size is 1,800; and (2) the subpopulation is capable of positive growth, and is not being limited by environmental factors (Taylor *et al.* 1987). These assumptions may no longer be correct (Regehr *et al.* 2006, 2010, Hunter *et al.* 2007, Rode *et al.* 2007, 2010).

Habitat and foraging

Polar bears in the SB strongly prefer sea ice situated over shallow waters of the continental shelf (Durner *et al.* 2009), where they prey primarily on ringed and bearded seals (Stirling and Archibald 1977, Bentzen *et al.* 2007) in the landfast ice and along the floe edge and adjacent pack ice (Stirling *et al.* 1993). Stirling (2002) provides an overview of population ecology of polar bears and seals in the Canadian sector of the SB from 1970 – 2000. As sea ice melts each summer, most polar bears in this region remain on the pack ice as it retreats from the coast toward the center of the polar basin, although at least 4 – 8% of the population has remained on land in recent years (Schliebe *et al.* 2008). Whether polar bears are on sea ice beyond the continental shelf or on land, they cannot hunt in their preferred habitat. Recent sea ice loss over the continental shelf has been associated with declining survival and breeding for the SB subpopulation (Regehr *et al.* 2010). Additional evidence suggests that polar bears in the region are under increasing nutritional stress. From 1982-2006, body size and body condition for most sex and age classes were positively correlated with the availability of sea ice habitat, and exhibited a statistically significant decline during this period. Cub litter mass and the number of yearlings per female also declined following years with lower availability of sea ice habitat (Rode *et al.* 2010). Using serum biomarkers, Cherry *et al.* (2009) found that a higher proportion of polar bears were fasting in the springs of 2005 and 2006 (21.4% and 29.3%), years following large sea ice retreats, compared to 1985-1986 (9.6% and 10.5%). Recent sea ice loss has also been associated with an unusual number of reports of inefficient foraging behaviors by polar bears (Stirling *et al.* 2008b), observations of cannibalism (Amstrup *et al.* 2006) and observations of polar bears that had apparently starved to death (Regehr *et al.* 2006). The abrupt retreat of sea ice from the coast, combined with stormy weather, has resulted in polar bear drownings (Monnett *et al.* 2006). Extensive open water and increased ice roughness, caused by the action of winter storms on thinner ice, may reduce foraging success (Stirling *et al.* 2008), increase the energetic costs of locomotion (Derocher *et al.* 2004), and increase the risk of injury or death for cubs. Less stable sea ice also has apparently led to more females denning on land (Fischbach *et al.* 2007). Using sea ice forecasts from climate models, Durner *et al.* (2009) predict that the SB region will lose 5.2% per decade of optimal polar bear habitat from 2001-2099. Hunter *et al.* (2007) indicated that the SB subpopulation will likely face severe declines in the next 100 years if sea ice loss continues as forecasted (Hunter *et al.* 2007). This prediction is consistent with worldwide forecasts for polar bears, which suggest that the SB and other subpopulations in ecologically similar regions may be extirpated by the mid-21st century as the result of sea ice loss (Amstrup *et al.* 2008).

Traditional ecological knowledge

In both Canada and the USA, research and management agencies exchange information on the SB subpopulation with aboriginal residents and others working in polar bear country through collaborative studies, meetings with local administrators and resource managers, and village visits. TEK on polar bear habitat use as well as the cultural significance of polar bears to Alaska Natives has been documented (Kalxdorff 1998, Russell *et al.* 2005). In Canada, recent work by Environment Canada has focused on incorporating TEK into a program to identify and protect polar bear maternity denning areas and denning habitat in the coastal region of the Mackenzie Delta and adjacent offshore islands (E. Richardson, unpublished data).

Human-bear conflicts

The potential for increased polar bear-human conflicts is a central conservation concern for the SB subpopulation. In the mid-1970s, during a period of low productivity of ringed seals, starving subadult polar bears killed two industrial workers and ate them during winter. Sea ice loss has been associated with nutritional stress in SB polar bears (Rode *et al.* 2010). Additionally, longer ice-retreat seasons cause polar bears to spend more time on shore where they can encounter humans (Schliebe *et al.* 2008). To address these challenges, the US and Norway are developing a database that can be used by all polar bear range states to document and analyze polar bear-human interactions, with the goal of reducing human-polar bear conflicts. In Alaska, the USFWS and USGS are involved in a variety of activities to minimize and mitigate human-polar bear conflicts around industrial operations (see *Development*) and communities. The feeding ecology and behavior of polar bears congregated at the carcasses of subsistence harvested bowhead whales (*Balaena mysticetus*) at Barter Island (*i.e.,* the village of Kaktovik, Alaska, USA) have been monitored since 2002 (Miller *et al.* 2006). Aerial surveys have been flown along the north coast of Alaska since 2001, to evaluate the abundance, distribution, and movements of polar bears onshore during the ice retreat season. Data from 2001−2005 (Schliebe *et al.* 2008) indicated: (1) on average, 3.7 ± 1.8% of the estimated 1,526 polar bears in the SB population were observed on shore in the fall; (2) sea ice conditions affected the number of bears on land and the duration of time they spent there; and (3) both the availability of subsistence-harvested bowhead whales as well as ringed seal density affected the spatial distribution of bears on shore. Starting in 2008, the USFWS has been assisting the Native Village of Kaktovik to develop a bear-human management plan which involves forming a local Bear Committee to address issues such as how to minimize attractants, organize polar bear patrols, address polar bear viewing, and identify education and outreach needs. Additionally, in November 2009, USFWS will help host an international workshop in Canmore, Alberta, to address bear-human conflicts.

Contaminants

In the USA, tissue samples for contaminant analysis and other studies are collected through ongoing research and the Polar Bear Bio-Monitoring Program, and stored through the Alaska Marine Mammal Tissue Archival Project (AMMTAP). Baseline information, including spatial and temporal, have been collected on essential and non-essential elements, chlorinated pesticides, PCBs, PBDEs, and PFOS (Woshner *et al.* 2001, Evans 2004ab, Kannan *et al.* 2005, 2007, Smithwick *et al.* 2006, Verreault *et al.* 2005, Muir *et al.* 2006). Concentrations of most contaminants are lower in the SB compared to other polar bear subpopulations, with the exception of β-HCH. Recent studies indicate that polychlorinated biphenyls have generally declined in SB polar bears (Kannan *et al.* 2005, 2007) and that organohalogen concentrations are lower than reported for other subpopulations (Bentzen *et al.* 2008a). Variation in diet and biomagnification of organochlorines among SB polar bears appears related to their sex, age, and trophic position (Bentzen *et al.* 2007, Bentzen *et al.* 2008b).

Development

The developed area of the North Slope oil fields is located on the central Beaufort Sea coast in Alaska, USA. It comprises the largest oil producing area in North America with a recent production of approximately 500,000 barrels per day and a total reserve of approximately 25 billion barrels. Over a dozen oil companies and numerous support companies are active in the region, and encounters with polar bears are not uncommon. For example, in 2008, ten oil companies observed 313 polar bears from 186 sightings. The highest numbers of bears were generally observed during the ice-free months of August and September (C. Perham, USFWS, unpublished data). Offshore production, the major concern regarding polar bears, is currently limited to the Endicott, Northstar, and Oooguruk facilities. Two more facilities, Liberty and Nikaitchuq, are scheduled to come online by 2011 (AOGA 2009). Current and anticipated Outer Continental Shelf lease sales make continued offshore development likely through the mid-21st century (http://www.mms.gov/alaska/). Recent studies to evaluate and mitigate potential impacts of oil and gas activities on polar bears include hypothetical oil spill assessments (Amstrup *et al.* 2006), mapping maternal denning habitat in areas likely to experience hydrocarbon development (Durner *et al.* 2006), the development of methods to detect maternal dens, using tools such as Forward Looking Infrared (FLIR; Amstrup *et al.* 2004b) imagery and scent-trained dogs (Shideler and Perham 2008, 2009), and evaluations of post-den emergence behavior and sensitivity to disturbance (Smith *et al.* 2007).

To minimize the disturbance of polar bears by industrial activities, the USFWS manages the Incidental and Intentional Take Program (see details in *Management in USA,* this volume). The USFWS has issued intentional take authorizations have been issued to the oil and gas industry, the mining industry, local North Slope communities, scientific researchers, and the military. From 2005 to 2008, 45 intentional take authorizations were issued. Furthermore, amendments to the MMPA provided authority for the USFWS to issue guidelines to the public for the deterrence of marine mammals, provided that deterrence activities do not result in serious injury or death to the animal. The USFWS will publish such guidelines for the polar bear in 2010.

In the Canadian Beaufort Sea, there has been considerable interest since the mid-1970s, in off-shore drilling and production of hydrocarbons. A small number of exploratory wells were drilled but to date, there has been no production from offshore areas. This interest continues and, most recently, approval was given for construction of a pipeline to take natural gas from the Mackenzie Delta and offshore to southern Canada and the US. In 2004, Imperial Oil submitted an Environmental Impact Statement (EIS) for the Mackenzie Gas Project (MGP) in Canada, including: the development of three anchor fields in the Mackenzie Delta, construction of gathering and processing facilities, and a 1200 km natural gas pipeline to Alberta. Two of the three proposed gas fields are located in the Mackenzie Delta where female polar bears from the SB subpopulation establish maternity den sites to give birth to and nurture their young. In 2007, Environment Canada initiated a three year study to investigate the potential impacts of the MGP on polar bear denning habitat, with an emphasis on identification and protection of important denning areas in the Mackenzie Delta and SB. In addition to the MGP, a number of offshore exploration licenses have been issued in the Canadian sector of the SB. Drilling of offshore exploration wells will likely to occur in the next 5-10 years. Assessing the potential impacts of near-shore and offshore development in both the US and Canada is essential for the conservation of the SB subpopulation.

Tourism

Interest in polar bear viewing is increasing in Alaska, particularly within the federally managed Arctic National Wildlife Refuge, as well as on non-federal lands near the Native communities of Barrow and Kaktovik. To date, polar bear-related tourism has been occurring at a relatively low level with little federal oversight or consistency among guiding companies. In 2009, USFWS started developing guidelines for refuge lands and waters for commercial polar bear viewing, which will be implemented through the refuge permit process in 2010. Additionally, USFWS has been working with local communities, air taxi operators, and guiding companies to develop similar community-based viewing guidelines for non-federal lands to ensure that activities remain both legal (*e.g.,* no disturbance to bears) and safe for residents, visitors, and polar bears. There has been no significant development of tourism in polar bear habitat in the Canadian Southern Beaufort Sea.

Protected areas

In the Canadian portion of the SB, polar bears make seasonal use of Ivvavik National Park and Herschel Island Territorial Park, primarily for maternity denning. Polar bears denning in these areas are protected from development.

Research and monitoring needs

Current and future studies aim to quantify polar bear movements and distribution, habitat use, feeding ecology, demography, health, and the impacts of climatic change. Springtime mark-recapture efforts by the USGS provide the central data for these investigations and are scheduled to continue. Updated analyses of current and historic data are in preparation to better understand the demographic effects of climatic variability. In coming years, there will be an increasing focus on the ecological mechanisms linking polar bears to sea ice and other species at lower trophic levels. Understanding these mechanisms is important to reducing the uncertainty in forecasting models for the SB and neighbouring subpopulations. The USGS, in collaboration with the University of Wyoming and the USFWS, conducted onshore capture studies in 2008 and 2009 to investigate how polar bears cope with longer ice-retreat seasons and to evaluate the relative benefits of onshore vs. on-ice summering strategies. USGS will continue to study the demographic and ecological patterns of land use of polar bears on-shore until 2015. Concurrently, the USFWS is conducting mark-resight studies to evaluate the abundance, demography, and movements of polar bears onshore. Captive feeding trials are underway to improve estimates of stable isotope fractionation values and fatty acid coefficients required for dietary analyses. Finally, new research methods are being developed to minimize disturbance to polar bears and maximize the amount of information obtained. For example, during onshore studies in 2009, glue-on and ear-mounted satellite telemetry tags were used to track polar bears instead of the traditional radio-collars.

Southern Hudson Bay (SH)

Status and delineation

Boundaries of the Southern Hudson Bay (SH) polar bear subpopulation are based on observed movements of marked bears and telemetry studies (Jonkel *et al.* 1976, Kolenosky and Prevett 1983, Kolenosky *et al.* 1992, Taylor and Lee 1995). The initial estimate of population numbers came 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 some intermixing with the Western Hudson Bay and Foxe Basin subpopulations during winter months. In 1988, a population-modeling workshop suggested an increase in the calculated subpopulation estimate from 900 to 1,000 bears because portions of the eastern and western coastal areas were not included in the area during original sampling. Additionally, the area away from the coast may have been under-sampled due to difficulties in locating polar bears inland (*i.e.,* below tree line). Thus, some classes of bears, especially pregnant females, were believed to be under-sampled. A new analysis of the 1984-1986 capture data produced an estimate for the study area of 634 (390 – 878 95% CI) and for 2003 – 2005, 673 (396 – 950, 95% CI) (Obbard *et al.* 2007). An additional analysis (M_h Chao implementation of a closed mark-recapture model) of bears in the Akimiski Island area, which is currently included in the geographic designation of the SH, resulted in 70 – 110 additional polar bears. In addition, there are some areas where bears are unsafe to capture. As a result, the abundance estimate for the area currently defined SH subpopulation is approximately 900.

Traditional ecological knowledge

McDonald *et al.* (1997) reviewed TEK, held by both Inuit and Cree, of polar bears in the southern Hudson Bay ecosystem.

Habitat and foraging

Recent analysis of coastal survey data (Stirling *et al.* 2004) suggests that polar bear numbers in SH have remained unchanged in recent years, which is consistent with the subpopulation estimates reported above. However, in western Hudson Bay, Stirling *et al.* (1999) suggest that climate change reductions to sea ice appear to have resulted in declines in body condition, and have been shown to reduce the demographic performance of the that subpopulation (Regehr *et al.* 2007). A similar pattern of decline in body condition was documented for the SH subpopulation between 1984-86 and 2000-04 (Obbard *et al.* 2006). Polar bears in SH use palsas for denning (M. Obbard, unpublished data); these palsas are collapsing due to increasing air and soil temperatures. It is unknown how collapse of these dens will change polar bear denning behaviour in SH.

Harvest management

Aboriginal (Cree First Nations) polar bear harvest in Ontario is monitored annually by the Ontario Ministry of Natural Resources. Inuit harvest from the Belcher Islands is monitored annually by Nunavut Department of Environment. There is no sport harvest in SH.

Tourism

There are small-scale tourist operations in Ontario, but none are likely to pose a threat to polar bears.

Protected areas

About one-third of maternity dens in the SH subpopulation occur in Polar Bear Provincial Park in Ontario, as does 70% of summer refuge coastal habitat (Obbard and Walton 2004).

Research and monitoring needs

As SH is the most southerly polar bear subpopulation in the world and the neighbouring subpopulation of Western Hudson Bay has experienced demographic declines, it is important to continue to monitor the health of individual bears and the entire subpopulation of SH.

Viscount Melville Sound (VM)

Status and delineation

A five-year study of movements and subpopulation size, using telemetry and mark-recapture, was completed for polar bears inhabiting Viscount Melville (VM) in 1992 (Messier *et al.* 1992, 1994, Taylor *et al.* 2002). Population boundaries were based on 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.* 2001a). The current subpopulation estimate of 215 ± 58 (1996) was based on simulations from parameters measured in 1993 (Taylor *et al.* 2002).

Habitat and foraging

VM area is characterized by heavy multi-year ice and low densities of ringed and bearded seals (Kingsley *et al.* 1985).

Harvest management

Based on the population inventory completed in 1992, management for recovery of the population began. A five-year moratorium on hunting began in 1994/95. Hunting resumed in 1999/00 with an annual quota of 4 bears. In 2004/05 the annual quota was again increased to 7 bears (4 bears in NWT, and 3 in Nunavut), which is believed to be significantly less than the sustainable removal rate. However, this rate is based on biological parameters that are now 17 years old.

Research and monitoring needs

A new population inventory is needed to evaluate the status of VM.

Western Hudson Bay (WH)

Status and delineation

The distribution, abundance, and population boundaries of the Western Hudson Bay (WH) subpopulation have been the subject of research programs since the late 1960s (Stirling *et al.* 1977, 1999, Derocher *et al.* 1993, 1997, Derocher and Stirling 1995, Taylor and Lee 1995, Lunn *et al.* 1997, Regehr *et al.* 2007). At times, over 80% of the adult population has been marked, and there are extensive records from mark-recapture studies and the return of tags from bears killed by Inuit hunters. This subpopulation appears to be geographically segregated from southern Hudson Bay to the southeast and Foxe Basin to the north during the open-water season, although it mixes with both subpopulations on the Hudson Bay sea ice during the winter and spring (Stirling *et al.* 1977, Derocher and Stirling 1990, Stirling and Derocher1993, Taylor and Lee 1995).

Between 1987 and 2004, WH declined from 1194 (95% CI = 1020, 1368) in 1987 to 935 (95% CI = 794, 1076) in 2004, a reduction of about 22% (Regehr *et al.* 2007). In particular, the survival of cubs, sub-adults, and old bears were negatively correlated with the date of breakup, *i.e.,* the earlier the breakup, the poorer the survival and conversely. Before 1998 the subpopulation had apparently remained stable (Stirling *et al.* 1999), indicating that, prior to the onset of a decline brought about by the negative effects of climate warming, the annual harvest of approximately 50 bears had been sustainable.

Traditional ecological knowledge

As a consequence of the pattern of sea ice breakup through late spring and summer, the great majority of bears of the WH subpopulation first come ashore in Manitoba where, to date, the assessment of population size, reproduction, and condition have been carried out (Stirling *et al.* 1999, Regehr *et al.* 2007). Their arrival in substantial numbers farther north in Arviat and beyond is reported to not begin until early to mid-October, peaking in November and early December. However, in response to observations by Inuit hunters of considerable numbers of bears occurring north of the WH study area (Tyrell 2007), in the fall of 2007 the Government of Nunavut, Canada conducted a capture operation to determine the proportion of bears marked in this region to ascertain the validity of TEK regarding the number of (unmarked) bears on the Kivalliq coast. Polar bears were captured from Chesterfield Inlet, Nunavut to the Seal River, Nunavut (Peacock and Taylor 2007), a region north of the typical study area for WH (Regehr *et al.* 2007). During this survey, it was determined that bears north of the Seal River, Manitoba, were marked in approximately the same proportion as those in the traditional study area. Though only 25 polar bears were seen and captured, the proportion marked was lower (0.50), but not significantly, than that in the traditional study area (0.59) and the proportion marked in the harvest on the Kivalliq coast (0.48) is also lower than the proportion marked in the study area (0.59), and lower than the figure reported in Regehr *et al.* (0.55; 2007).

Peacock and Taylor (2007) supported the conclusions of the long-term study (Regehr *et al.* 2007); this capture survey did not support the suggestions of large numbers of bears occurring north of the traditional WH study area that were unavailable for capture by the long-term research program. However, because of the trend in the proportion of tagged bears in the Nunavut capture and harvest samples and because a northward, distributional shift of bears in western Hudson Bay (Towns 2009) may result in more bears occurring in the Kivalliq region in the fall, future studies to estimate the size of the WH subpopulation should expand into Nunavut. McDonald *et al.* (1997) reviewed traditional Cree and Inuit knowledge of polar bears in Hudson Bay.

Contaminants

McKinney *et al.* (2009) documented increasing contaminant burdens in WH polar bears that may have been a consequence of dietary shifts resulting from climate induced change in sea ice. A collaborative study of the impacts of organochlorines (OC) on the immune system of polar bears in WH and Svalbard demonstrated that OC exposure significantly influences specific lymphocyte proliferation responses and part of the cell-mediated immunity, which also is associated with impaired ability to produce antibodies (Lie *et al.* 2004, 2005). Fat samples have been collected from polar bears in WH for many years as part of several global studies (*e.g.,* Norstrom 2004).

Protected areas

Most of the maternal denning area of WH polar bears is protected within Wapusk National Park. The Churchill and Cape Tatnam Wildlife Management Areas (WMA) provide additional protection outside of the National Park. On 7 February 2008, polar bears in Manitoba were recognized as Threatened under the Manitoba

Endangered Species Act based on the impacts of climate change. Declaring the polar bear a threatened species will further ensure its protection, along with its habitat on both Crown and privately-owned land. The listing provides the ability to restrict development near critical habitat along the Hudson Bay coastline in Manitoba.

Harvest management

Once the WH subpopulation began to decline, the harvest was no longer sustainable but remained unchanged. Thus, its additive contribution to the reduction in total subpopulation size probably accelerated the decline between 1988 and 2004. In 2005, harvest in Nunavut was increased from 47 to 56 bears per year based on local hunters seeing more bears. Nunavut reduced the harvest to 36 in 2007 and to 8 in 2008. In 1954, legislation was passed that prohibited non-aboriginals from hunting polar bears or for anyone to trade or barter in hides from bears in Manitoba.

Human-bear conflicts

In 2008/09, 100% of the harvest in Nunavut was comprised of polar bears killed in defence of life and property. In Churchill, Manitoba, the Polar Bear Alert Program actively deters and relocates bears from the town site. In Manitoba, in 2008/09, two polar bears were removed during deterrent activities. The tourism and bear-viewing industry is heavily regulated, though some citizens have been charged with feeding polar bears where dog sled teams are located. Local residents in Nunavut claim that this activity food-conditions polar bears, which move northward into Nunavut in advance of freeze-up, increasing human-bear conflicts in Nunavut villages. This interpretation has not been confirmed through research and it is likely that bears entering villages in Nunavut are attracted by smells of potential food there. A wildlife deterrent specialist was hired by the Government of Nunavut in 2008, to begin to address issues surrounding polar bear-human interactions in Nunavut.

Tourism

The tourism and bear-viewing industry in Manitoba is regulated. The Government of Manitoba implemented a permit system for all commercial tourism operations within the Churchill WMA (Calvert *et al.* 1991, 1995). This permit system: (1) requires tour operators to keep their vehicles on designated routes; (2) restricts access to prime polar bear staging areas; (3) prohibits tour operators from placing food for feeding or holding polar bears; and (4) allows for limited, temporary overnight facilities at designated locations for extended tours (Calvert *et al.* 1995). Beginning in 2008, all tourism flights into the core maternity denning area of the Churchill WMA were discontinued. Any flight to a den site must now be to a specific, pre-selected, abandoned den that is not within the Churchill WMA. Several researchers have discussed whether the tourist industry has negative impacts on polar bears (Dyck and Baydack 2004, Eckhardt 2005, Dyck *et al.* 2007); however, these suggestions have not been supported by more recent studies (Stirling *et al.* 2008).

Habitat and foraging

Over the past three 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 (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 three weeks (Stirling *et al.* 1999, 2004). From 1971–2001, warming in western Hudson Bay has ranged from 0.5° C/decade at Churchill, Manitoba to 0.8° C/decade at Chesterfield Inlet, Nunavut (Gagnon and Gough 2005). 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. Regehr *et al.* (2007) documented significant negative effects of the earlier break-up of sea ice on the survival and size of WH.

Research and monitoring needs

Continued monitoring of population size, survival of bears of different age classes, reproduction, and body condition have been ongoing in Western Hudson Bay since the early 1980s, with the result that data from this subpopulation provide the best indications of how polar bears respond to the negative effects of climate warming. On a global scale, climate warming has reduced the total extent of arctic sea ice by about 15% over the past 20 years. As the arctic climate continues to warm, increasing amounts of open water in winter will stimulate change in the distribution and relative abundance of arctic seals and the diet of polar bears, some of which is becoming apparent now. If the current pattern of warming continues, significant effects on local populations of polar bears and seals will probably be apparent within the next few decades. There are few studies that clearly demonstrate some of the effects of long-term climatic warming on sea ice and any arctic mammals such as polar bears. Thus, it is important to maintain the monitoring of the WH subpopulation because it continues to indicate potential problems that may require adaptive management solutions in other areas in the future.

Range-wide threats and uncertainties

Anthropogenic and natural changes in arctic environments, as well as recognition of the shortcomings of our knowledge of polar bear ecology, are increasing the uncertainties of polar bear conservation and management. Higher temperatures and erratic weather fluctuations, symptoms of climate change, are increasing across the range of polar bears. Following the predictions of climate models, such changes have been most prevalent in the Arctic and have already altered local and global sea-ice (Gough *et al.* 2004, Serreze and Rigor 2006, Parkinson and Cavalieri 2008). Because changes in sea-ice are known to alter polar bear numbers, productivity, condition and distribution (Stirling *et al.* 1999, Fischbach *et al.* 2007, Schleibe *et al.* 2008, Durner *et al.* 2009, Regehr *et al.* 2010, Rode *et al.* 2010), effects of climate change can only increase future uncertainty and may increase risks to the welfare of polar bear subpopulations (Stirling and Parkinson 2006). Population and habitat modeling have predicted substantial declines in the distribution and abundance of polar bears in the future (Hunter *et al.* 2007, Durner *et al.* 2009, Amstrup *et al.* 2008). Uncertainty about effects of climate change on polar bears must be included in future management and conservation plans. Our status report currently indicates that two subpopulations (WH and SB) have likely declined due to climate change. It is thought that there may also be some impacts of climate change in other populations (CS, SH), however data are not conclusive or available.

Persistent organic pollutants, which reach Arctic regions via air and water currents, also increase uncertainty for the welfare of polar bears. Recent studies have documented new pollutants in polar bear tissues (Verreault *et al.* 2005, 2006, Muir *et al.* 2006, Smithwick *et al.* 2006, McKinney *et al.* 2009). The effects of pollutants on polar bears are only partially understood. Levels of such pollutants in some polar bear subpopulations, 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, 2001, Henriksen *et al.* 2001). Population level impacts on polar bears are unknown, at present, but reproductive and survival rates may be affected (Derocher *et al.* 2003, Derocher 2005).

An additional emerging threat to polar bears is the increase in development in the Arctic along with increased ice-breaking and shipping. There are currently no data on the effects of ice-breaking on polar bear habitat use and habitat selection. Some information regarding the effects of disturbance and development on polar bear denning exist (Lunn *et al.* 2004, Durner *et al.* 2006), but in general our knowledge about potential effects of large scale development is lacking. While there have been small scale studies on polar bear denning habitat (Kolenosky and Prevett 1983, Messier *et al.* 1994, Lunn *et al.* 2004, Richardson *et al.* 2005, Durner *et al.* 2006), large scale mapping of polar bear denning habitat across the Arctic has not occurred. It is also unknown how climate change will change denning locations and habitats, but, for example, increases of rain events will certainly be detrimental for denning polar bears (Stirling and Derocher 1993, Derocher *et al.* 2004)

Our understanding of polar bear population dynamics has greatly improved with increasing development of analytical methods (*e.g.,* Taylor *et al.* 1987, 2002, 2005, 2006ab, 2008ab, 2009, Amstrup *et al.* 2001, McDonald and Amstrup 2001, Regehr *et al.* 2007, 2009, Aars *et al.* 2009). These new tools suggest that previous estimates of population parameters and numbers can be biased. Vital rates are population specific, and different from the generalized rates that were often used to generate previous status reports (Taylor *et al.* 1987). The status report identified two subpopulations (KB, BB) that are likely declining due to over-hunting. Another two subpopulations (LS, NW) have likely short-term reductions due to sex-selective harvesting. For the two subpopulations (SB, WH) that are being impacted by climate change, harvest represents an additive impact. Although there are no demographic data, it is believed that illegal harvest may be contributing to declining numbers in CS. Climate-induced habitat change and increasing human-bear interactions will also need to be incorporated into polar bear population projections (*e.g.,* Hunter *et al.* 2007) and polar bear harvest management in the future. In addition, harvest practices may have to be reconsidered given recent knowledge about long-term environmental trends and fluctuations that can affect sustainable removal rates.

In some jurisdictions of Canada, the governance system includes aboriginal co-management boards and aboriginal hunting organizations. Under some co-management systems, both local knowledge and science are to be considered equally in both management and research decisions. In recent years, there has been greater pressure on the development of alternative techniques because some of the current methods (*e.g.,* mark-recapture, collaring) are considered as being disrespectful or harmful to the animals. As a result population inventory and ecological studies have been delayed or not permitted; reduced monitoring will constrain governments' ability to assess sustainability of harvest.

Table 1. Status table of world polar bear subpopulations.

Subpopulation	Aerial Survey/M-R Analysis		Additional/Alternative Analysis				Historical annual removals (5 yr mean)	Potential maximum annual removals	Status	Current trend	Estimated risk of future decline (10 yrs)*	Comments
	Number (year of estimate)	±2 SE or 95% CI	Number (year of estimate)	±2 SE or min-max range	Simulation	TEK						
Arctic Basin	Unknown						N/A	0	Data deficient	Data deficient	Data deficient	Geographic catchall for bears in the region which do not belong to other subpopulations; the region is characterized by low density of bears and low productivity.
Baffin Bay	2074 (1998)	1544-2604	1546 (2004)	690-2402	X		212	176	Data deficient	Declining	Very high	Population estimate for 2004 is simulated from vital rates measured in 1997.[1] 100% of PVA runs resulted in population decline after 10 years. TEK suggests population is increasing. Both TEK and professionals have suggested immigration from LS. Quotas have decreased in Greenland (2006) and Increased in Nunavut (2005), decrease to start (2010).
Barents Sea	2650 (2004)	1900-3600					1	0	Data deficient	Data deficient	Data deficient	Population estimate is based on a new aerial survey[2]. There was likely an increase in the subpopulation size after 1973 until recently. Current growth trend is unknown.

Table 1. Continued…

Subpopulation	Aerial Survey/M-R Analysis		Additional/Alternative Analysis				Historical annual removals (5 yr mean)	Potential maximum annual removals	Status	Current trend	Estimated risk of future decline (10 yrs)*	Comments
	Number (year of estimate)	±2 SE or 95% CI	Number (year of estimate)	±2 SE or min-max range	Simulation	TEK						
Chukchi Sea	Unknown						37 - plus unknown but substantial in Russia (100 – 200)	No quotas	Reduced	Declining	Data deficient	Abundance estimates are not available. The trend is believed to be declining and the status relative to historical levels is believed to be reduced based on legal/illegal harvest levels that were thought to be unsustainable. Sea ice loss is one of the highest levels in the Arctic. Combined impacts of high levels of legal/illegal harvest with rapid sea ice loss suggest that the risk for depletion is likely high.
Davis Strait	2142 (2007)	1811-2534					60	66	Not reduced	Declining	Very high	New estimates of natural survival and current harvest suggest the population may begin to decline[3]. Scientific[4] and local knowledge[5] suggest the population has significantly increased in the past.
East Greenland	Unknown						58	54	Data deficient	Data deficient	Data deficient	No subpopulation inventories have been conducted. During the last decades the extent of sea ice has decreased[6]. This decline is likely to continue[7] resulting in continued habitat decline. Various studies indicate that these bears are negatively affected by relatively high body burden of organic pollutants[8]

Table 1. Continued…

Subpopulation	Aerial Survey/M-R Analysis		Additional/Alternative Analysis									
	Number (year of estimate)	±2 SE or 95% CI	Number (year of estimate)	±2 SE or min-max range	Simulation	TEK	Historical annual removals (5 yr mean)	Potential maximum annual removals	Status	Current trend	Estimated risk of future decline (10 yrs)*	Comments
Foxe Basin	2197 (1994)	1677-2717	2300 (2004)	1780-2820	X	X	101	108	Data deficient	Data deficient	Data deficient	Estimate based on mark-recovery with tetracycline biomarking and harvest.[9] There are no estimates of vital rates. Sustainability of harvest is unknown.
Gulf of Boothia	1592 (2000)	870-2314					60	74	Not reduced	Stable	Very low	11% of PVA simulations resulted in population decline after 10 years. Population has high vital rates and low harvest rates[10]
Kane Basin	164 (1994 - 1997)	94-234					11	13	Data deficient	Declining	Very high	100% of PVA runs resulted in decline after 10 years. Research data are 11 years old.[11]
Kara Sea	Unknown						N/A	0	Data deficient	Data deficient	Data deficient	No population surveys have been conducted.
Lancaster Sound	2541 (1998)	1759-3323					83	85	Data deficient	Declining	High	69% of PVA simulations resulted in subpopulation decline after 10 years. PVA estimate should be regarded as conservative due to unique male-bias in harvest. Demographic data are 11 years old.[12] Population has highly selective harvest for males; however it is likely that selective hunting will decline with less sport hunting.

Table 1. Continued…

Subpopulation	Aerial Survey/M-R Analysis		Additional/Alternative Analysis									
	Number (year of estimate)	±2 SE or 95% CI	Number (year of estimate)	±2 SE or min-max range	Simulation	TEK	Historical annual removals (5 yr mean)	Potential maximum annual removals	Status	Current trend	Estimated risk of future decline (10 yrs)*	Comments
Laptev Sea	800-1200 (1993)						N/A	0	Data deficient	Data deficient	Data deficient	Abundance based on using aerial counts of dens on the Severnaya Zemlya in 1982 and on anecdotal data collected in 1960-80s on the number of females coming to dens on Novosibirsk Islands and on mainland coast.[13] The estimate should be regarded as dated and preliminary.
M'Clintock Channel	284 (2000)	166-402					2	3	Reduced	Increasing	Very low	0% of PVA simulation runs resulted in subpopulation decline after 10 years. Population is managed for recovery; harvest is below sustainable rates.[14]
Northern Beaufort Sea	1202 (2006)	686-1718					29	65	Not reduced	Stable	Data deficient	Population estimate is from on-going analysis of a new mark-recapture inventory.[15] Boundary with SB is being re-considered, which will affect vital rates and population estimate.
Norwegian Bay	190 (1998)	102- 278					4	4	Data deficient	Declining	Very high	82% of PVA simulations resulted in population decline after 10 years; demographic data are 11 years old.[12] Projections of decline are high also because of low sample size.

Table 1. Continued…

Subpopulation	Aerial Survey/M-R Analysis		Additional/Alternative Analysis				Historical annual removals (5 yr mean)	Potential maximum annual removals	Status	Current trend	Estimated risk of future decline (10 yrs)*	Comments
	Number (year of estimate)	±2 SE or 95% CI	Number (year of estimate)	±2 SE or min-max range	Simulation	TEK						
Southern Beaufort Sea	1526 (2006)	1210-1842					44	80	Reduced	Declining	Moderate	Population estimate is from an analysis of mark-recapture data from 2001 - 2006.[16] Estimated risk of future decline is based on vital rates estimated from the 2001-2006 data[17] used in matrix-based demographic models that incorporate sea ice forecasts[18]. The SB-NB boundary is being re-considered, which may affect estimates of the size and status of both subpopulations.
Southern Hudson Bay	900 - 1000 (2005)	396-950 (ON) 70-110 (James Bay)					35	61	Not reduced	Stable	Very high	Population estimate of 681 is for the Ontario Coast and 110 for James Bay; the estimate uses professional judgment of abundance in unsurveyed areas.[19]
Viscount Melville	161 (1992)	121- 201	215 (1996)	99-331	X		5	7	Data deficient	Data deficient	Data deficient	Vital rates from mark-recapture research conducted at maximum depletion indicate relatively high productivity at low density.[20] The estimate for population size for management is the result of a simulation from 1992 estimate. Data are 17 years old. Discussions have been initiated for a population inventory.

Table 1. Continued…

Subpopulation	Aerial Survey/M-R Analysis		Additional/Alternative Analysis				Historical annual removals (5 yr mean)	Potential maximum annual removals	Status	Current trend	Estimated risk of future decline (10 yrs)*	Comments
	Number (year of estimate)	±2 SE or 95% CI	Number (year of estimate)	±2 SE or min-max range	Simulation	TEK						
Western Hudson Bay	935 (2004)	791-1079					44	16	Reduced	Declining	Very high	100% of PVA simulations resulted in subpopulation decline after 10 years. Subpopulation is declining without harvest.[21] Local people are seeing more polar bears and TEK suggests that there may have been a northward shift in distribution.

* Where PVA simulations have been conducted, risk of decline (of at least 10%):Very Low (0-20%), Lower (20-40%), Moderate (40-60%), Higher (60-80%), Very High (80-100%).[1]Taylor *et al.* 2005, [2]Aars *et al.* 2009, [3] Peacock 2009, [4]Stirling and Parkinson 2006, [5]Kotierk, unpublished data, [6]Parkinson 2000,[7]Rysgaard *et al.* 2003, [8]Born and Sonne 2006, [9]Taylor *et al.* 2006b, [10]Taylor *et al.* 2009b, [11]Taylor *et al.* 2008a, [12]Taylor *et al.* 2008b, [13]Belikov 1993, [14]Taylor *et al.* 2006a, [15]Stirling *et al.* 2007, [16]Regehr *et al.* 2006, [17]Regehr *et al.* 2010, [18]Hunter *et al.* 2007, [19]Obbard *et al.* 2007, [20]Taylor *et al.* 1992,[21] Regehr *et al.* 2007

Table 2. Mean (and standard error [SE]) of natural (*i.e.,* un-harvested) survival parameters used in the assessment of risk for subpopulations in Table 1 for which data are available, and best estimates of parameters of natural survival for populations modeled using quantitative viability analyses. It is to these rates that anticipated annual removal rate are added for simulation

Subpopulation	Male				Female			
	COY	1-4	5-20	>20	COY	1-4	5-20	>20
LS[1]	0.634 (0.123)	0.838 (0.075)	0.974 (0.030)	0.715 (0.095)	0.750 (0.104)	0.898 (0.050)	0.946 (0.018)	0.771 (0.054)
NW[1]	0.634 (0.123)	0.838 (0.075)	0.974 (0.030)	0.715 (0.095)	0.750 (0.104)	0.898 (0.050)	0.946 (0.018)	0.771 (0.054)
KB	0.345 (0.200)	0.663 (0.197)	0.997 (0.026)	0.997 (0.026)	0.410 (0.200)	0.756 (0.159)	0.997 (0.026)	0.997 (0.026)
BB	0.570 (0.094)	0.938 (0.045)	0.947 (0.022)	0.887 (0.060)	0.620 (0.095)	0.938 (0.042)	0.953 (0.020)	0.919 (0.050)
VM	0.448 (0.216)	0.924 (0.109)	0.924 (0.109)	0.924 (0.109)	0.693 (0.183)	0.957 (0.028)	0.957 (0.028)	0.957 (0.028)
GB	0.817 (0.201)	0.907 (0.084)	0.959 (0.039)	0.959 (0.039)	0.817 (0.201)	0.907 (0.084)	0.959 (0.039)	0.959 (0.039)
MC	0.619 (0.151)	0.983 (0.034)	0.921 (0.046)	0.921 (0.046)	0.619 (0.151)	0.983 (0.034)	0.977 (0.033)	0.977 (0.033)
SH[2]	0.492 (0.143)	0.812 (0.076)	0.811 (0.076)	0.293 (0.135)	0.645 (0.135)	0.893 (0.051)	0.892 (0.052)	0.44 (0.0148)
WH	0.500 (0.033)	0.870 (0.026)	0.940 (0.010)	0.780 (0.023)	0.610 (0.028)	0.920 (0.020)	0.940 (0.008)	0.810 (0.020)
DS[3]	0.842 (0.071)	0.875 (0.058)	0.913 (0.032)	0.801 (0.086)	0.842 (0.071)	0.886 (0.053)	0.928(0.030)	0.827(0.086)
SB[4]	0.335 (0.071)	0.900 (0.130)	0.961 (0.092)	0.961 (0.092)	0.335 (0.071)	0.934 (0.162)	0.965 (0.099)	0.965 (0.099)

[1] Survival estimates pooled for LS and NW (see text for LS and NW).
[2] Survival estimates are total apparent survival, not natural survival.
[3] Yearling rates are estimated separately from subadults, 0.905 (0.050) for both males and females.
[4]Natural survival rates were calculated from the time-invariant estimates of total survival in Regehr *et al.* (2009), using the harvest mortality correction from Regehr *et al.* (2007). Adult female survival is for females available to breed (stage 4). COY survival was calculated from estimates of cub litter survival using equations in Hunter et al. (2007). Standard errors were approximated from bootstrap confidence intervals. The subpopulation viability analysis in Table 1 used time-varying vital rates from Regehr et al. (2009) in matrix population models that incorporated sea ice forecasts (Hunter et al. 2007). Time-invariant vital rates are provided here for comparison with other subpopulations.

Table 3. Mean (standard error [SE]) of reproductive parameters (standing age capture data) used in the assessment of risk for subpopulations in Table 1. Blank cells indicate estimates from the population are currently unavailable. See text for year of studies.

Subpopulation	Cub litter size	4-yr-female litter prod'n rate	5-yr-female litter prod'n rate	6-yr-female litter prod'n rate	>6-yr-female litter prod'n rate	Proportion of male cubs
LS	1.688 (0.012)	0.000 (0)	0.107 (0.050)	0.312 (0.210)	0.954 (0.083)	0.531 (0.048)
NW	1.714 (0.081)	0.000 (0)	0.000 (0)	0.000 (0)	0.689 (0.534)	0.544 (0.066)
KB	1.667 (0.083)	0.000 (0)	0.000 (0)	0.357 (0.731)	0.478 (0.085)	0.426 (0.029)
BB	1.587 (0.073)	0.096 (0.120)	0.881 (0.398)	1.000 (0.167)	1.000 (0.167)	0.493 (0.029)
VM	1.640 (0.125)	0.000 (0)	0.623 (0.414)	0.872 (0.712)	0.872 (0.712)	0.535 (0.118)
GB	1.648 (0.098)	0.000 (0)	0.194 (0.178)	0467. (0.168)	0.965 (0.300)	0.46 (0.091)
MC	1.680 (0.147)	0.000 (0)	0.111 (0.101)	0.191 (0.289)	0.928 (0.334)	0.545 (0.057)
SH	1.575 (0.116)	0.087 (0.202)	0.966 (0.821)	0.967 (0.022)	0.967 (0.022)	0.467 (0.086)
WH	1.540 (0.110)	0.000 (0)	0.257 (0.442)	0.790 (0.180)	0.790 (0.180)	0.480 (0.110)
DS	1.49 (0.150)	0.000 (0)	0.580 (0.440)	0.180 (0.050)	0.420 (0.060)	0.536 (0.117)
SB[1]	1.724 (0.170)	0.000(0)	0.437 (0.060)	0.437 (0.060)	0.437 (0.060)	0.520 (0.040)
NB	1.756 (0.166)	0.118 (0.183)	0.283 (0.515)	0.883 (0.622)	0.883 (0.622)	0.502 (0.035)

[1]Cub litter size was calculated from Hunter et al. (2007). Litter production rate is the time-invariant estimate for females available to breed (stage 4) in Regehr et al. (2010). Standard errors were approximated from bootstrap confidence intervals. Proportion of male cubs is from Regehr et al. (2006).

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Resolutions

of the 15th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Copenhagen, 29 June–3 July 2009

1. Effects of global warming on polar bears

The IUCN Polar Bear Specialist Group

Recognising that sea ice is essential to the continued survival of polar bears; and

Recognising the 2007 conclusion of the Intergovernmental Panel on Climate Change (IPCC): "Climate change in polar regions is expected to be among the largest and most rapid of any regions on the Earth, and will cause major physical, ecological, sociological, and economic impacts especially in the Arctic."; and

Recognising that the IPCC has concluded with "very high confidence" that human produced green house gases are playing a significant forcing role in global warming; and

Recognising that, as a result of warming, the maximum ice cover of the Arctic Ocean has declined significantly over the past 30 years both spatially and temporally; and

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

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

Recommends that urgent global actions be taken to significantly reduce atmospheric greenhouse gas concentrations; and

Recommends that polar bear range state governments and designated authorities agree to consider the current and likely future impacts of global warming in all management and planning affecting polar bears and their key habitats.

2. Recommendations for renewed cooperative research in Baffin Bay

The IUCN Polar Bear Specialist Group

Recognising that the contracting parties shall manage polar bear populations in accordance with sound conservation practices based on the best available scientific data according to the Agreement on Conservation of Polar Bears Article II; and

Recognising that an agreement between Canada and Greenland outlining shared responsibility for sustainable harvest management is forthcoming; and

Recognising the right of local people using traditional methods to take polar bears according to the Agreement on Conservation of Polar Bears Article III; and

Recognising that scientific evidence indicates that the shared Baffin Bay polar bear population has been subject to long-term over-exploitation by Canada and Greenland; and

Recognising that scientific information and Inuit Knowledge are in apparent conflict; and

Recognising that significant reduction in the sea ice in Baffin Bay may have affected the distribution of polar bears; and

Recognising that the existing estimate for the Baffin Bay population from 1997 is outdated in light of the climate induced changes which in itself may negatively have affected the population; therefore

Recommends that a new assessment of the Baffin Bay population be conducted jointly by Canada and Greenland.

3. On the 2008 status report on polar bear by the Canadian Committee on the Status of Endangered Wildlife in Canada (COSEWIC)

The IUCN/SSC Polar Bear Specialist Group

Recognising that changes in sea ice distribution and duration due to global warming form the most significant threat to the future welfare of world-wide polar bear subpopulations; and

Recognising that Canada's 13 subpopulations of polar bears occur over broad geographic regions and that the rate, timing and magnitude of global warming in the Arctic will vary geographically and that the impacts on polar bear subpopulations will similarly vary; and

Recognising that the Canadian COSEWIC report treats all 13 Canadian subpopulations as a single designatable unit and notes that the current overall trend for polar bear subpopulations in Canada is a slow decline; and

Recognising that the Canadian COSEWIC report estimates current population growth rates for each subpopulation based on available historic data and does not account for the projected effects of future global warming on demographic rates; and

Noting that the 2008 COSEWIC report does not quantitatively evaluate the threat of global warming, especially predicted changes in sea ice, on polar bear subpopulations; and

Recognising that the world is currently in a period of rapid warming; and

Recognising that negative effects of global warming on several polar bear subpopulations have and are currently being documented; therefore

Recommends that due to the speed of current global warming the status of polar bears in Canada be re-assessed within 5 years of the last re-assessment rather than delaying to the normal 10-year cycle; and further

Recommends that the status of polar bears in Canada be re-assessed within the context of ongoing and projected habitat losses; and further

Recommends that geographic variation in anticipated effects of global warming and other potential population stressors be included when re-assessing the status of polar bears in Canada

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4. Need for polar bear monitoring and capture

The IUCN Polar Bear Specialist Group

Recognising that under the International Agreement on Conservation of Polar Bears the signatory parties have the responsibility to conduct research programs relating to the conservation and management of polar bears in their jurisdictions; and

Recognising that effective monitoring should occur because of the increasing uncertainties posed to polar bears by global warming; and

Recognising that capture and radio-collaring of polar bears has been critical to understanding polar bear biology; and

Recognising that scientists do use internationally-recognized best practices and strive to improve all research methods and develop less-invasive protocols; and

Recognising that, at present, monitoring vital rates requires the capture of polar bears; and

Recognising that conservation cannot be successful without good monitoring data; therefore

Recommends that the need to capture polar bears for monitoring and research projects in Nunavut be reviewed, and that where necessary, management authorities take actions necessary to allow that such vital monitoring can go forward.

5. On minimizing human-polar bear interactions

The IUCN Polar Bear Specialist Group

Recognising that interactions between polar bears and humans can result in loss of human life, disturbance and destruction of bears, and loss of property; and

Recognising that polar bear mortalities resulting from interactions with people can adversely affect bear population welfare and management strategies; and

Recognising that such interactions are increasing, and likely to continue increasing because of increased human activity and climate change induced changes in polar bear distribution; therefore

Recommends that all Signatory Nations to the Agreement on Conservation of Polar Bears should make immediate use of all available information, methods, and means, in order to minimize detrimental interactions between polar bears and humans and urges those nations to conduct cooperative investigations necessary to do so.

6. On the conservation of the Chukchi polar bear subpopulation

The IUCN Polar Bear Specialist Group

Recognising that the Chukchi Sea has experienced some of the highest rates of sea ice loss in the Arctic, and that sea ice loss is predicted to continue; and

Recognising that the Chukchi Sea polar bear subpopulation experiences a high level of illegal harvest in Russia; and

Recognising that the Chukchi Sea polar bear subpopulation is harvested at lower, but unregulated, levels in the US; and

Recognising that information is largely unavailable on population size and structure, distribution, habitat use, and survival and breeding rates; and

Recognising that a bilateral treaty between the US and Russia, implemented in 2007, mandates the conservation of the Chukchi Sea polar bear subpopulation for future generations; and

Recognising the importance of traditional knowledge and supporting the involvement of local communities in conservation efforts; therefore

Recommends that the US and Russia continue and expand independent and collaborative studies, including the involvement of local communities, to collect the scientific information necessary to ensure the conservation of the Chukchi Sea polar bear subpopulation; and

Recommends that effective conservation measures, including law enforcement to prevent illegal takes, be implemented immediately.

7. International study to understand the effects of climate change on pollution levels and the effects of pollution in polar bears

The IUCN Polar Bear Specialist Group

Recognising levels of mercury and perflourinated compounds in polar bears of some regions have significantly increased in recent years; and

Recognising that persistent organic pollutants are still present at levels in polar bears that can interfere with endocrine, immune and reproductive function; and

Recognising that the high pollutant levels in polar bears appears to result from long range atmospheric transport of pollutants from low latitude sources into the Arctic environment; and

Recognising that such transport mechanisms may be enhanced and effects on polar bears amplified as a result of climate change; and

Recognising that previous studies by researchers in Denmark and Norway have laid the groundwork for an understanding of the dynamic links between climate change and changing contaminant burdens; therefore

Recommends that Denmark and Norway build upon past work to lead a circumpolar study of the dynamic links between climate change, pollution levels, and the physiological effects of pollution in polar bears.

8. Recommendations for the collection of scientific samples from harvested polar bears

The IUCN Polar Bear Specialist Group

Recognising that the contracting parties of the International Agreement on the Conservation of Polar Bears shall manage polar bear populations in accordance with sound conservation practices based on the best available scientific data according to the Agreement on Conservation of Polar Bears Article II; and

Recognising that sound management of polar bear populations requires collection of biological samples that allow for determination of age and sex of the harvest, but that such samples are not currently being collected in all jurisdictions; therefore

Recommends that all jurisdictions implement a system for monitoring the polar bear harvest that ensures the collection of biological samples.

Press Release

15th Working Meeting of the IUCN/SSC Polar Bear Specialist Group

The 15th working meeting of the IUCN Polar Bear Specialist Group (PBSG), hosted by the Greenland Institute of Natural Resources, was held at the Greenland Representation in Copenhagen Denmark, 29 June–3 July 2009. The Polar Bear Specialist Group is composed of researchers and managers representing each of the five circumpolar nations that signed the International Agreement for the Conservation of Polar Bears of 1973. Since the late 1960s, the members of PBSG have met every 3 to 5 years under the umbrella of the Species Survival Commission of the IUCN (the International Union for the Conservation of Nature and Natural Resources) to review and exchange information, and make recommendations for research and management of polar bears throughout the Arctic.

The PBSG renewed the conclusion from previous meetings that the greatest challenge to conservation of polar bears is ecological change in the Arctic resulting from climatic warming. Declines in the extent of the sea ice have accelerated since the last meeting of the group in 2005, with unprecedented sea ice retreats in 2007 and 2008. The PBSG confirmed its earlier conclusion that unabated global warming will ultimately threaten polar bears everywhere.

The PBSG also recognized that threats to polar bears will occur at different rates and times across their range although warming-induced habitat degradation and loss are already negatively affecting polar bears in some parts of their range. Subpopulations of polar bears face different combinations of human threats. The PBSG recommends that jurisdictions take into account the variation in threats facing polar bears.

The PBSG noted polar bears suffer health effects from persistent pollutants. At the same time, climate change appears to be altering the pathways by which such pollutants enter ecosystems. The PBSG encourages international efforts to evaluate interactions between climate change and pollutants.

The PBSG endorses efforts to develop non-invasive means of population assessment, and continues to encourage jurisdictions to incorporate capture and radio tracking programs into their national monitoring efforts. The members also recognized that aboriginal people are both uniquely positioned to observe wildlife and changes in the environment, and their knowledge is essential for effective management.

The PBSG recognizes that where habitats are stable, polar bears are a renewable resource, and reaffirmed its support of the right of aboriginal groups to harvest polar bears within sustainable limits. The PBSG noted that the subpopulation of polar bears in Baffin Bay, shared between Greenland and Canada, may simultaneously be suffering from significant habitat change and substantial over harvest, while at the same time interpretations by scientists and local hunters disagree regarding population status. Similarly, the Chukchi Sea polar bear subpopulation which is shared by Russia and the United States is likely declining due to illegal harvest in Russia and one of the highest rates of sea ice loss in the Arctic. Consistent with its past efforts to coordinate research and management among jurisdictions, the PBSG recommended that the polar bear subpopulations in Baffin Bay and the Chukchi Sea be reassessed and that harvests be brought into balance with the current sustainable yield.

A variety of management changes have occurred since the PBSG last met in 2005. The PBSG members were particularly pleased that quotas for the harvest of polar bears in Greenland were implemented in January 2006, and that quota reductions have been implemented in some parts of Greenland. Also, since the last meeting, the government of Nunavut reduced the harvest quota in Western Hudson Bay because of the documented population decline.

The PBSG re-evaluated the status of the 19 recognized subpopulations of polar bears distributed over vast and relatively inaccessible areas of the Arctic. Despite the fact that much new information has been made available since the last meeting, knowledge of some subpopulations is still poor. Reviewing the latest information available, the PBSG concluded that one of 19 subpopulations is currently increasing, three are stable, and eight are declining. For the remaining seven subpopulations available data were insufficient to provide an assessment of current trend. The total number of polar bears is still thought to be between 20,000 and 25,000. However, the mixed quality of information on the different subpopulations means there is much room for error in establishing that range. That potential for error is cause for concern, given the ongoing and projected changes in habitats and other potential stressors. Nonetheless, the PBSG is optimistic that humans can mitigate the effects of global warming and other threats to polar bears, and ensure that they remain a part of the Arctic ecosystem in perpetuity.

Dr. Erik Born from the Greenland Institute of Natural Resources was elected as the new chair of the group after Dr. Andrew Derocher from the University of Alberta, who has been serving as chair since 2005.

Polar Bear Management in Canada, 2005–2008

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The management of polar bears in Canada is primarily the responsibility of the provincial and territorial jurisdictions in which they occur. In many jurisdictions, the decision-making process is shared with Aboriginal groups as part of the settlement of land claims. The federal Government of Canada provides national coordination and is the authority for international agreements (e.g., *Agreement on the Conservation of Polar Bears*, CITES), national legislation (e.g., *Species at Risk Act*, *Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act*), and the protection of natural heritage (e.g., National Parks, National Park Reserves).

This report summarizes the changes in the management of polar bears in Canada that have occurred since the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group (PBSG) in 2005. Changes made prior to 2005 are outlined in the Canadian management reports included in the proceedings of previous working meetings of the PBSG. A summary of the regulations covering polar bear management in Canada, as of 31 December 2008, is presented in Table 1.

National Oversight Committees

Given the shared responsibilities among jurisdictions, wildlife management boards, and Aboriginal groups, it is important that Canada has robust mechanisms to coordinate and ensure complementary actions while respecting each other's areas of responsibility as prescribed by legislation or agreements. Three national committees provide oversight of polar bear management in Canada.

Canadian Wildlife Directors' Committee (CWDC)

The CWDC is composed of the wildlife directors representing all 14 jurisdictions with responsibility for wildlife conservation in Canada. The role of the CWDC is to provide leadership in the development and coordination of policies, strategies, programs, and activities that address wildlife issues of national concern and contribute to the conservation of biodiversity, and to provide

Table 1. Summary of regulations covering polar bear management in Canada as of 31 December 2008.

Category	Jurisdiction						
	Manitoba	Newfoundland and Labrador	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	No closed season for aboriginal hunters	Closed	No sport hunting	1 Oct–31 May as currently identified in regulations
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	Treaty # 9 First Nations residing along the coast	Inuit and First Nations	Inuit only who are issued polar bear tags
Quota	None[1]	6	By settlement: 2008–09 quota is 103 (97 + 6 administered on behalf of the Yukon)	By settlement: 2008–09 quota is 456	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, unless permit issued	No	No[2]	Yes
Bears in dens protected by law	Yes	Yes	Yes, also protects bears constructing dens	Yes, also includes bears constructing dens	No	No[1]	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

Table 1. continued…

Category	Jurisdiction						
	Manitoba	Newfoundland and Labrador	Northwest Territories	Nunavut	Ontario	Québec	Yukon
Export permit required and cost (out of province or territory of origin)	Required; $20.00	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 from which specimen is exported						
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, Conservation Officers Services Branch
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 royalty of 2 years ago	Permit required from Conservation Officer
Basis of Regulation	The Wildlife Act; The Endangered Species Act; The Polar Bear Protection Act	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 2001; Wildlife Regulations

Table 1. continued…

	Jurisdiction						
Category	Manitoba	Newfoundland and Labrador	Northwest Territories	Nunavut	Ontario	Québec	Yukon
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	$40.00 licence	$390.57 Fur Dealer's 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	$34.31 Taxidermist's Licence	$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	$40.00 licence	$299.01 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 and NWT Wildlife Research permit (free)	$5.00 licence to capture live wildlife and Nunavut Wildlife Research Permit	District Manager	Ministerial permit	Free Wildlife Research Permit, $5.00 fee for capture of live wildlife
Live Animal Export	Ministerial permit	Ministerial permit	Licence to Export Live Wildlife, $3000.00/polar bear (live export not supported by Inuvialuit)	Licence to Export Live Wildlife, $3000.00/polar bear	District Manager	Ministerial permit	Special permit: extremely difficult

[1] Polar bears are not hunted in Manitoba. For management purposes, 8 animals are assumed for defense/accidental human-caused mortalities
[2] Not protected by law but protected by an agreement between Québec government and Inuit (Anguvigak group)

advice and support to appropriate Deputies' and Ministers' Councils on these matters. Working within the CWDC: 1) facilitates a harmonized approach to national programs affecting wildlife; 2) provides a forum for the development of national policy frameworks; 3) facilitates the development of national strategies affecting wildlife; and 4) promotes co-operative management and information sharing among wildlife agencies in Canada.

Federal-Provincial-Territorial Polar Bear Administrative Committee (PBAC)

The PBAC provides a forum for provincial, territorial, and federal management authorities to work together to manage polar bears in Canada and to ensure that Canada fulfills its obligations as a party to the *Agreement on the Conservation of Polar Bears*, as well as any other agreement involving polar bears. The PBAC discharges these functions by: 1) referring all research needed to conserve polar bears and their habitat in Canada to the Polar Bear Technical Committee (PBTC); 2) evaluating recommendations of the Polar Bear Technical Committee, and when necessary making recommendations to the CWDC; 3) responding to requests for information from jurisdictions, boards, agencies and the CWDC; and 4) referring all national policy issues to the CWDC.

In order to comply with both the purpose and functions of the PBAC, members represent jurisdictions, management boards, or other agencies that have legal responsibility for polar bear management in Canada. The PBAC meets at least semi-annually (jointly with CWDC) and holds additional teleconferences as needed (on average six per year).

Federal-Provincial-Territorial Polar Bear Technical Committee (PBTC)

The PBTC meets annually to review scientific and traditional knowledge necessary to meet defined management needs in support of Canada's national and international conservation responsibilities under the *Agreement on the Conservation of Polar Bears*. The PBTC helps facilitate coordination of research activities among Canadian jurisdictions that have polar bears, as well as Alaska and Greenland for those subpopulations that are shared with Canada. The PBTC provides technical advice and recommendations to PBAC, as required, on: 1) design, collaboration, and conduct of polar bear research in Canada; 2) harvest and population trends; and 3) the need for management actions. The PBTC discharges these functions by: 1) identifying and coordinating research needed to conserve polar bears and their habitat in Canada; 2) sharing information on polar bear populations that occur wholly within or are shared by Canada; 3) evaluating the results of this research, exchanging technical information and traditional knowledge, and making recommendations to the PBAC; 4) responding to requests for technical information and traditional knowledge from the PBAC; 5) evaluating impacts of management actions, including harvest, and making recommendations to the PBAC or any member agency that requests advice; 6) preparing an annual status report on Canadian polar bear subpopulations, including harvest, based on scientific information and traditional knowledge provided by member agencies; and 7) referring all policy issues to the PBAC.

To fulfill the purpose and functions of the PBTC, members must have recognized scientific or traditional knowledge of polar bear biology and habitat.

Status report on polar bear subpopulations within and shared by Canada

The status of the 13 polar bear subpopulations that lie either within Canada's borders or are shared with Greenland or Alaska (Fig. 1, Tables 2–4) is determined by the number of individuals in the subpopulation, the rates of birth and death, and the rate at which animals are harvested. Subpopulation 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 (e.g., Taylor et al. 2001). The current subpopulation boundaries were established by the PBTC in 1996 (Lunn et al. 1998), although some minor "smoothing" of the boundaries has occurred more recently.

The following management reports, status table, and accompanying tables of demographic parameters and harvest summaries were developed by the PBTC based on discussions held at the Committee's meeting in February 2009 in Whitehorse, Yukon.

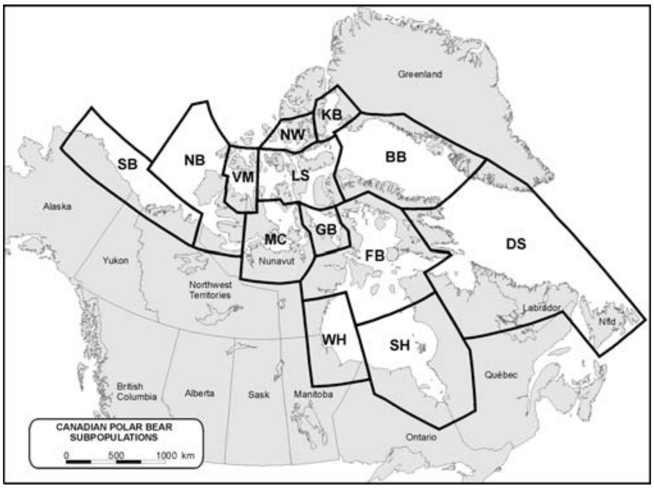

Fig. 1. Canadian polar bear subpopulations as of 31 December 2008. BB: Baffin Bay; DS: Davis Strait; FB: Foxe Basin; GB: Gulf of Boothia; KB: Kane Basin; LS: Lancaster Sound; MC: M'Clintock Channel; NB: Northern Beaufort Sea; NW: Norwegian Bay; SB: Southern Beaufort Sea; SH: Southern Hudson Bay; VM: Viscount Melville Sound; WH: Western Hudson Bay.

Polar Bear Kills by Jurisdiction

Table 5 summarizes the annual quotas and total known human-caused mortality from 2003–04 through 2007–08 and the jurisdictional recommended quotas for 2008–09 within Canada. Tables 6 and 7 summarize the total known number of polar bears killed by humans from subpopulations within or shared with Canada from 2003–04 through 2007–08.

Management Changes and Reports

Provincial and Territorial Jurisdictions

Manitoba

On 7 February 2008, polar bears in Manitoba (the Western Hudson Bay [WH] subpopulation) were recognized as Threatened under the Manitoba *Endangered Species Act* based on the impacts of climate change. Declaring the polar bear as Threatened will further ensure its protection, along with its habitat on both Crown and privately-owned land. The listing provides the ability to restrict development near critical habitat along the Hudson Bay coastline in Manitoba.

Beginning in 2008, all tourism flights into the core maternity denning area of the Churchill Wildlife Management Area (WMA) were discontinued. Any flight to a den site must now be to a specific, pre-selected, abandoned den that is not within the Churchill WMA.

The annual Polar Bear Alert Program for the Churchill town site and surrounding area continues each autumn. The objectives of this program are: 1) to ensure the safety of people and the protection of property from damage by polar bears; and 2) to ensure that bears are not unnecessarily harassed or killed. Program highlights are summarized in Table 8. The Polar Bear Holding Facility in Churchill now has five additional air-conditioned holding cells. There are 28 holding cells available and these can be configured to accommodate single animals or family groups. A special holding cell was constructed in a room separate from the other cells to accommodate orphaned cubs.

Newfoundland and Labrador

In December 2005, the Nunatsiavut Government was established to represent the residents of the Labrador Inuit Settlement Area, which was created by the signing of the *Labrador Inuit Land Claims Agreement* (LILCA) in January 2005. Management authority for polar bears will continue to reside with the Province of Newfoundland and Labrador, but is inclusive of considerable input and solicitation from the Nunatsiavut Government, the Torngat Wildlife and Plant Co-Management Board, and Parks Canada Agency.

Table 2. Summary of the status of polar bear subpopulations in Canada based on review and discussion by the Canadian Polar Bear Technical Committee February 2009 (therefore, may differ from PBSG status table in these Proceedings).

Sub-pop'n [1]	Estimate for management			5-year mean harvest			Permitted harvest [3]	Scientific near term likely trend assessment [2]	Local knowledge assessment [4]	Comments
	Size	SE	Year	Actual removals	Prop'n female	Likelihood of decline [2]				
BB	1546	428	2004	212.0	0.36	100%	178	Decline; PVA [5]	Abundant and increasing [6,7]	Greenland began a quota system 2006, reducing harvest. Combined Canadian and Greenlandic harvest is still sufficient to cause a decline according to scientific information. Inuit Knowledge [6] suggests population is increasing; proposed immigration from LS [7]. BB is a seasonal-ice population; ice habitat is expected to decrease in the future. Capture data are 12 years old. [5]
DS	2142	72	2007	60.4	0.31	100%	54 + Quebec	Stable; Scientific and professional judgment [8]	Abundant, 61% of local respondents said there were 'many' or 'the most' bears observed [9]	New estimates of natural survival and current harvest suggest the population may begin to decline [8]; scientific [8] and local knowledge [9] suggest the population has significantly increased in the past
FB	2300		2004	101.0	0.33	unknown	106 + Quebec	Unknown	Abundant [10]	Population estimate is from a back calculation using a PVA simulation to increase the 1994 estimate [11]; the increase in the population was supported by TEK. Scientific vital rates are unknown. Population estimate is 14 years old
GB	1528	285	2000	60.0	0.36	11%	74	Increasing; PVA [12]	Has increased [13]	Population has high vital rates and low harvest rates. [12]

Table 2. Continued…

Sub-pop'n [1]	Estimate for management			5-year mean harvest			Permitted harvest [3]	Scientific near term likely trend assessment [2]	Local knowledge assessment [4]	Comments
	Size	SE	Year	Actual removals	Prop'n female	Likelihood of decline [2]				
KB	164	35	1998	11.4	0.28	100%	15	Decline; PVA[14]	Needs to be assessed	Research data are 11 years old.[14] Using these data, population is in decline at current harvest conditions, and would be projected to be 69 animals currently. Population may act as a sink, replenished from BB. Harvest is shared between Greenland and Nunavut. With no harvest, likelihood of decline is 26%; sustainable harvest is approximately 1 bear/year.
LS	2541	391	1998	83.0	0.24	69%	85	Decline[15]; PVA	Needs to be assessed	Research data are 12 years old.[16] Population has highly selective harvest for males; however it is likely that selective hunting will decline with less sport hunting.
MC	284	59	2000	2.2	0.27	0%	3	Increasing; PVA[17]	Needs to be assessed	Population is managed for recovery; harvest is below sustainable rates.[17]
NB	1200		2006	29.4	0.42	unknown	65	Stable; Population size over time[18], professional[19] and habitat assessment[20]	Needs to be assessed	The estimate of population size for management is larger than published estimate to incorporate unsurveyed areas.[18] Boundary with SB is being re-considered, which will affect vital rates and population estimate.
NW	190	44	1998	3.6	0.06	82%	4	Decline; PVA[16]	Needs to be assessed	Research data are 11 years old. Population would be stable with 0 - 1 bear taken/year.[16]

Table 2. Continued…

Sub-pop'n[1]	Estimate for management			5-year mean harvest			Permitted harvest[3]	Scientific near term likely trend assessment[2]	Local knowledge assessment[4]	Comments
	Size	SE	Year	Actual removals	Prop'n female	Likelihood of decline[2]				
SB	1526	158	2006	44.4	0.38	99%	80	Decline; PVA[20], PVA-habitat assessment[21] and ecological studies[22]	Needs to be assessed	Combined PVA and habitat analyses are ongoing to determine likelihood of decline and effect of harvest. Boundary with NB is being reconsidered, which will affect vital rates and population estimate
SH	900-1000		2005	35.4	0.31	92%	55 + Quebec	Stable. Decline expected; Professional judgment[23], biological information[24]	Needs to be assessed	PVA analyses are ongoing to determine likelihood of decline and effect of harvest. Population estimate of 681 is for the Ontario Coast and 110 for James Bay. The estimate for management includes professional judgment of abundance in unsurveyed areas.[23]
VM	215	20	1996	4.6	0.26	5%	7	Increasing*; PVA	Needs to be assessed	Vital rates from M-R research conducted at maximum depletion indicate relatively high productivity at low density. The estimate for population size for management is the result of a simulation from 1992 estimate. *Data are 17 years old.[25] Discussions have been initiated for another population inventory
WH	935	72	2004	44.4	0.35	100%	8 + Manitoba	Decline; Population estimates, PVA, habitat assessment and biological information[26]	Seeing more bears[27]	Population has reduced vital rates due to climate warming.[26] Local knowledge suggests that people are seeing more bears, and bears may have moved north in distribution.[27]

[1] 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; SB: Southern Beaufort Sea; SH: Southern Hudson Bay; VM: Viscount Melville Sound; WH: Western Hudson Bay

Table 2. Continued…

[2] proportion of runs, using RISKMAN population viability analysis (PVA) model and vital rates presented (survival & recruitment tables) resulting in ***any*** decline in size after 10 years of simulation using sex ratio of the harvest. One minus the value is likelihood of an increase

[3] identified permitted harvest includes the maximum harvest that is presently allowed by jurisdictions with an identified quota plus what is taken by non-quota jurisdictions

[4] local knowledge may include information from traditional knowledge social science studies, recorded public comments and information provided by hunters, elders and the public at community consultations or interviews

[5] Taylor, M.K., J. Laake, P.D. McLoughlin, E.W. Born, H.D. Cluff, S.H. Ferguson, A. Rosing-Asvid, R. Schweinsburg, and F. Messier. 2005. Demography and viability of a hunted population of polar bears. Arctic 58:203-214; unpublished PVA using published demographic data and current harvest

[6] recorded comments during NWMB public meeting in April 2008 in Pond Inlet, Nunavut

[7] Dowsley, M. and G. W. Wenzel 2008. "The time of the most polar bears": A Co-management conflict in Nunavut. Arctic 61:177-189

[8] Peacock E., unpublished data

[9] Kotierk, M., unpublished data

[10] comments at community consultations throughout Foxe Basin

[11] Taylor, M.K., J. Lee, J. Laake, and P.D. McLoughlin. 2006. Estimating population size of polar bears in Foxe Basin, Nunavut using tetracycline biomarkers. File report to the Department of the Environment, Government of Nunavut, 13 pp

[12] Taylor, M.K., J. Laake, P.D. McLoughlin, H.D. Cluff, and F. Messier. In press. Demography and population viability of polar bears in the Gulf of Boothia, Nunavut. Marine Mammal Science

[13] Keith, D., J. Arqvik, L. Kamookak, J. Ameralik and the Gjoa Haven Hunters' and Trappers' Organization 2005. Inuit Qaujimaningit Nanurnut: Inuit Knowledge of Polar Bears. Edmonton , AB : Gjoa Haven Hunters' and Trappers' Organization and CCI Press, vii + 242 pp

[14] Taylor, M.K., J. Laake, P.D. McLoughlin, H. D. Cluff, E. W. Born, A. Rosing-Asvid, F. Messier. 2008. Population parameters and harvest risks for polar bears (*Ursus maritimus*) of Kane Basin, Canada and Greenland. Polar Biology 31:491-499

[15] using data from (15) PVA with modern harvest data suggest decline

[16] Taylor, M.K., J. Laake, P.D. McLoughlin, H.D. Cluff, and F. Messier. 2008. Mark-recapture and stochastic population models for polar bears of the high arctic. Arctic 61:143-152

[17] Taylor, M.K., J. Laake, P.D. McLoughlin, H.D. Cluff, and F. Messier. 2006. Demographic parameters and harvest-explicit population viability analysis for polar bears in M'Clintock Channel, Nunavut, Canada. Journal of Wildlife Management 70:1667-1673

[18] professional judgment, I. Stirling, personal communication

[19] Stirling, I., T.L. McDonald, E.S. Richardson, and E.V. Regehr. 2007. Polar bear population status in the Northern Beaufort Sea. U.S. Geological Survey Administrative Report, 36 pp

[20] habitat assessment, Durner, G. M., D. C. Douglas, et al. 2007. Predicting the future distribution of polar bear habitat in the polar basin from resource selection functions applied to 21st century General Circulation Model projections of sea ice. USGS, U.S. Department of the Interior, 32 pp

[21] PVA using data from Hunter, C.M., H. Caswell, M.C. Runge, E.V. Regehr, S.C. Amstrup, and I. Stirling. 2007. Polar bears in the southern Beaufort Sea II: demography and population growth in relation to sea ice conditions. U.S. Geological Survey Administrative Report, 51 pp

[22] Rode, K. D., S. C. Amstrup, et al. 2007. Polar bears in the southern Beaufort Sea III: stature, mass and cub recruitment in relationship to time and sea ice extent between 1982 and 2006. U.S. Geological Survey Administrative Report, 32 pp

[23] professional judgment, M. Obbard

[24] Obbard, M.E., T.L. McDonald, E.J. Howe, E.V. Regehr, and E. Richardson. 2007. Polar bear population status in southern Hudson Bay, Canada. U.S. Geological Survey Administrative Report, 36 pp

[25] Taylor, M.K., J. Laake, H.D. Cluff, M. Ramsay, and F. Messier. 2002. Managing the risk from hunting for the Viscount Melville Sound polar bear population. Ursus 13:185-202

[26] Regehr, E.V., N.J. Lunn, S.C. Amstrup, and I. Stirling. 2007. Effects of earlier sea ice breakup on survival and population size of polar bears in western Hudson Bay. Journal of Wildlife Management 71:2673-2683

[27] recorded comments from NWMB public hearing in Arviat, Nunavut, 2007; Nunavut Tunngavik Incorporated preliminary western Hudson Bay Inuit Qaujimajutauqangit workshop summary, 2007

Table 3. Natural (i.e., unharvested) survival parameters used in the assessment of risk for subpopulations in Table 2, and best estimates of parameters of natural survival for subpopulations modeled using RISKMAN. It is to these rates that anticipated annual removal rate are added for simulation. See text for year of studies.

Sub-pop'n [1]	Males								Females							
	COY		1-4 years		5-20 years		>20 years		COY		1-4 years		5-20 years		>20 years	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
BB	0.570	0.094	0.938	0.045	0.947	0.022	0.887	0.060	0.620	0.095	0.938	0.042	0.953	0.020	0.919	0.050
DS[2]	0.842	0.071	0.875	0.058	0.913	0.032	0.801	0.086	0.842	0.071	0.886	0.053	0.928	0.030	0.827	0.086
FB[3]																
GB	0.817	0.201	0.907	0.084	0.959	0.039	0.959	0.039	0.817	0.201	0.907	0.084	0.959	0.039	0.959	0.039
KB	0.345	0.200	0.663	0.197	0.997	0.026	0.997	0.026	0.410	0.200	0.756	0.159	0.997	0.026	0.997	0.026
LS[4]	0.634	0.123	0.838	0.075	0.974	0.030	0.715	0.095	0.750	0.104	0.898	0.050	0.946	0.018	0.771	0.054
MC	0.619	0.151	0.983	0.034	0.921	0.046	0.921	0.046	0.619	0.151	0.983	0.034	0.977	0.033	0.977	0.033
NB[5]																
NW[4]	0.634	0.123	0.838	0.075	0.974	0.030	0.715	0.095	0.750	0.104	0.898	0.050	0.946	0.018	0.771	0.054
SB	0.430	0.110	0.930	0.040	0.930	0.040	0.930	0.040	0.430	0.110	0.930	0.040	0.930	0.040	0.930	0.040
SH[6]	0.492	0.143	0.812	0.076	0.811	0.076	0.293	0.135	0.645	0.135	0.893	0.051	0.892	0.052	0.44	0.0148
VM	0.448	0.216	0.924	0.109	0.924	0.109	0.924	0.109	0.693	0.183	0.957	0.028	0.957	0.028	0.957	0.028
WH	0.500	0.033	0.870	0.026	0.940	0.010	0.780	0.023	0.610	0.028	0.920	0.020	0.940	0.008	0.810	0.020

[1] 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; SB: Southern Beaufort Sea; SH: Southern Hudson Bay; VM: Viscount Melville Sound; WH: Western Hudson Bay

[2] yearling rates are estimated separately from subadults, (mean=0.905, SE=0.050) for both males and females

[3] no data unavailable

[4] survival estimates pooled for LS and NW (see text for LS and NW)

[5] data analysis is underway

[6] survival estimates are total apparent survival, not natural survival

Table 4. Reproductive parameters (standing age capture data) used in the assessment of risk for subpopulations in Table 2. No estimates for Foxe Basin are currently available

Sub-pop'n[1]	Cub litter size		Female litter production rate: 4-year-olds		Female litter production rate: 5-year-olds		Female litter production rate: 6-year-olds		Female litter production rate: >6 year-olds		Proportion of male cubs	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
BB	1.587	0.073	0.096	0.120	0.881	0.398	1.000	0.167	1.000	0.167	0.493	0.029
DS	1.470	0.160	0.000		0.564	0.184	0.445	0.527	0.389	0.024	0.516	0.117
FB												
GB	1.648	0.098	0.000		0.194	0.178	0.467	0.168	0.965	0.300	0.460	0.091
KB	1.667	0.083	0.000		0.000		0.357	0.731	0.478	0.085	0.426	0.029
LS	1.688	0.012	0.000		0.107	0.050	0.312	0.210	0.954	0.083	0.531	0.048
MC	1.680	0.147	0.000		0.111	0.101	0.191	0.289	0.928	0.334	0.545	0.057
NB	1.756	0.166	0.118	0.183	0.283	0.515	0.883	0.622	0.883	0.622	0.502	0.035
NW	1.714	0.081	0.000		0.000		0.000		0.689	0.534	0.544	0.066
SB	1.750	0.170	0.000		0.470	0.090	0.470	0.090	0.470	0.090	0.520	0.040
SH	1.575	0.116	0.087	0.202	0.966	0.821	0.967	0.022	0.967	0.022	0.467	0.086
VM	1.640	0.125	0.000		0.623	0.414	0.872	0.712	0.872	0.712	0.535	0.118
WH	1.540	0.110	0.000		0.257	0.442	0.790	0.180	0.790	0.180	0.480	0.110

[1] 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; SB: Southern Beaufort Sea; SH: Southern Hudson Bay; VM: Viscount Melville Sound; WH: Western Hudson Bay

Table 5. Harvest quotas and known numbers of polar bears killed[1] in Canada, 2004–05 through 2007–08.

	Jurisdiction[2]							
Management Year[3]	MB[4]	NL	NT	NU	ON	QC[5]	YT[6]	Total
2004–2005								
Quota	8	6	97	507	30	62	6	716
Killed	2	5	54	466	2	16	0	545
Sent to zoos	0	0	0	0	0	0	0	0
2005–2006								
Quota	8	6	93	474	30	62	6	679
Killed	4	4	36	452	4	14	0	514
Sent to zoos	0	0	0	0	0	0	0	0
2006–2007								
Quota	8	6	97	512	30	62	6	721
Killed	3	4	45	498	3	24	0	577
Sent to zoos	0	0	0	0	0	0	0	0
2007–2008								
Quota	8	6	97	486	30	62	6	695
Killed	2	6	31	446	5	16	0	506
Sent to zoos	0	0	0	0	0	0	0	0
2008–2009								
Quota	8	6	97	456	30	62	6	665

[1] all known human-caused mortalities, including subsistence kills, sport-hunt kills, problem kills, illegal kills, and bears that die while being handled during research

[2] MB: Manitoba; NL: Newfoundland and Labrador; NT: Northwest Territories; NU: Nunavut; ON: Ontario; QC: Québec; YT: Yukon Territory

[3] management year extends from 1 July to 30 June the following year

[4] there is no quota in Manitoba because polar bears are not hunted. For management purposes, 8 animals are assumed for defense/accidental human-caused mortalities

[5] total allowable kill in Québec is controlled through agreements with Aboriginal peoples; length of hunting season is adjusted and only certain sex- and age-categories can be taken

[6] Yukon quota of six is administered by the NWT through the Inuvialuit Game Council; all kills are included in NWT (Inuvialuit Settlement Region) totals

Table 6. Total known number of polar bears killed by humans[1] from subpopulations within or shared with Canada, 2003–04 through 2007–08.

	Known human-caused mortality[2]														
	2003–2004			2004–2005			2005–2006			2006–2007			2007–2008		
Subpopulation	Total	F	M	Total	F	M	Total	F	M	Total	F	M	Total	F	M
Baffin Bay															
Greenland	164	57	107	155	53	102	135	46	89	75	24	51	66	45	21
Nunavut	72	21	51	97	35	61	98	28	70	99	39	60	99	29	70
Sub-total	236	78	158	252	88	163	233	74	159	174	63	111	165	74	91
Davis Strait															
Greenland	1	0	1	3	1	2	4	1	3	0	0	0	1	0	1
Nfld/Labrador	8	1	7	5	1	4	4	1	3	4	1	3	6	3	3
Nunavut	42	16	26	43	17	26	39	17	22	37	11	26	47.5	10	37.5
Québec	18	6	12	10	3	7	6	1	5	14	2	12	10	3	7
Sub-total	69	23	46	61	22	39	53	20	33	55	14	41	64.5	16	48.5
Foxe Basin															
Nunavut	95	25	70	94	25	69	100	38	60	101	42	59	103	36	67
Québec	1	0	1	6	0	6	2	1	1	1	0	1	2	0	2
Sub-total	96	25	71	100	25	75	102	39	61	102	42	60	105	36	69
Gulf of Boothia															
Nunavut	41	16	25	66	22	44	65	20	45	72	26	46	56	23	33
Sub-total	41	16	25	66	22	44	65	20	45	72	26	46	56	23	33
Kane Basin															
Greenland	12	2.4	9.6	9	1.8	7.2	25	5	20	5	2	3	5	4	1
Nunavut	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Sub-total	12	2.4	9.6	10	2.8	7.2	25	5	20	5	2	3	5	4	1

Table 6. Continued…

Subpopulation	Known human-caused mortality[2]														
	2003–2004			2004–2005			2005–2006			2006–2007			2007–2008		
	Total	F	M	Total	F	M	Total	F	M	Total	F	M	Total	F	M
Lancaster Sound															
Nunavut	79	22	57	87	20	67	81	18	63	94	20	74	74	19	55
Sub-total	79	22	57	87	20	67	81	18	63	94	20	74	74	19	55
M'Clintock Channel															
Nunavut	0	0	0	2	1	1	3	1	2	3	0	3	3	1	2
Sub-total	0	0	0	2	1	1	3	1	2	3	0	3	3	1	2
Northern Beaufort Sea															
NWT	33	11	22	32	13	18	26	15	11	27	8	19	17	7	8
Nunavut	3	0	3	4	2	2	1	1	0	4	3	1	0	0	0
Sub-total	36	11	25	36	15	20	27	16	11	31	11	20	17	7	8
Norwegian Bay															
Nunavut	3	1	2	4	0	4	3	0	3	4	0	4	4	0	4
Sub-total	3	1	2	4	0	4	3	0	3	4	0	4	4	0	4
Southern Beaufort Sea															
NWT+Yukon	28	13	15	19	2	17	10	3	7	16	6	9	14	7	7
USA	44	12	19	30	9	14	30	11	18	19	5	8	12	4	6
Sub-total	72	25	34	49	11	31	40	14	25	35	11	17	26	11	13
Southern Hudson Bay															
Nunavut	25	9	16	25	4	21	25	9	16	25	8	17	25	7	18
Ontario	8	3	3	2	0	2	4	2	2	3	1	2	5	1	2
Québec	11	3	8	0	0	0	6	2	4	9	2	7	4	2	2
Sub-total	44	15	27	27	4	23	35	13	22	37	11	26	34	10	22

Table 6. Continued…

	Known human-caused mortality[2]														
	2003–2004			2004–2005			2005–2006			2006–2007			2007–2008		
Subpopulation	Total	F	M	Total	F	M	Total	F	M	Total	F	M	Total	F	M
Viscount Melville Sound															
NWT	1	0	1	3	0	3	0	0	0	2	1	1	0	0	0
Nunavut	4	1	3	2	2	0	4	1	3	4	1	3	3	0	3
Sub-total	5	1	4	5	2	3	4	1	3	6	2	4	3	0	3
Western Hudson Bay															
Manitoba	5	2	2	2	0	2	4	2	1	3	2	1	2	1	1
Nunavut	47	14	33	41	13	27	33	14	19	55	16	39	31	14	17
Sub-total	52	16	35	43	13	29	37	16	20	58	18	40	33	15	18
Total	745			742			708			676			590		

[1] all known human-caused mortalities, including subsistence kills, sport-hunt kills, problem kills, illegal kills, and bears that die while being handled during research

[2] unverified males or bears of unknown sex are included in annual totals but not in M or F columns

Table 7. Summary of the number of polar bears killed by humans[1] from subpopulations within or shared with Canada, 2003–04 through 2007–08.

Subpopulation	5-year		3-year		2007–2008	
	Mean	Proportion female	Male	Proportion female	Mean	Proportion female
Baffin Bay	212	0.36	191	0.37	165	0.45
Davis Strait	60.4	0.31	57.3	0.27	65	0.25
Foxe Basin	101	0.33	103	0.38	105	0.34
Gulf of Boothia	60	0.36	64	0.36	56	0.41
Kane Basin	11.4	0.28	12	0.31	5	0.80
Lancaster Sound	83	0.24	83	0.23	74	0.26
M'Clintock Channel	2.2	0.27	3	0.22	3	0.33
Northern Beaufort Sea	29.4	0.42	25	0.47	17	0.47
Norwegian Bay	29.4	0.42	25	0.47	17	0.47
Southern Beaufort Sea	44.4	0.38	34	0.40	26	0.46
Southern Hudson Bay	35.4	0.31	35	0.33	34	0.31
Viscount Melville Sound	4.6	0.26	4	0.23	3	0.00
Western Hudson Bay	44.4	0.35	42	0.38	32	0.44

[1] all known human-caused mortalities, including subsistence kills, sport-hunt kills, problem kills, illegal kills, and bears that died while being handled during research

Table 8. Manitoba Polar Bear Alert Program, 2005–2008.

	Year			
Reason	2005	2006	2007	2008
Occurrences[1]	132	267	247	171
Bears captured	58	62	49	33
Bears killed by Department personnel	1	0	1	0
Bears killed by public	0	3	0	0
Handling deaths	0	0	1	1
Natural deaths	0	0	0	0
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

The province issues licences, establishes quotas, seasons, and management areas pursuant to Sections 39 and 114 of the Wildlife Regulations, and the annual Polar Bear Hunting Order. Pursuant to section 12.3.6 of the LILCA, Inuit have exclusive right to harvest the total allowable harvest established by the province. The total harvest allocation for polar bears is currently six animals.

In July 2006, the provincial and Nunatsiavut governments released a 5-yr management plan for polar bears, which was a requirement of the species being listed as Vulnerable by the province under its *Endangered Species Act* in 2002. The goal of the management plan is to maintain and enhance the sustainability of the Davis Strait polar bear subpopulation through appropriate species and habitat management initiatives within Newfoundland and Labrador. To achieve that goal, a series of objectives has been identified including equitable Labrador Inuit hunting access, continued cooperation, habitat protection, a better understanding of distribution and population numbers of polar bears, threat assessment, and management and development of education and stewardship programs. The plan is for a 5-yr period (2006–2010) and it will be re-evaluated and revised accordingly at the end of that period. However, the plan can be revised earlier if new information becomes available that would significantly alter the plan's direction.

Northwest Territories

In February 2006, the *Polar Bear Management Agreement for the North Beaufort Sea and Viscount-Melville Sound Polar Bear Populations between the Inuit of the Kitikmeot West Region of Nunavut and the Inuvialuit* was signed by the Kitikmeot Hunters and Trappers Association and the Inuvialuit Game Council. This user-to-user agreement complements the agreement already in place for the Southern Beaufort Sea subpopulation between the Inupiat of the North Slope and the Inuvialuit to ensure co-operation and co-operative management of shared subpopulations of polar bears. Work continues in the development of a government-to-government agreement between Nunavut and Northwest Territories.

Results from mark-recapture estimates completed in 2006 indicate the Southern Beaufort Sea subpopulation is likely declining, whereas the Northern Beaufort Sea subpopulation is likely stable. Information provided by analysis of movements of collared bears (Amstrup et al. 2004) indicates that the boundary between the Southern and Northern Beaufort Sea subpopulations is currently set too far east. An analysis is underway to consider the implications of a proposed boundary change on the Southern and Northern Beaufort Sea abundance estimates, population parameters, and estimates of growth rates. Once this analysis is complete, a review of current management, including quotas, will be undertaken with Nunavut, the Yukon, and Alaska management authorities and communities, and subpopulation Memoranda of Understanding (MOU) will be updated.

Nunavut

The *Nunavut Land Claim Agreement* (NLCA) recognizes that certain populations of wildlife found in the Nunavut Settlement Area (NSA) cross jurisdictional boundaries and are harvested outside the NSA by persons resident elsewhere and therefore requires that the Department of Environment of the Government of Nunavut and the Nunavut Wildlife Management Board (NWMB) take into account the harvesting activities outside the NSA and the terms of domestic inter-jurisdictional agreements or international agreements pertaining to wildlife. Since 2005, Nunavut has taken an active role through the PBAC in the development of inter-jurisdictional agreements with territorial and provincial jurisdictions that share polar bear subpopulations with Nunavut.

In 2007–08, the Nunavut polar bear quota for the Western Hudson Bay subpopulation was reduced from 56 animals per year to 36 animals per year. In 2008–09, it was further reduced to eight animals per year. This decision was made by the NWMB and agreed to by the Minister of the Department of Environment (DOE), based on data suggesting a decline in the subpopulation, which was linked to date of sea ice break-up (Regehr et al. 2007).

In April 2008, the NWMB held a public hearing to consider a change to the quota for the three Nunavut communities that harvest from the Baffin Bay (BB) subpopulation. The DOE presented data from an Inuit knowledge study (Dowsley and Wenzel 2008), a capture-recapture population inventory (Taylor et al. 2005), and new harvest data indicating a decline in the population due to overharvest. At that time, a decision was made by the NWMB and DOE not to reduce the annual quota of 105 bears for Nunavut for 2008–09, largely as a result of an outstanding MOU between Canada and Greenland but also based on Inuit Knowledge that suggested an increase of polar bears in the area. *[Note added in press: A new public hearing regarding reducing the harvest from BB in Nunavut was held in Iqaluit, NU in September, 2009 and on March 5, 2010 NWMB and DOE agreed to reduce the Nunavut harvest in BB by 10 bears/yr over the next 4 years.]*

In 2008, a planned capture-recapture inventory of the Foxe Basin subpopulation was postponed indefinitely due to community concerns over capture and handling of polar bears. In March 2009, a Wildlife Research Symposium was held in part to increase communication over this issue. An aerial survey occurred in 2009 to estimate the size of the Foxe Basin subpopulation.

A wildlife deterrent specialist has been hired to develop community deterrent plans for all Nunavut communities.

Ontario

No changes in the management of polar bears have occurred since the last meeting of the Specialist Group. The polar bear was first listed as Vulnerable by the Ontario Ministry of Natural Resources (OMNR) in 2000 following recommendations of the Committee on the Status of Species at Risk in Ontario (COSSARO). In October 2002, COSSARO re-evaluated the status of polar bear based on an addendum to the 1999 status report (Stirling and Taylor 1999) prepared for COSEWIC, and on recent unpublished research on changes in body condition in the SH population. OMNR confirmed the status of Vulnerable for polar bear in Ontario at that time. In September 2004, OMNR changed the name of the status category 'Vulnerable' to 'Special Concern' to conform to the category names used at the national level by COSEWIC. In June 2009, COSSARO assessed the polar bear as Threatened in Ontario.

A summary of the ecology, status, and management initiatives for the Southern Hudson Bay (SH) subpopulation was prepared in 2008 (OMNR 2008). This document is intended for general audiences and the text is available in both English and Cree. The report is intended to help build a common understanding between the OMNR and the Aboriginal communities that harvest polar bears in Ontario.

Québec

No changes in the management of polar bears have occurred since the last meeting of the Specialist Group. From 2005 to 2007, Makivik Corporation with the Nunavik Research Center became a partner for the Davis Strait polar bear subpopulation inventory conducted by the Department of Environment, Government of Nunavut. Makivik Corporation was created in 1978 pursuant to the signing of *the James Bay and Northern Québec Agreement* (JBNQA) of 1975; it is a non-profit organization owned by the Inuit of Nunavik. Though the Coordinating Committee is, in the words of the JBNQA, "the preferential and exclusive forum for Native people and governments jointly to formulate regulations and supervise the administration and management of the Hunting, Fishing and Trapping Regime", Makivik is the recognized Inuit Party to the Agreement. Makivik's central mandate is the protection of the integrity of the JBNQA, and focuses on the political, social, and economic development of Nunavik.

Yukon Territory

As set out in the Yukon *Wildlife Act*, Yukon has management responsibilities for Southern Beaufort Sea polar bears. Yukon shares management of this population with Alaska, NWT, and the regional co-management boards, including collaboration with the Wildlife Management Advisory Council (North Slope) [WMAC (NS)]. Yukon has recently re-engaged in research and monitoring of polar bears and their habitats, and, in collaboration with its partners, determines the harvestable quota for bears. Yukon will also provide assistance to WMAC (NS) in Western Beaufort environmental impact project assessments that could affect polar bears.

Yukon currently identifies six tags for polar bear harvest in the Southern Beaufort Sea subpopulation. All harvest of polar bears within the Yukon occurs in the Inuvialuit Settlement Region. As the communities that use the tags are located in the NWT, the tags are administered by

GNWT and allocated by the Inuvialuit Game Council. Yukon is currently developing an agreement with GNWT for joint tag administration for the Southern Beaufort Sea subpopulation. In 2006, the Yukon began developing a Climate Change Action Plan. Implementation of this action plan may assist in identifying climate change impacts on polar bear habitat. In 2005, the Yukon began developing legislation for species-at-risk. Under this proposed legislation a management plan will be required for polar bears. No other changes have occurred since the last PBSG meeting.

Management Boards and Aboriginal Groups

Nunavik (northern Québec)

Under the JBNQA the taking of polar bears is restricted to Aboriginal peoples to protect traditional subsistence harvesting rights. In law, provisions have been made to ensure the Inuit of Nunavik have exclusive access to an agreed level of harvest (Guaranteed Harvest Level - GHL), subject to the principles of conservation, before any sport or commercial activity would be permitted. Set at 62 polar bears per year for the entire region, this level of harvest is based on the recorded subsistence harvest during 1976–1980. The GHL is not linked to specific polar bear subpopulations, but rather to the entire region. Although the Government of Québec retains the right to institute conservation measures, this has not been considered necessary to date.

Under present legislation, sport hunting is not permitted and polar bears may only be harvested for subsistence use. The hide may be sold if a provincial tag is obtained and attached.

Nunavut Wildlife Management Board

Through a delegation of authority from the federal government, ultimate responsibility for the management of polar bears in Nunavut lies with the Government of Nunavut (GN), as represented by the Minister of Environment. However, this responsibility is subject to the terms of the NLCA, which established a system of 'co-management' for wildlife. Under the NLCA, the Minister's decision-making authority for wildlife management is shared with the NWMB and is subject to strict requirements for consultation with Regional Wildlife Organizations and community-based Hunters and Trappers Organizations (Figure 2). The NWMB is an institution of public government whose board members are appointed in equal numbers by government and Inuit organizations. The NWMB is the main instrument of wildlife management and the main regulator of access to wildlife – including polar bears – in the Nunavut Settlement Area. The NWMB exercises co-jurisdictional decision-making with relevant Ministers of the Crown regarding a variety of wildlife management matters – including the establishment, modification and removal of restrictions on the harvest of polar bears. Under that co-jurisdictional arrangement, both the NWMB and the territorial Minister of Environment may only impose restrictions on the harvest of polar bears within limits set by the NLCA. For instance, decisions of the NWMB or the Minister are permitted to restrict or limit Inuit harvesting only to the extent necessary to affect a valid conservation purpose, or to provide for public health or public safety. The Minister's acceptance or rejection of NWMB decisions can only be based on consideration of conservation, public safety or humane harvesting. The intent of this co-management system is to ensure that decisions are based on the best available science and *Inuit Qaujimajatuqangit* (Inuit traditional knowledge), and that these decisions consider not only conservation as a founding principle but also take into account the values, beliefs, view, and needs of Inuit. The system is also designed to ensure that Inuit are involved in all aspects of wildlife management including research, monitoring, and harvest management.

Wildlife Management Advisory Council (North Slope)

The Wildlife Management Advisory Council [WMAC (NS)] was created in 1988 under the *Western Arctic (Inuvialuit) Settlement Act*, ultimately the result of the 1984 *Inuvialuit Final Agreement* (IFA). The Council is comprised of five members: two members appointed by the Inuvialuit Game Council, one appointed by the federal Minister of Environment, one appointed by the Yukon Territorial Government, and an independent chairperson appointed by the Yukon Government with the consent of the Inuvialuit and Canada.

The mandate of WMAC (NS) is to conserve

and protect wildlife, habitat, and traditional Inuvialuit use within the Yukon North Slope. The Council provides advice to the appropriate minister on all matters relating to wildlife policy and the management, regulation, and administration of wildlife, habitat, and harvesting for the Yukon North Slope.

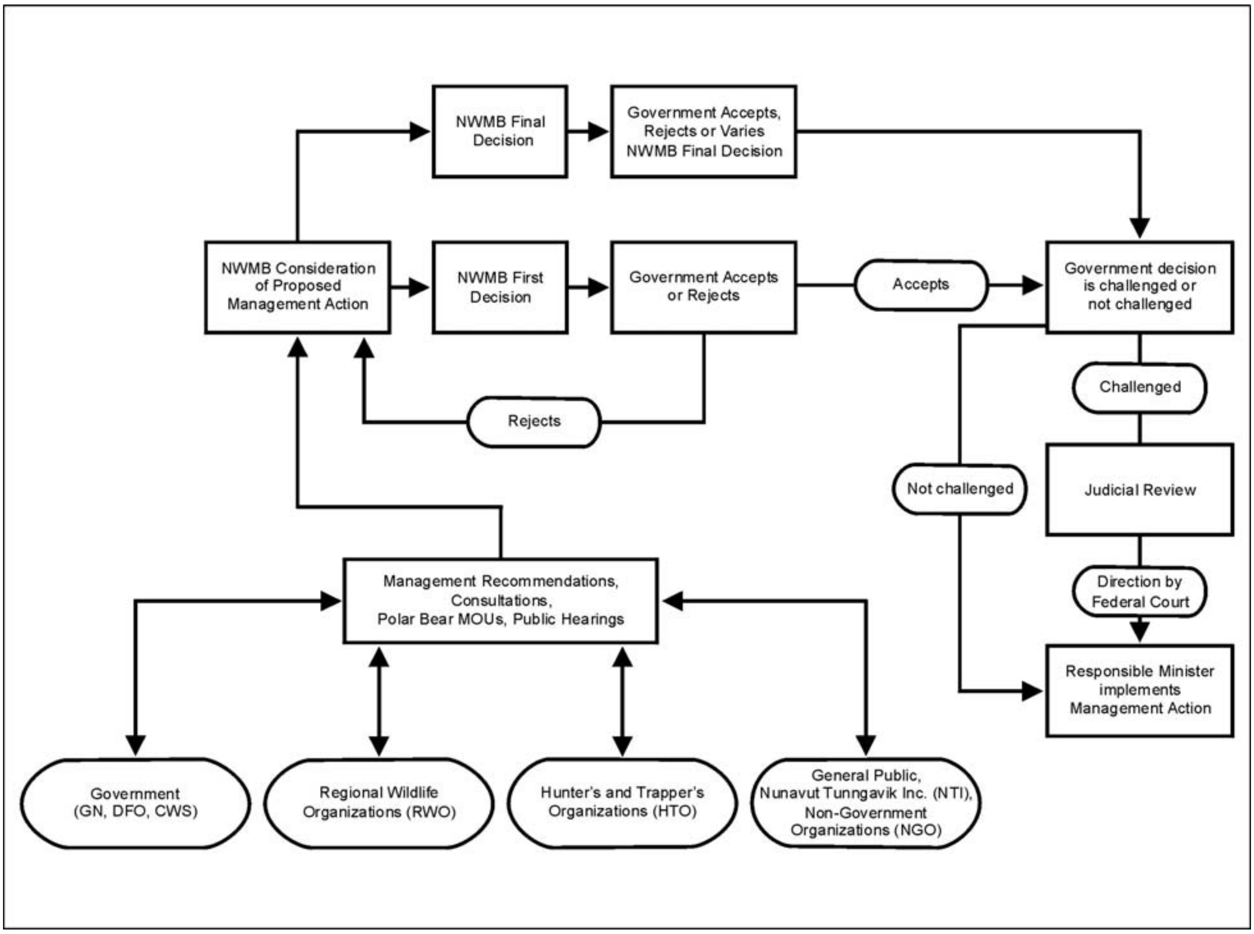

Fig. 2. Wildlife management decision-making process under Article 5 of the Nunavut Land Claim Agreement.

The Council gives guidance to a number of boards and councils in the region, recommends quotas for Inuvialuit game harvesting on the Yukon North Slope, and recommends measures to protect critical habitat for wildlife or harvesting purposes. WMAC (NS) recently expressed an interest in and need to become more actively involved in polar bear management, research, and monitoring issues. Previously, the Council had no involvement in these matters. The mandate of WMAC (NS) applies to the Yukon North Slope between the Alaska and Northwest Territories borders, and includes the near shore and offshore areas.

Wildlife Management Advisory Council (NWT) and Inuvialuit Game Council

The Wildlife Management Advisory Council (NWT) [WMAC (NWT)], hereafter referred to as the Council, consists of three members appointed by the Inuvialuit, two members appointed by the Government of the Northwest Territories, one member appointed by the Government of Canada, and a Chair. The Chair is appointed by the Government of the Northwest Territories with the consent of the Inuvialuit and the Government of Canada.

The Council's jurisdiction is that part of the Inuvialuit Settlement Region (ISR) within the Northwest Territories. The Council's mandate is to advise appropriate ministers on all matters relating to wildlife policy and the management, regulation, research, enforcement, and administration of wildlife, habitat, and harvesting for the Western Arctic Region, within the NWT. It is the responsibility of the Council to prepare conservation and management plans, and to determine and recommend harvestable quotas. The Council also reviews and advises the appropriate governments on existing or proposed wildlife legislation and on any proposed Canadian position for international purposes that would affect wildlife in the Western Arctic Region.

All harvest of polar bears in the NWT occurs within the ISR. Within the ISR, the Council is the primary vehicle for wildlife management. The Council makes recommendations for any management changes within the ISR, including quotas, to the NWT Minister of Environment and Natural Resources (formerly Resources Wildlife and Economic Development). The Inuvialuit Game Council (IGC), comprised of representatives from each of the six Hunters and Trappers Committees, allocates the total quota among the communities.

Federal Government

CITES

The 1973 *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES) has been in effect since July 1975. Polar bears are included in Appendix II to the Convention.

In Canada, CITES is implemented through national legislation, the *Wild Animal and Plant Protection and Regulation of International and Inter-Provincial Trade Act* (WAPPRIITA). As the responsible authority for the implementation of CITES, Environment Canada must determine if the export or import of a species would be detrimental to the survival of that species. Such "non-detrimental findings" (NDF) are a requirement of the Convention. Given the shared jurisdiction for wildlife in Canada, coordination with provincial and territorial jurisdictions is required. At the present time, the export of polar bears from Canada is allowed under CITES. To ensure that the trade in polar bear continues to be non-detrimental to the species, Canada is drafting a Polar Bear Standing NDF Report. Consultations with responsible jurisdictions, wildlife management boards, and other stakeholders are ongoing. Environment Canada has met with the wildlife management boards in the Northwest Territories, the Yukon, and Nunavut, as well as Nunavut Tunngavik Incorporated (NTI), the group that oversees implementation of the NLCA. Further consultations will take place over the fall 2009 in Nunavut with NTI, Inuit wildlife organizations, and the NWMB. Environment Canada aims to publish the NDF report for polar bear in late fall 2009.

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 Government of Canada through the issue of permits. Data for 1975–2003 were included in the management reports prepared for the previous five Working Meetings of the IUCN/SSC Polar Bear Specialist Group. Data for 2004–2008 are summarized in Table 9.

Parks Canada Agency

Parks Canada Agency is responsible for the management of Canada's system of protected heritage areas, including national parks and national historic sites. Parks Canada's primary and legislated mandate is to maintain or restore ecological integrity of the national parks (*Parks Canada Guiding Principles and Operational Procedures* (Parks Canada 1994), *Canada National Parks Act* [R.S.O. 2000]). There are currently eight national parks that have polar bears: Ivvavik in the Yukon; Aulavik in the NWT; Auyuittuq, Quttinirpaaq, Sirmilik and Ukkusiksalik in Nunavut; Wapusk in Manitoba; and Torngat Mountains in Labrador.

Parks Canada's interest in conservation of polar bears and their habitat comes from its ecological integrity mandate and policies of ecosystem-based management and inter-jurisdictional cooperation. Parks Canada contributes to sustaining polar bear populations by protecting important habitats such as maternal denning and coastal summer retreat areas. Parks Canada has and will continue to support polar bear research and monitoring efforts in areas within and adjacent to the national parks.

Table 9. Number of polar bear parts and live polar bears legally exported, estimated number of polar bears from which parts originated, and number of CITES export permits issued by Canada 2005–2008[1].

	Year			
Part	2005	2006	2007	2008
Bones	56	40	108	38
Carvings	0	2	0	0
Claws	75	60	0	0
Feet	0	1	0	0
Hides[2]	554	494	695	1,051
Leather or fur products	0	0	0	0
Live animals[3]	0	0	0	0
Skulls, jaws, or teeth	106	102	166	71
Specimens, scientific	830	1,843	1,065	3,571
Total parts exported	1,621	2,542	2,034	4,731
Estimated number of bears from which parts originated	273	342	336	249
Export permits issued	206	226	276	183

[1] Canadian Wildlife Service CITES unpublished data
[2] includes head mounts, whole mounts, and pieces
[3] sent to zoos

Parks Canada also has a public safety duty to minimize human–bear encounters and conflict within the national parks. Park visitors, researchers, military personnel, local residents, park staff, and Inuit all have the potential to come into contact with polar bears. Human and polar bear activities overlap in space and time, particularly during April–October. To date, the number of park visitors and park users is low and the number of encounters has been correspondingly low. Measures in place to reduce the risk of encounters include mandatory park visitor registration and an orientation that includes polar bear safety messages. All other park users receive a polar bear safety pamphlet and discuss location-specific risks and mitigation measures with knowledgeable park staff and community members. Polar bear safety plans and operational procedures are in place or being developed for the aforementioned national parks.

Species at Risk Act and COSEWIC

The federal *Species at Risk Act* (*SARA*) was proclaimed on 5 June 5 2003. The purposes of *SARA* are to prevent wildlife from becoming extinct in Canada, to provide for the recovery of wildlife species that are extirpated, endangered, or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming threatened or endangered. *SARA* established the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as the legal entity that provides advice to government on the status of wildlife species.

The first step in the listing process for an eligible species under *SARA* is an assessment of status. COSEWIC commissions the preparation of a status report through an open competition process or will accept an unsolicited status report from any member of the public when accompanied by an Application for Wildlife Species Assessment. A status report contains the best available information on the biology of a species including scientific knowledge, community knowledge, and aboriginal traditional knowledge. This status report forms the basis for a species assessment and status designation by COSEWIC. Status designations are Extinct, Extirpated, Endangered, Threatened, or Special Concern. COSEWIC may also determine that there is insufficient information for a classification, or that the species is not currently at risk. COSEWIC provides its assessment and the reasons for it to the federal Minister of the Environment and the Canadian Endangered Species Conservation Council. At the same time, the status report is posted on the public registry.

Within 90 days, the federal Minister of the Environment posts a response statement on the public registry, which identifies how the Minister intends to respond to the COSEWIC assessment, indicating if consultations will be normal or extended. The posting of the response statements launches the consultations for the listing of eligible species at risk, and provides timelines for action. Environment Canada also makes available documents providing detailed information on the consultation process and the eligible species.

For species undergoing normal consultations, the assessment is forwarded to Governor-in-Council within three months of the publication of the response statements, for those undergoing extended consultations the Minister of the Environment forwards the assessment to the Governor-in-Council once the consultation requirements have been met.

The next step in the listing process involves consultations with affected provincial and territorial governments, Aboriginal peoples, stakeholders, and the general public on whether or not the species should be added to the List of Wildlife Species at Risk under the *SARA*. Where existing lands claims agreements apply to eligible species, such that they fall under the authority of a wildlife management board, the Minister of the Environment will consult with the relevant Board. Aboriginal peoples identified as affected by the potential listing will also be contacted. Environment Canada will also consult with other federal departments and agencies. At the end of consultations, the Minister makes a recommendation to the Governor-in-Council on listing under *SARA*. Within nine months of having received the COSEWIC assessment, the Governor-in-Council must make a decision on whether or not to add the species to the official List of Wildlife Species at Risk. If no action is taken, the species is automatically added. Once listed, the measures to protect and recover a listed wildlife species are implemented.

In spring 2008, COSEWIC completed its most recent re-assessment of the polar bear in

Canada as being a species of Special Concern. COSEWIC provided the Minister of the Environment with this report in August 2008. In November 2008, the Minister of the Environment responded that he intended to make a recommendation to the Governor-in-Council that the polar bear be added to Schedule 1 as Special Concern. Consultations on the proposed listing of the polar bear under *SARA* are underway. A final listing decision is not expected before fall 2010.

International

Listing of the Polar Bear as Threatened Throughout Its Range under the US *Endangered Species Act*

In 2008, the polar bear was listed as a threatened species under the US *Endangered Species Act (*ESA*)*. The decision was based on evidence that showed that loss of sea ice threatens and will likely continue to threaten polar bear habitat. The loss of habitat was identified as the threat that put polar bears at risk of becoming endangered in the foreseeable future, the standard established by the ESA for designating a threatened species.

With its listing under the ESA, the polar bear was automatically declared a depleted stock under the US *Marine Mammal Protection Act* (MMPA). This resulted in US citizens no longer being able to obtain permits under the MMPA to import polar bear parts, including hides and trophies, into the United States from legal sports hunts in Canada. Since 71% of the non-aboriginal hunters that have come to Canada to harvest polar bears have been US citizens (Peacock et al. unpublished), this listing has affected local economic opportunities in northern communities in the NWT and Nunavut. A portion of the total number of polar bear tags in both the NWT and Nunavut can be allocated to non-resident hunters, thus the non-resident harvest does not increase the total number of tags allocated annually. Although the listing will likely mean fewer US citizens coming to hunt in Canada, it is unclear at this time whether the listing will affect the number of polar bears harvested in Canada.

Range States

The 1973 *Agreement on the Conservation of Polar Bears* recognized the special responsibilities and special interests of the States of the Arctic Region in relation to the protection of the fauna and flora of that region, and further recognized that the polar bear was a significant resource of that region that required additional protection. Co-operative conservation of polar bear populations has been a focus of the Parties to the Agreement for over 30 years. With increasing international concern for the conservation of polar bears, there was a critical need for the range countries to renew their cooperative efforts.

Canada participated in the 2007 (Shepherdstown, USA) and 2009 (Tromsø, Norway) meetings of the Polar Bear Range States. The general objective of the meetings was to provide an international forum to discuss the conservation and management of polar bears. These discussions included collecting current information on national management and research programs underway in each country and discussing the status of polar bear populations and factors affecting polar bear conservation, including illegal taking, habitat loss or degradation, pollution, and other human-caused threats. The meetings produced recommendations on possible additional national or collective measures that range countries may consider to further conserve the species.

Canada offered to host the next Range States meeting in 2011, and, in conjunction with Norway as the previous host, will facilitate interim teleconferences to ensure effective collaboration amongst the Range States.

Canada-US Memorandum of Understanding

On 8 May 2008, the US Secretary of the Interior, Dirk Kempthorne, and Canada's Minister of the Environment, John Baird, met to discuss a number of cross-border issues. As part of the meeting, Secretary Kempthorne and Minister Baird agreed to work together toward the long-term protection of the polar bear, which resulted in the signing of the *Memorandum of Understanding Between Environment Canada and the United States Department of the Interior for the Conservation and Management of Shared Polar Bear Populations*. The MOU constitutes an agreement reached between the governments of Canada and the United States to collaborate on issues related to the polar bear, which will complement existing mechanisms. The focus of the MOU will be to act as a forum to develop Canada–United States positions in advance of range states meetings, to provide a mechanism for further consideration of traditional knowledge, and to promote the development and adoption of consistent methodology for polar bear population modeling, data capture, and research.

One of the key initiatives described in the MOU is the establishment of a bilateral Oversight Group. This group is to comprise three representatives from Canada: the Director General of the Canadian Wildlife Service, a provincial/territorial authority, and a representative from a Canadian Aboriginal organization as well as three representatives from the United States, including the Director of the United States Fish and Wildlife Service, a representative from the Alaska Department of Fish and Game, and a representative of Alaska Native tribal government.

The Oversight Group would not act in isolation, but would engage other organizations and stakeholders to facilitate the exploration of different perspectives which could add valuable insight to polar bear conservation.

Proposed Canada-Nunavut-Greenland MOU

Environment Canada, the Department of Environment of Nunavut, and the Department for Fisheries, Hunting and Agriculture of the Government of Greenland are currently drafting a Memorandum of Understanding (MOU) for the conservation and management of polar bears within the Kane Basin (KB) and Baffin Bay (BB) subpopulations. The purpose of the MOU is to effectively manage the BB and KB subpopulations in order to ensure their conservation and sustainable management into the future. It is hoped that the MOU will be ready to be signed by fall 2009.

Current Initiatives

National Conservation Strategy

An initiative of the Polar Bear Administrative Committee, a national conservation strategy for polar bears has been in development for several years in Canada. The draft conservation strategy is intended to be a high-level document that illustrates, strengthens, and formalizes the existing management system. It also seeks to identify current and emerging challenges to polar bear conservation, and to facilitate future conservation initiatives. The high-level conservation strategy is intended to be supported by more detailed inter-jurisdictional agreements, which are also under development.

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Research on Polar Bears in Canada, 2005–2009

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Research on polar bears (*Ursus maritimus*) in Canada is conducted by Federal, Provincial, or Territorial governments and by university faculty. Collaborative research between university researchers and government scientists is coordinated through partnership agreements. International cooperative projects are conducted with research partners in Alaska, Denmark, Greenland, and Norway. Funding is provided by government agencies, universities, wildlife management boards, non-governmental organizations, independent foundations, and competitive grants to graduate students. This report summarises research involving Canadian members of the IUCN/SSC Polar Bear Specialist Group from 2005-2008.

Subpopulation Delineation, Estimation, and Modelling

Aerial Survey Development in Nunavut

Traditional capture-recapture methods have drawn criticism from Inuit co-management boards due to concerns about wildlife drugging and handling. In response to these concerns, the Government of Nunavut is investigating alternative approaches that will better reflect Inuit societal values as well as enable more rapid and frequent assessment of the territory's subpopulations. Numerous researchers (e.g., Belikov *et al.* 1988, Crete *et al.* 1991, McDonald *et al.* 1999, Wiig and Derocher 1999, Evans *et al.* 2003, Aars *et al.* 2009) have conducted aerial surveys to monitor polar bear populations using a variety of methods. However, there remains a need for a robust aerial survey technique to estimate population size across Nunavut's varied landscapes.

Foxe Basin: Southampton Island pilot study and spring trials

Nunavut Department of Environment conducted trials to assess aerial survey sampling techniques across the Foxe Basin (FB) subpopulation and more systematically on Southampton Island in southwestern FB from August–September 2008. The variable topography and high polar bear densities during late summer suggested Southampton Island as a suitable site for a pilot study. Surveys were conducted using a combination of coastal contours spaced at intervals of 500 m, 1.5 km, and 2.5 km from shore and semi-randomized inland transects. Because polar bears tend to congregate along the coast during the ice-free season, sampling effort was concentrated at the 500 m contour. Transects totalling 3800 km were flown over Southampton Island in a Bell 206B Long Ranger helicopter during a 5-d period, resulting in 242 sightings (151 independent bears). The sampled strip width was conservatively estimated at 1 km (i.e., 500 m on either side of the aircraft); thus all sightings >500 m from transects were censored. Lincoln-Peterson sight-resight analyses produced estimates of 93 independent bears (95% CI: 88–99) within 1 km of the coast, and 120 bears (95% CI: 113–126) within 2 km of the coast. Inland sightings were extrapolated across the remainder of the island, yielding a total population estimate of about 203 independent bears. This figure likely underestimates the island's late summer population, as a high density region of south-eastern Southampton Island was unrepresented in the 1.5 km contour and inland estimates, demonstrating the problem of clumped distribution to aerial survey sampling methods. In addition to informing the design of a comprehensive FB survey to occur in fall 2009, this research identified mechanisms to minimize availability bias, including incorporating explanatory variables (e.g., topography) in analyses and adopting conservative strip-widths.

To evaluate the feasibility of a springtime survey in southerly subpopulations, aerial survey trials were conducted in April 2009 across Foxe Basin. Over a 2-week period, 4700 km were flown and 22 individuals (16 independent bears) were observed. Small samples sizes preclude any statistical analyses or conclusions. However, there was a marked decline in detection during the springtime survey compared to the late summer survey. This decrease, likely a product of a more concentrated distribution and greater visibility of bears during the ice-free season, suggests that spring sampling does not provide a practical alternative to a late summer aerial survey in FB and presumably other open-water populations with low topography. Analysis of these data and future refinement of aerial survey techniques will form part of the dissertation of Seth Stapleton, University of Minnesota.

Distance Sampling Aerial Survey of Polar Bears in Western Hudson Bay

In August 2007, Environment Canada conducted a distance sampling aerial survey of polar bears ashore in Western Hudson Bay (WH) to determine how well the technique might work to estimate population size. The recent estimate for WH from capture-recapture methods provided a benchmark. The survey was flown in a Bell 206B Jet Ranger at an altitude of 500 feet AGL. Thirty-two transect lines, oriented east-west, were flown between Churchill and the Nelson River in addition to the coast between Churchill and the Nelson River. Laser range finders were used to determine the perpendicular distance of each bear from the helicopter. Covariates including habitat type, age- and sex-class, activity of animals when sighted, and weather conditions were recorded. Transects totalled 4,500 km in 33.9 hours. Observers counted 108 bears on the coastal transect and 120 on the east-west transects.

On the coastal transect the left front observer essentially saw 'all bears', whereas the probability of a bear being detected by either the left rear or right rear observer increased with distance from the aircraft. For the inland transects, if a bear was seen by the front observer, there was a higher probability that it was seen by the right rear observer than by the left rear observer. If a bear was seen by either the right rear or left rear observer, the probability of it being seen by the front observer was greater if the bear was on the left side of the aircraft than on the right. The number of bears estimated from the aerial survey was 408 (95% CI = 280-593). Of that total, 108 were coastal and 300 inland. These numbers do not reflect the current size of WH (Regehr *et al.*2007*a*), because the aerial survey was conducted in only a sub-region of WH.

Subpopulation assessment studies

Davis Strait

Nunavut Department of Environment (DOE) conducted an inventory of the Davis Strait (DS) subpopulation from 2005–2007. These data, combined with data from earlier studies (1974–1999) (2,037 capture events, 139 harvest events of marked individuals), were used to evaluate changes in recruitment and abundance, and trends in survival using a Burnham mark-recapture-recovery model. The subpopulation increased from approximately 900 bears in the late 1970s (likely a low-biased estimate) to 2,142 in 2007 (95% CI 1,811–2,534). Natural survival increased for all sex and age classes, but has now stabilized. We included time covariates to examine variation in survival: total ice concentration from May–October, abundance of harp seals (*Phoca groenlandica*), the Arctic Oscillation, and the average age of adult polar bears. The most important variable was the abundance of harp seals which primarily affected sub-adults (β = 0.31 ± 0.44 (SE), non-subadult; β = 2.96 ± 1.3, subadults). Average age of adults also increased (β = 2.06 ± 0.45, F = 20.66, p 0.00, df = 812; mean age in 1970s, 9.20 ± 4.55 and from 2005–2007, 11.26 ± 5.06). As average adult age increased, survival decreased primarily for sub-adults (β = -0.10 ± 0.54 for non-subadults; β = -3.00 ± 1.3 for subadults). The influence of ice conditions on survival was complex, as ice duration increased from 1974–1983, but has decreased since 1984. With summer ice concentration <20%, there is a negative relationship between polar bear survival and ice concentration; this metric of ice concentration has not exceed 16.8% since 1995. The increase in polar bear density was likely due to the increase in seals and relatively low harvest rate (2.8%). Using new estimates of natural survival and recruitment parameters, the 10-year mean λ (unharvested) is 0.99 ± 0.0005 (SE). We conclude that the population likely peaked just prior to 2007 and is now declining.

Foxe Basin

The Foxe Basin subpopulation has received little recent research attention (Lunn *et al.* 1987, Taylor *et al.* 1990). No population boundary delineation using satellite telemetry has occurred and demographic rates have not been estimated. The mean population size for polar bears in FB from 1989 to 1994 was estimated to be 2197 ± 260 SE (Taylor *et al.* 2006). In recent years, Inuit Knowledge has indicated increases in sightings of polar bears, resulting in an increase in the 2005 Total Allowable Harvest (TAH) from 97 to 106 polar bears, which was considered sustainable with a population estimated at 2,300 bears.

Population delineation—In an effort to delineate the FB population, NU DOE deployed satellite GPS collars (Telonics Gen III and Gen IV Argos/GPS) on adult females accompanied by cubs during 2007-2009. Unfortunately, many collars failed apparently due to premature opening of Telonics CR-2A remote release devices. In August 2008, 4 satellite ear tags (Mikell Vellum) were deployed on adult male polar bears (average retention, 108 ± 7 days). Information from these collars will be used for habitat and movement analyses. Delineation using cluster-analysis (Taylor *et al.* 2001) will incorporate data from FB collected by 2010 and, the neighbouring subpopulations of Gulf of Boothia (Taylor *et al.*2009), Southern Hudson Bay (M. Obbard, Ontario Ministry of Natural Resources), and Western Hudson Bay (A. Derocher, University of Alberta).

Population and status assessment—As part of the population delineation and habitat ecology study in FB, 35 bears were captured in 2007 and 78 in 2008; these captures will ultimately be used in mark-recapture-recovery modelling to estimate polar bear population size and survival in FB. The initial plan was to start a large-scale mark deployment in FB in 2008; however, this was cancelled due to Inuit concerns over drugging polar bears. It is unlikely that vital rates will be estimated for this population. All independent bears handled in 2008 (n = 33) were fitted with a radio-frequency identification (RFID) ear tag in the right ear. Bears with RFID tags could be identified from 2km at 1,000 ft above ground level (AGL), and 1 km at 400 ft AGL. RFID tags were retained on all polar bears that were opportunistically observed up to 3 weeks post deployment. One bear was harvested in Coral Harbour, NU 6 months after deployment; the RFID tag remained attached to the ear. NU DOE intends to continue tests of the RFID tags.

Northern Beaufort Sea

The Canadian Wildlife Service (CWS) conducted a 4-yr capture-recapture study of the Northern Beaufort Sea (NB) subpopulation from 2003-2006. These data were combined with previously collected data, and open population capture-recapture models were applied over a 35-yr period. Capture records for 1031 individual bears from 1971-2006 were used to assess the relationships between polar bear survival and sex, age, time period, and a number of environmental covariates (Stirling *et al.* 2007). Model-averaged estimates of survival (which include harvest mortality) for senescent adults ranged from 0.33 (1980s, males) to 0.92 (1990s, females). Estimates of cub-of-the-year (COY) and yearling survival ranged between 0.10 (1980s, male yearlings) and 0.97 (1990s, female COY). Survival of subadults and adults were nearly identical and ranged from 0.61 (1980s, males) to 0.97 (1990s, females). Wide confidence intervals for survival of young age classes were likely due to small sample sizes. In addition, we modeled recapture probability as a function of three covariates (*effort*, *radio.vhf*, *radio.satellite*) that quantified search effort and whether adult female polar bears were wearing a VHF or satellite radio collar. Models that allowed associations between annual variation in survival, habitat, or relative seal abundance variables were not, in general, supported by the data. The model-averaged estimate of subpopulation size from 2004–2006 was 980 (± 155, 95% CI) and was not significantly different from estimates for the periods 1972–1975 (745 ± 246, 95% CI) and 1985–1987 (867 ± 141, 95% CI).

We suggest that the current estimate of 980 bears is conservative due to the strong possibility of an underestimate in 2006, and that the estimates of 1100–1200 in 2004 and 2005 may more accurately reflect the current number of bears in NB. These abundance estimates apply primarily to that segment of the NB subpopulation residing west and south of Banks Island to the mainland coast, plus a small but unknown fraction of the population residing farther north around Prince Patrick Island. In 1992–1994, capture effort focused in the area around Prince Patrick Island confirmed significant mixing between northern and southern segments of the population, that some bears residing in the extreme northern portions may not have been equally available for capture during other sampling periods, and that the number of bears around Prince Patrick Island was small relative to the rest of the subpopulation. Therefore, our estimates of total abundance during the other three sampling periods were considered to be slightly low. Currently, the NB subpopulation appears to be stable, probably because ice conditions remain suitable for feeding through much of the summer and fall in most years and the Inuvialuit harvest has not exceeded sustainable levels. Details on the analysis, results and conclusions of this study may be found in Stirling et al. (2007).

Southern Beaufort Sea

In collaboration with the US Geological Survey (USGS), the CWS conducted a 4-yr capture-recapture study of the Southern Beaufort Sea (SB) polar bear subpopulation from 2003–2006. Polar bears in the US portion of the study area were captured between Barrow, Alaska, and the Canadian border from late March through early May of 2001–2006, and bears in the Canadian portion of the study area were captured by the CWS between April and May of 2003–2006. Regehr *et al.* (2006) estimated that there were 1,526 (± 315, 95% CI) polar bears in the SB region in 2006. Although the number of bears in the SB subpopulation had previously been estimated at 1800 individuals, a lack of precision between estimates prevented any firm conclusions regarding a potential population decline.

Regehr *et al.* (2007*b*) used multi-state capture-recapture models that classified individuals by sex, age, and reproductive category to estimate vital rates of SB bears. These vital rates were subsequently evaluated in relation to the duration of the ice-free period over the continental shelf in the southern Beaufort Sea. The best supported models included dependence of yearly survival rates on the duration of the ice-free period, and included time variation in breeding probabilities. In addition, both adult female survival and cub-of-the-year litter survival were shown to vary with sea ice conditions. The role of varying demographic rates in relation to sea ice dynamics was further investigated by Hunter *et al.* (2007) using a female-dominant stage-classified matrix population model in which individuals were classified by age and breeding status to investigate the role of sea ice dynamics in population level growth rates in the southern Beaufort Sea. A time-invariant deterministic model estimated the overall growth rate for the population to be 0.997 indicating a 0.3% decline per year. Growth rate was most elastic to changes in adult female survival. Results from both deterministic and stochastic population projections from this study predict serious declines in SB over the next century if sea ice conditions continue to degrade as predicted by global circulation models.

Southern Hudson Bay

The Ontario Ministry of Natural Resources conducted a 3-yr capture-recapture study of the Southern Hudson Bay (SH) subpopulation from 2003–2005; these data were combined with similar data for 1984-86,and with less intensively collected data from 1999-2002 (Obbard *et al.* 2007). A reanalysis was conducted in 2008; those results are reported here. Capture-recapture information was available on 863 individual polar bears, 356 of which were captured during 1984-1986, 516 of which were captured from 1999-2005, and 9 of which were captured in both periods. The geographic distribution of capture locations was similar between intensive capture-recapture periods, though the distribution of bears varies somewhat among years due to differences in sea ice dynamics. We applied Cormack-Jolly-Seber (CJS) open population capture-recapture models to data collected from 1984–86 and 1999–2005 to estimate population size and survival. We used a variety of individual, environmental, and time-varying covariates to explain variation in survival and recapture probabilities.

The mean population size for 1985–1986 was 634 (± 244, 95% CI). The mean population size from 2003–2005 was 673 (± 277, 95% CI). Model-averaged survival estimates provided weak evidence for a decline in total apparent survival of all age and sex classes between 1984–86 and 1999–2005. Six of the top 10 models with ΔAIC_c values ≤ 4.0 contained year effects. However, sampling variation was large and these declines (~3% for subadult and adult females and 4% for males) may reflect sampling error. Nonetheless, a decline in survival of this magnitude is consistent with the hypothesis that the SH subpopulation is currently under stress. Such declines may eventually have negative demographic consequences because of the high sensitivity of population growth rate to changes in adult female survival. If the body condition of polar bears in SH continues to decline, effects on reproduction will become evident. This suggests that SH is at an ecological tipping point and the net result will be a future decline in abundance.

Western Hudson Bay

Analysis of capture-recapture data—Environment Canada completed analysis of capture-recapture data for the WH subpopulation (Regehr *et al.* 2007*a*). A flexible extension of Cormack–Jolly–Seber capture–recapture models was used to estimate population size and survival for polar bears captured from 1984 to 2004 along the western coast of Hudson Bay and in the community of Churchill, MB. Population size declined from 1,194 (± 174, 95% CI) in 1987 to 935 (± 141, 95% CI) in 2004. Total apparent survival of prime-age polar bears (5–19 yr) was stable for females (0.93; 95% CI=0.91–0.94) and males (0.90; 95% CI=0.88–0.91). Survival of juvenile, subadult, and senescent polar bears was correlated with spring sea ice breakup date, which was variable among years and occurred approximately 3 weeks earlier in 2004 than in 1984. This correlation suggests a causal association between earlier sea ice breakup (due to climatic warming) and decreased polar bear survival. It may also explain why Churchill, like other communities along the western coast of Hudson Bay, has experienced an increase in human–polar bear interactions in recent years. Earlier sea ice breakup may have resulted in more nutritionally stressed bears, which are more likely to come into conflict with humans. Because WH is near the southern limit of the species' range, these findings may foreshadow the demographic responses and management challenges of more northerly subpopulations if climatic warming in the Arctic continues as projected.

Survey of WH north of the Seal River—Polar bear abundance, survival, and body condition have declined in WH (Regehr *et al.* 2007*a*, Stirling *et al.* 1999). These trends were based on data collected primarily between the community of Churchill and the Nelson River to the south. However, the northern boundary of the subpopulation is Chesterfield Inlet more than 300 miles north of Churchill. In their recent assessment, Regehr *et al.* (2007*a*) cited Derocher and Stirling (1990) and N.J. Lunn and I. Stirling (personal communication) as indicating that polar bears were "rarely seen along that (Churchill to Chesterfield Inlet) section of coast until freeze-up begins in late autumn". This information contradicted recent Inuit Knowledge from hunters and elders indicating that polar bears were common north of Churchill during August and September, and could be found in both coastal and inland areas (Nunavut Tunngavik Inc. 2007, Tyrrell 2007). Failure to sample the entire demographic unit can result in unaccounted for capture heterogeneity, which causes both survival and population numbers to be underestimated. Additionally, the failure to sample the entire summer retreat area left open the possibility that the decline identified by Regehr *et al.* (2007*a*) was due to permanent northward emigration of bears from the areas searched by capture teams.

To address these concerns, coastal and some inland areas were surveyed by helicopter from Chesterfield Inlet, NU to the Seal River, MB in the autumn of 2007. Twenty-five polar bears were sighted and captured. Of the 22 independent bears captured, 10 were previously marked by CWS or Manitoba Department of Conservation (MDOC). The proportion of marked individuals in the capture sample (0.46) was similar to that in the Nunavut harvest from 1984–2003 (0.48, SE=0.11). The proportion of marked animals in the long-term CWS capture sample was 0.59 (SE=0.01), and in the MDOC capture sample it was 0.59 (SE=0.01) (Regehr *et al.* 2007*a*). This suggests that the bears encountered north of the Seal River are not a spatially distinct sub-group of the WH population during the time of year when most of the sampling reported in Regehr *et al.* (2007*a*) occurred. There was no significant difference in latitude between marked and unmarked bears, rejecting the hypothesis that polar bears that summered north of the CWS study area in 2007 were less likely to be captured in the CWS-MDOC study.

This survey supported the conclusions of Regehr *et al.* (2007*a*). Nevertheless, the fall study area for WH should be expanded into Nunavut, as bears may increasingly occur in the Kivalliq region should the distribution of bears shift northward.

Identifying Units of Conservation for Polar Bears in Canada

The global population of polar bears comprises 19 relatively discrete subpopulations. However, the degree of genetic exchange differs among subpopulations resulting in varying degrees of relatedness between groups. Paetkau *et al.* (1999) identified 4 genetic clusters of polar bears in the Canadian Arctic. Under the Canadian Species at Risk Act, separate legal protection may be given to intraspecific groups or designatable units (DU) that are genetically, geographically, or biogeographically distinct. Following the framework developed by Green (2005), and subsequently adopted by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), DUs can be assigned when distinct groups have different conservation needs. Thiemann *et al.* (2008*a*) examined the conservation status of polar bears across the Canadian Arctic and integrated ecological and genetic data to determine if the DU framework could be applied to polar bears. The authors concluded that threats to the conservation of polar bears are not spatially uniform and identified five DUs that captured broad patterns of polar bear biodiversity. Thiemann *et al.* (2008*a*) suggested that the current approach to polar bear conservation in Canada is flawed and called for an improved framework that considers the ecology of the species and the environmental changes it is currently facing.

Traditional Knowledge and Human Dimensions Research

Identifying polar bear maternity denning habitat in the Mackenzie Delta and near shore Beaufort Sea: integrating science and traditional knowledge

In response to potential oil and gas development in the Mackenzie Delta, CWS conducted a 4-yr program to identify and map important polar bear maternity denning habitat of the SB subpopulation. Researchers conducted aerial surveys in March from 2006–2009 to locate active maternity den sites. In addition to aerial surveys, CWS in association with the Northwest Territories Department of Environment and Natural Resources and the various Hunters and Trappers Committees conducted interviews in the spring of 2008 to document Traditional Knowledge of denning areas and areas used by females with cubs.

Den sites located during spring aerial surveys were visited in summer to quantify site-level habitat characteristics for the development of a landscape level maternity denning habitat model. Nine maternity den sites were located from 2006–2009 during aerial surveys, and 110 den locations were identified during 47 interviews conducted in the Inuvialuit Settlement Region (Tuktoyaktuk n = 26, Aklavik n = 10, Inuvik n = 11). Data from these interviews provided an important historical perspective on denning activity in SB, and den locations identified by local individuals confirmed the spatial information on denning activity from aerial surveys and satellite telemetry data. Research on the development of a landscape-level maternity denning habitat model is ongoing and a final report for this program is expected in 2010. This study will form part of the dissertation of Evan Richardson, University of Alberta.

Local Knowledge of Polar Bears in the Davis Strait Area

The *Nunavut Land Claims Agreement* creates a polar bear management system that a) serves and promotes the long-term economic, social, and cultural interests of Inuit harvesters and, b) invites public participation and promotes public confidence, particularly amongst Inuit; therefore, the Government of Nunavut is making an effort to ensure that local values are available for decision-making. Nunavut DOE gathered traditional and public knowledge in Pangnirtung, Iqaluit, and Kimmirut—communities that harvest from the DS subpopulation. To gather traditional knowledge, elders and hunters were interviewed about polar bears, climate change, Inuit knowledge, and research. To gather public knowledge, public opinion polls were conducted at randomly selecting houses. Public opinion polls are a commonly used method to inform decision-making. For the public opinion poll, the social carrying capacity (Minnis and Peyton, 1995, Beyer *et al.*, 2006, Peyton *et al.*, 2001) of local residents for polar bears was assessed. This involved asking respondents about the current polar bear abundance and what were their preferred, lowest, and highest tolerated polar bear abundance. "There are currently many polar bears" was the most common response. For the preferred polar bear population size is, "[that] there are polar bears" was the most common response.

Inuit knowledge of Foxe Basin polar bears

In 2009, the Inuit knowledge interview component of the FB polar bear project began with objectives to: 1) document Inuit knowledge of Foxe Basin sea ice habitat used by polar bears, seasonal movements and distribution, denning habitat, prey, and behaviour; and 2) explore approaches for incorporating Inuit knowledge with scientific knowledge. Inuit knowledge was collected using semi-directed interviews. An interview guide with a list of questions categorized by topic was used to direct the discussions with individuals and focus groups. Regional maps were used during each interview to mark polar bear habitat, concentration areas, prey, and other important locations. Research participants were Inuit elders and active, long term polar bear hunters from Coral Harbour, Repulse Bay, Hall Beach, Igloolik, Cape Dorset, and Kimmirut. Expansion to Chesterfield Inlet is planned. Forty-six people were interviewed. The original audio and video recordings and transcripts will be archived at the Igloolik Research Centre, Igloolik, NU.

In addition to this new information, the existing oral history collections (Igloolik Research Centre, Parks Canada) and Nunavut government reports were reviewed for pertinent information about polar bears and seals. Polar bear, seal, walrus (*Odobenus rosmarus*), ocean currents, and sea ice GIS layers from the 1990s Hudson Bay traditional knowledge study, Inuit land use and occupancy study, and the Nunavut coastal resources inventory have been obtained. All information will be combined to form the Foxe Basin Inuit knowledge of polar bears database. The Inuit knowledge and satellite telemetry data will be assembled to create seasonal habitat-use models. Inuit knowledge will also contribute to validation of fine scale habitat selection models derived from telemetry location data and satellite imagery. The study will form part of the dissertation of Vicki Sahanatien, University of Alberta.

The Roles of Inuit Knowledge and Scientific Expertise in Polar Bear Management in Nunavut

This study is examining the roles of Inuit knowledge and scientific expertise in the contemporary management of polar bears in Nunavut. Through the creation of the Nunavut Territory in 1999, Inuit knowledge has gained official status in wildlife management, as well as in the general governance process. However, the meaningful contribution of Inuit and scientific knowledge to environmental decision-making is currently posing various challenges to resource users, and to wildlife biologists and managers. This research explores the ways in which different types of knowledge are constructed, identified, transformed, and authorised through the process of managing polar bears in Nunavut. The project will contribute to a better understanding of the histories of science and environmental governance in the Canadian Arctic, the cultural production of environmental knowledge, and the relational networks in which resource users, managers and knowledge producers move and operate in Nunavut's socio-political landscape. It also aims to contribute to the formulation of more effective and culturally sensitive polar bear management practices. The study will form part of the dissertation of Dominique Henri, University of Oxford.

Feeding and Dietary Studies

Examining the fasting physiology of polar bears in the SB using serum urea and creatinine

The ratio of serum urea to serum creatinine was used as a physiological biomarker of fasting to monitor the feeding ecology of polar bears in the Beaufort Sea. Blood was drawn from 436 polar bears on the Canadian side of the Beaufort Sea during April and May of 1985–86 and 2005–06. Polar bears that had serum urea/creatinine values $\leq$ 10.0 were considered to be in a physiological fasting state. The proportions of bears fasting at the time of capture were: 9.6% in 1985, 10.5% in 1986, 21.4% in 2005, and 29.3% in 2006. Logistic regression was used to determine whether fasting state was affected by year and sex, age, and reproductive class.

Bears captured in 2005 and 2006 were more likely to be fasting than bears in 1985 and 1986. In addition, adult males in all years were more likely to be fasting than other classes. The increased number of polar bears in a fasting state from all sex, age, and reproductive classes in 2005–06 corresponded with broad scale changes in ice composition in the Beaufort Sea, which likely affected the availability of prey. The higher proportion of adult males fasting from all years was likely due to spring breeding behaviour. This study will form part of the dissertation of Seth Cherry, University of Alberta.

Dietary analyses in seasonal-ice populations

Nunavut DOE analyzed hair samples obtained from captured polar bears from seasonal sea ice populations (Davis Strait, Baffin Bay) and multi-year sea ice populations (Viscount Melville, Lancaster Sound, Norwegian Bay and Kane Basin) for isotopic structure. Initial objectives were to evaluate whether sufficient archived samples existed to examine temporal changes in diet in DS. However, the study also examined geographic variation across two ecoregions for polar bears and age-class differentiation in diet.

Preliminary analysis suggests that there is significant structure (a high degree of dietary variability) in the 952 hair samples analyzed for carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable-isotopes. Results suggest that polar bears forage at various trophic levels, shown by the variation in $\delta^{15}N$, and have both pelagic and benthic influences in their diet. Sufficient sampling variation exists to examine seasonal differences in diet within seasonal-ice populations suggesting significant difference in both trophic level and benthic-pelagic feeding patterns of polar bears between the spring and fall. Subadult bears in Davis Strait appear to eat at lower trophic levels than adult bears, though there is an interaction between sex and age class. In general, female bears show significantly less pelagic feeding and also forage at lower trophic levels than male bears.

Initial analyses suggest that there may have been some change in the concentrations of both the N^{15} and C^{14} isotopes in polar bear tissues in the fall in Davis Strait. However, sample size for the 1990s is low (n = 21) compared with the 2000s (n = 452), and more sophisticated analyses must be conducted to determine the significance of this apparent change. Preliminary results suggest that polar bears had higher trophic level feeding and less pelagic feeding in the 1990s than 2000s. Analyses are ongoing to examine isotopic structure of terrestrial and pelagic food sources in Davis Strait to quantify contribution to diet.

Use of Fatty Acid Signature Analysis to Study Polar Bear Diets

Though polar bear populations generally depend on the availability of ringed seals (*Phoca hispida*), individual polar bears may alter their foraging habits to exploit locally abundant alternative prey. This study examined broad scale foraging patterns of polar bears across the Canadian Arctic, using a quantitative fatty acid signature analysis. The technique is based on the fact that dietary fatty acids are predictably incorporated into the fat stores of predators. Adipose tissue samples were collected from polar bears and their marine mammal prey in 10 Canadian subpopulations and a multivariate least squares model (Iverson *et al.* 2004) used to estimate the diet composition of individual bears.

In most areas, polar bear diets were dominated by ringed seals, but in the eastern Arctic bears fed primarily on harp seals. Some individuals fed substantively on other prey including bearded seal (*Erignathus barbatus*), beluga whale (*Delphinapterus leucas*), and walrus. Diets were generally similar within broad geographic regions (e.g., within the Hudson Bay–Foxe Basin complex), but also showed some variability at finer spatial scales. Diets differed significantly between bears of different age and sex classes, with large adult males being the primary consumers of bearded seal and walrus. Polar bear diets differed among years, especially in Western Hudson Bay and Davis Strait, apparently in response to bottom-up food web effects likely associated with climate change (see Thiemann et al. 2008*b*). Ongoing work is aimed at examining temporal changes in the diets of individuals and identifying the habitat characteristics that influence foraging habits.

Contaminants Studies

Influence of diet and metabolism on accumulation of chemicals

In this study, polar bears harvested by hunters and conservation officers in communities spanning the Canadian Arctic were sampled in 2007 and 2008. Over the course of 2008, samples of fat or liver were analyzed for a diverse suite of chlorinated and brominated contaminants and degradation products and for fluorinated and precursor contaminants. Information was also collected on diet using isotopes of carbon and nitrogen (in muscle) and fatty acid profiles (in fat) of both the polar bears (fat) and their prey, ringed seals (blubber). Archived fat samples from WH spanning 1991-2007 held in Environment Canada's National Wildlife Research Centre Specimen Bank were analyzed to examine relationships among sea ice break-up date, diet, and temporal trends in contaminant levels.

Differences in the timing of the annual sea ice breakup explained a significant proportion of the diet variation among years McKinney *et al.* (2009). There was an increase in open water-associated versus ice-associated seal species (ringed seals vs. harbour seals [*Phoca vitulina*]) in years of earlier sea ice breakup. This dietary change influenced trends in contaminants. In some cases it appeared to increase them (e.g., flame retardants) and in some cases decreased them (e.g., PCBs). These results suggest that climate change is a modulating influence on the diet and consequently persistent chlorinated and brominated contaminants in WH bears.

Health and Environment

Non-invasive stress monitoring

Environmental change due to human activities is believed to negatively affect the sustainability of wild animal populations. Assessing the health of wild animal populations using traditional wildlife biology approaches is difficult, especially for large mammalian carnivores such as polar bears, and there is a need to develop novel approaches. The objective of this study is to develop, validate, and apply the determination of cortisol (the primary stress hormone associated with the hypothalamic-pituitary-adrenal axis) in hair as a sensitive, reliable, and non-invasive measure of long term stress in free-ranging polar bears. The first phase (2008) of this research involved development of the hair cortisol extraction procedure and extensive evaluation of the accuracy and breadth of application of the procedure. The second phase (2009-10) will validate the technique in a large number of hair samples collected from polar bears captured in SH during 2007-09. Finally, hair cortisol data will be compared with measures of environmental change, individual animal health, and other measures of long term stress collected invasively from the same bears. Future use of this technique should be broadly applicable to any mammal with hair, including other species at risk. This study will form part of the dissertation of Brian McNab, University of Saskatchewan.

Serum proteins as indicators of stress and health

Currently, there are few data regarding the health status of polar bears. One of the key components of wildlife health is the stress status of individual animals, but there are no clear indicators to assess stress levels across wildlife populations. In parallel with the "non-invasive stress monitoring" research described above, this study is identifying and validating blood serum proteins that may indicate long-term stress or altered health status in polar bears captured for management or research purposes.

To date, cortisol binding globulin (CBG) has been cloned and sequenced from grizzly bear (*U. arctos*) serum and a polyclonal antibody was generated to a peptide fragment from the deduced bear CBG amino acid sequence. This anti-bear CBG antibody cross-reacts well with polar bear CBG and is now being used to investigate established differences in serum cortisol levels between polar bears from WH and SH. Several serum proteins were identified, based on proteomic analysis, which are differentially expressed in grizzly bears in response to stressors. Most of the proteins are acute phase proteins that are part of the acute phase response (APR) in mammals. Classically, the APR was known to be induced by inflammatory stressors, such as bacterial infection. However, recent studies showed that non-inflammatory, psychophysical stress can also induce the APR and long-term expression of this response is associated with growth failure in many animal species and humans due to the disruption of homeostasis. Consequently, acute phase proteins are being used as biomarkers of altered health status in domestic animals and humans.

Commercial antibodies to several acute phase proteins cross-react well with bear proteins, and these antibodies will be used during 2009-10 to measure acute phase protein levels in serum collected from polar bears captured in WH and SH. To validate these measures as indicators of altered health, acute phase protein levels will be correlated with measures of individual animal health (growth, reproduction) and measures of long term stress (serum and hair cortisol, serum heat shock proteins, serum CBG) collected from the same bears. These studies will form part of the dissertation of Brian Chow, University of Waterloo.

Movement Studies

Ecology of polar bears in the Southern Beaufort Sea

In April and May 2007-09, satellite-linked GPS collars (Telonics, Mesa, AZ) were deployed on adult and juvenile polar bears in the SB subpopulation. The objectives of this study are to examine site fidelity and movement patterns. The core interest groups are subadult females and subadult males. The study deployed 18, 11, and 25 collars in the three years of the study. This project is continuing to generate insights into polar bear spatial ecology and a final year of collar deployment is planned for 2010. All collars were equipped with remote release devices (Telonics CR-2a releases). For subadults, these were programmed to release in 14 months; adult collars were programmed to release at either 14 or 26 months.

Eighteen bears collared in 2007 moved an average distance of 5,399 km and were monitored for an average of 300 days. Though the movements of most bears were concentrated in the SB subpopulation area, 12 of 18 bears moved into the NB region. There was also evidence of emigration to the west as 4 bears collared in 2007 travelled west and north of the SB boundary. Though 1 of these collars stopped transmitting in January 2008, the other 3 provided locations until June or July 2008. These bears (1 subadult and 3 adult females) had not returned to their previous spring capture locations.

Poor weather in 2008 precluded deployment of all collars. Of the 11 bears collared in spring 2008, 8 moved west into Alaska. Of these, 3 bears moved 400-500 km offshore, which put them beyond the boundaries of the SB subpopulation. Although 2 of the collars deployed in 2008 failed prematurely, the others provided a picture of how polar bears cope with ice-free conditions off the Alaskan coast. Two bears were near the coast of Alaska and remained onshore throughout the ice-free period. One bear was on or near the coast since mid-June whereas another bear moved from approximately 200 km offshore at the end of June to within 30 km of the coast. Satellite data indicate there was little or no ice in the area, so the status of this bear was uncertain. Overall, these results suggest that the majority of bears in the SB moved north with the receding pack ice, rather than remaining onshore.

As sample size has increased, age- and sex-specific differences in movement patterns have appeared. Juvenile males had the highest average movement rates at 22.7 km/day, followed by juvenile females at 19.9 km/d and adult females at 19.5 km/d. These preliminary data support the hypothesis that juvenile polar bears, especially males, may move more than other bears but the level of fidelity is still being assessed. It is important to note that of the 4 bears that appeared to emigrate from the population in 2007, all were female and 3 were adults.

Three bears collared in 2008 showed strongly directional westward movements into the Chukchi Sea subpopulation. These bears included an adult female, a subadult male, and a subadult female. This last bear was also collared in 2007 and spent nearly all of its time in the Canadian portion of SB. This bear did not show annual spatial fidelity. In contrast, the only other bear to wear a collar in both 2007 and 2008 has remained near the coast in both years. This bear also visited the village of Kaktovik in both 2007 and 2008. Preliminary data from these two bears (one a juvenile and the other an adult) suggest that polar bears may show increased spatial fidelity with increasing age. The study will be useful for analysis of the potential effects of offshore petroleum exploration and development on the Canadian side of the Beaufort Sea. The study will form part of the dissertation of Evan Richardson, University of Alberta.

Effects of climate change on the on-ice movements of Southern Hudson Bay polar bears

Research on the genetic structure of Hudson Bay polar bears (Crompton et al. 2008) suggested that some male and female bears in the SH subpopulation show fidelity to breeding areas and suggested that gene flow, especially between SH and WH, would be interrupted by future changes to sea ice patterns. To address this hypothesis, Telonics GPS/satellite collars were deployed on adult female polar bears along the Ontario coast in 2007 (9), 2008 (13, and 2009 (15). Data will provide detailed information on movements and locations during the spring breeding season that may identify breeding areas and provide insights into the effects of predicted changes to sea ice distribution and duration on gene flow among the Hudson Bay subpopulations. This study will form part of the M.Sc. thesis of Kevin Middel, Trent University.

Assessing movements and habitat use of adult female polar bears in Western Hudson Bay

This project uses Telonics GPS collars to monitor polar bear movement patterns, habitat selection, and home ranges, as they relate to seasonal and yearly sea ice dynamics in WH. The Hudson Bay marine ecosystem experiences a high degree of natural intra-annual variation in sea ice composition and extent, which makes it an ideal location to study polar bear movement in relation to changing ice conditions. It is also home to the southernmost polar bear populations in the world where longer-term effects of climate change on polar bears are well documented. Climate change scenarios for Hudson Bay forecast greater temperature increases than average global predictions; this will likely result in longer ice-free periods and less consolidated winter sea ice. Monitoring how the WH subpopulation responds to these changes will be important to future global polar bear conservation initiatives.

Between 2004 and 2008, 59 GPS collars were deployed on adult female polar bears. In addition, data from 46 Doppler shift satellite-linked collars deployed between 1991 and 1999 were included in analyses. In 2007 and 2008, collars were equipped with CR-2a release mechanisms with pre-programmed drop-off dates. Results suggest that movement patterns were not dependent on reproductive status, but changed significantly with season. Annual distance moved by bears in WH has decreased since 1991, which suggests that measured declines in bear condition and numbers may be due to reduced prey intake. Additional analyses will continue to monitor these trends in movements.

Currently, data from these collars are being used in individual and population level habitat selection analysis. In addition, collars are monitoring the amount of time bears spend onshore in the summer ice-free period. These data are being used to examine the relationship between climate change and the length of the summer fasting period for the WH polar bear population. Movement data are also being used to examine fidelity to specific regions in western and southern Hudson Bay during the summer months. In 2007, 4 out of 9 collared polar bears came ashore outside of the WH subpopulation boundary in Ontario. Possible environmental correlates associated with varying degrees of fidelity to the western Hudson Bay coast are being examined. This study will form part of the dissertation of Seth Cherry, University of Alberta.

Polar bear movements and sea ice habitat in Foxe Basin

The objectives of this study are: 1) to obtain baseline data on movements and home ranges of FB polar bears, 2) to describe polar bear sea ice habitat characteristics using resource selection models, 3) to investigate the relationship of polar bear movements with sea ice features, and 4) to model the effects of climate change on polar bear sea ice habitat. We are using data from satellite collars deployed from 2007–2009.

Annual home ranges for FB bears with at least three seasons of data ranged from 108,348–339,681 km². Annual home range sizes in FB are larger than those reported for the northern Beaufort Sea and similar to those in SB and WH. All FB seasonal home range sizes increased from open-water to freeze-up, then most decreased during the winter season. The total annual distance moved for bears with at least three seasons of data ranged from 3,254 to 7,064 km.. Distances moved monthly by adult females in FB are generally larger than those reported for SB and NB subpopulations. Mean movement rate during freeze-up was greatest, followed by rates during the winter and the open-water seasons. These rates are similar to those reported for WH. Polar bears had greater residence times on large (2- 10 km) ice floes except during October and November freeze-up when small ice floes (< 500 m) were used. Landfast ice received little use in all seasons. Movement rates over different sizes of ice floes were similar. Sea ice habitat is being studied at multiple scales using sea ice maps (Canadian Ice Service), MODIS, EnviSat, and SSM/I images. Spatial, predictive resource selection models will be developed for FB habitat selection using discrete choice modeling and Canadian Ice Service ice maps. Habitat selection by family group type, age, and gender will be compared by sea ice year and season. The relationship of polar bears with sea ice features (polynyas, leads, landfast floe edge) is being investigated using MODIS and EnviSat imagery.

Preliminary analyses of sea ice concentration (SSM/I) and available polar bear habitat from 1979–2004 have been conducted using trend and landscape fragmentation analyses. Overall, available polar bear habitat in Foxe Basin during fall and spring is decreasing and becoming increasingly fragmented. This analysis will be expanded to include Hudson Bay and the 2005–2009 SSM/I data. Analyses and reporting of these data will form part of the dissertation of Vicki Sahanatien, University of Alberta.

Other Ecological Studies

Distribution of permafrost in Hudson Bay Lowlands of Ontario

In the Hudson Bay Lowlands of Ontario, pregnant polar bears often dig maternity dens in the sides of permafrost features called palsas (Obbard and Walton 2004). Predictions from climate change models suggest a 50% reduction of permafrost in the HBL by 2100 (Gough and Leung 2002), yet no thorough mapping of the current distribution of permafrost has been conducted. Helicopter-based transects to document the distribution of permafrost were conducted in 2007 and 2008.

Two remote weather stations were established to provide long-term monitoring of meteorological data. Data from these stations can be combined with data available from Environment Canada for the airports at Fort Severn and Peawanuck. Additional surveys are planned for 2009 and a third weather station will be established near the James Bay coast to complete a small network between the James Bay coast and the Severn River.

Terrestrial distribution of polar bears in Western Hudson Bay and problem bear dynamics

Long-term patterns of polar bear distribution in WH during the ice-free season were examined along with the temporal and spatial patterns of problem bears near Churchill, MB. A distributional shift of bears occurred towards the northeast over 1986-2004 (Towns *et al.* 2009). Bears do not travel as far inland as they once did. Similar to earlier studies, the population remains segregated by age and sex class; however, changes in this distribution suggest bears are adapting their behavioural response. A higher proportion of females with young was near the coast in 2002–04 compared with 1986–2001.

The number of problem bears near Churchill has increased. The northward shift in bear distribution brings bears closer to Churchill and distance from the town was inversely related to the probability of being a problem bear. The declining condition of bears in the subpopulation likely contributed to the increase in problem bears as food-stressed animals searched for alternative food sources. The date of sea ice formation explained some of the yearly variation in the number of problem bears, suggesting that changes in climatic conditions play a role in human-bear interactions.

Monitoring long-term trends in condition and reproduction of polar bears in relation to climatic warming in Western Hudson Bay

If climate warming in the Arctic continues as projected by the Intergovernmental Panel on Climate Change (2007), diminished ice cover and extended ice-free seasons will have profound negative effects on the sustainability of polar bear subpopulations, particularly those at the southern parts of the range (Stirling and Derocher 1993, Stirling *et al.* 1999, Derocher *et al.* 2004). Studies of polar bear ecology in WH by CWS began in 1980, and have continued to the present. During this period, the breakup of sea ice has been occurring earlier (Stirling *et al.* 1999, Gagnon and Gough 2005, Stirling and Parkinson 2006) and has resulted in declines in the condition of adult male and female polar bears, and in natality (Stirling *et al.* 1999). A re-assessment of the size of the WH subpopulation was undertaken in the early 2000s because of the concern of climate change impacts. Results showed that the subpopulation had declined by 22% from approximately 1,200 in 1987 to 935 in 2004 (Regehr *et al.* 2007*a*). Furthermore, the analysis showed that, although the reduced time available to polar bears on the sea ice had not had an apparent effect on the survival of prime-age bears (5-19 yrs old), the natural survival rates of dependent young, juvenile bears, and old bears were declining and were related to earlier breakup of sea ice.

Continuing to monitor these long-term trends is a high priority as climatic warming is predicted to continue. There are few studies that clearly demonstrate some of the effects of long-term climatic warming on sea ice and any arctic mammals such as polar bears. The ongoing ecological research of polar bears in WH represents a significant contribution to Canada's national and international participation in scientific research related to climatic warming. The results are of immediate management importance in WH and will provide some of the basis for predicting what might happen in areas further north in the future.

Mathematical modelling of polar bear ecology

Climate change and human harvest are among the most significant threats to polar bear populations today. Climatic warming and resulting sea ice reductions affect polar bears because they depend on this substrate for most aspects of their life history, including access to seals, their main prey. Harvest is highly sex-selective, and males have been reduced significantly in most Canadian populations, leading to concerns that males might eventually be depleted to a point where many females become unable to mate (Allee effect). Few studies have attempted quantitative predictions of polar bear population dynamics under climate change, and all predictions are associated with large uncertainty. The conditions that would lead to an Allee effect are similarly unclear, but sex-selective harvest is ongoing. To examine the ecology of polar bears, mathematical models were coupled with empirical data to understand and anticipate effects of climate change and human harvest on the reproductive success of female polar bears.

In order to predict a condition leading to an

Allee effect, a mechanistic model for the polar bear mating system was developed (Molnár *et al.* 2008). The model described observed mating dynamics well, predicts the proportion of mated females from population density and operational sex ratio, and specifically outlines conditions for an Allee effect. Female mating success was shown to be a nonlinear function of the operational sex ratio, implying sudden reproductive collapse if males are severely depleted. The threshold operational sex ratio for such an Allee effect depends on population density.

To predict effects of climatic warming on female reproduction, a body composition model was developed to estimate the amount of energy stored in the fat and protein reserves of a polar bear (Molnár *et al.* 2009). Based on this model, a dynamic energy budget model was developed that predicts changes in energy stores of both fasting and feeding adults. Metabolic rates of adult polar bears were estimated using the energy budget model, and corresponded closely to theoretically expected and experimentally measured values. The models were then used to predict changes in litter size of pregnant females in WH as a result of predicted losses in sea ice and feeding opportunities, and consequent reductions in female energy stores. Severe declines in litter size can be expected under climatic warming, although the precise rates of change depend on current, to date unobserved, summer feeding rates. Behavioural adaptation towards terrestrial feeding is unlikely to significantly compensate for expected losses in storage energy and resultant reductions in litter size. The research is a significant step towards a predictive framework for polar bear populations, and could aid optimal population management and proactive direction of conservation efforts. These studies form part of the dissertation of Peter Molnár, University of Alberta.

Genetics Studies

Genetic structure of Hudson Bay polar bears

Polar bear subpopulations in the greater Hudson Bay region have been placed in four management units based primarily on data from tag returns from harvested animals, capture–recapture studies, and radio- and satellite telemetry. In this study, a high level of gene flow was observed among management units using 26 microsatellite loci and analysis of genetic profiles of 377 polar bears. Individual-based Bayesian analysis identified population genetic structuring into three clusters with significant genetic differentiation (using F_{ST}). The data suggest differentiation of polar bears sampled from islands in James Bay, despite extensive dispersal capabilities of polar bears that could homogenize the population. Mapping of high-ancestry individuals suggests that two of the three clusters have foci in southern Hudson Bay and may be a result of predictable annual freeze-thaw patterns that are maintaining breeding 'groups'. Predicted changes in the distribution and duration of sea ice in Hudson Bay suggest that gene flow among these clusters may be reduced in the future (Crompton *et al.* 2008).

Re-assessment of genetic structure of Canadian polar bear subpopulations

Nunavut DOE initiated a reassessment of Canadian polar bear population structure to 1) evaluate potential adjustments in management boundaries as a result of distributional changes related with climate change; and 2) take advantage of more appropriate and modern methods of assessing genetic population differentiation (Beerli 1998, Pritchard *et al.* 2000). Preliminary results of the first phase of the project are reported here: reassessment of the genetic structure using both existing (Paetkau *et al.* 1999, Paetkau *et al.* 1995) and new microsatellite genetic data. New microsatellite data were collected as a part of the Davis Strait /Baffin Bay/Foxe Basin paternity study. Tissue samples were collected from a uniform geographical distribution of Davis Strait polar bears from 2005–2007, and from harvest of Baffin Bay bears in 2007 and Foxe Basin in 2008. Nuclear DNA extracts were amplified at 21 microsatellite loci. Program STRUCTURE (Pritchard *et al.* 2000) was used to assess the likelihood of adult polar bears being assigned to genetic clusters (n = 2016 including individuals analysed by Paetkau et al. (1999) and 1149 new individuals).

After examining the likelihoods, and the distribution of the average likelihood of assignment to different numbers of clusters, a preliminarily conclusion is that the optimum number of genetic clusters that best define world polar bear population structure is six. Although six clusters do not have the highest likelihood, it is the number of clusters with the highest likelihood and most reasonable biological interpretation. These clusters also conform to some degree to groups of polar bears that differ ecologically (Thiemann *et al.* 2008*a*). The proportions of membership of individuals to these clusters are not uniformly high, suggesting either 1) genetic exchange among these groups of bears or 2) because of high effective population sizes, slow genetic drift between regions. Nonetheless, there is genetic clustering of polar bears.

This work is preliminary. Samples from James Bay and southern Hudson Bay, which were not included in Paetkau *et al.*'s (1999) original global assessment, will be added as Crompton *et al.* (2008) identified that there may be some significant substructure within the SH subpopulation. Our intent is to use a structurally tiered approach of additional clustering analyses to examine global versus local substructure. We will also employ other methods (e.g., Beerli *et al.* 1999) to examine unidirectional gene flow. We intend to combine an assessment with demographic information to inform the appropriateness of Canadian management zones.

Research Techniques

Chemical immobilization techniques

Quick immobilization of wild animals by remote drug delivery requires complete injection of an adequate dose of drug into skeletal muscle followed by its absorption into blood circulation and transport to sites of action in the central nervous system. Hyaluronidase is a naturally-occurring enzyme used as a component of immobilizing drug mixtures to accelerate drug absorption from muscle or fat and reduce induction times for several species of terrestrial mammals. This study assessed the efficacy and safety of hyaluronidase to improve chemical immobilization of free-ranging polar bears captured from helicopter by remote drug delivery along the Ontario coast during September 2005 and October 2007. A single blind study design was used whereby one person prepared and loaded all darts without the other (the darter) knowing whether hyaluronidase (150 IU per dart) or sterile water was added to the immobilizing drug mixture of xylazine and zolazepam-tiletamine (XZT). Treatment bears were generally immobilized with smaller XZT dosages (7.9 vs. 9.4 mg/kg; $P = 0.08$) and shorter induction (10 vs. 15 min; $P = 0.004$) than control bears. Vital rates and serum biochemistry results were similar between control and treatment bears. However, induction times correlated directly with rectal temperature at ≤15 min after immobilization ($r = 0.39$, $P = 0.004$), suggesting use of hyaluronidase helped prevent development of hyperthermia. Overall, hyaluronidase was effective and safe for capture of polar bears (Cattet and Obbard 2010). We recommend further study to determine whether effects of hyaluronidase are dose-dependent. Further, we recommend that others involved with capture of polar bears or other fat species consider use of hyaluronidase to improve chemical immobilization.

Reconstructing reproductive histories of female polar bears using cementum patterns in premolar teeth

Distinct annuli in cementum, a mineralized tissue surrounding the root of mammalian teeth, are commonly used to age wildlife. Life history information may be recorded in cementum patterns but comparison between animals is complicated by variation within and between teeth. This study examined sources of variation in cementum growth in first premolar teeth and methods were developed to reduce error and permit comparisons within and between individuals. Analyses of annular width suggest that a minimum of 10 measurements from one image were required to produce precise estimates of cementum Growth Layer Group (GLG) width. Variance components analysis revealed that comparisons between distal and mesial aspects of the root introduced the greatest variation amongst bears. Controlling for aspect, variance was partitioned differently between the mesial and distal surfaces. Comparisons between maxillary and mandibular premolars from the same bear indicated that data from these teeth should not be pooled. However, data collected from left and right lower premolars may be combined. Indices to represent adjusted GLG widths were described which reduce age and allometric effects, to allow life history or environmental factors to be compared (Medill *et al.* 2009).

Premolar teeth collected from adult female polar bears from WH were examined to determine whether the pattern of cementum deposition can be used to reconstruct past reproductive events. The widths of annular cementum GLGs were measured and compared as Proportional Width Index (PWI) values. Teeth from females with known reproductive states (pregnant, with cubs, or with yearlings) were used to confirm and calibrate corresponding cementum GLGs. Differences between consecutive GLG widths (ΔPWI) were used to predict the presence of cubs. Reproductive parameters derived from cementum-based predictions were compared with those from direct observation. Significant differences in PWI were observed between GLGs deposited in the year females were pregnant and when accompanied by cubs, or yearlings. ΔPWI correctly classified the presence or absence of cubs in 72% of GLGs where reproductive state of the female was known. Cementum width reflects the presence or absence of a litter regardless of the number of offspring. Observations of females with early litter loss suggest cementum deposition responds to the duration of lactation, recording a minimum age of litter survival. Predictions of litter production rate and litter loss derived from cementum were similar to observations from capture data; however, age at first parturition was underestimated. The study concluded that patterns of cementum deposition may be used to assess the reproductive history of female polar bears from WH. Teeth collected from other populations and taxa may provide more information on individual or population dynamics relevant to management decisions.

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Polar Bear Management in Greenland, 2005–2008

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Regulations for the management and protection of polar bears in Greenland were introduced in 1994. In October 2005 a new Executive Order came into force. Some important protective measures in the new Executive Order on the Protection and Hunting of Polar Bears are:

- Year-round protection of all cubs (regardless of age) and females accompanied by cubs. The Executive Order also introduces a prohibition of the export of polar bear cubs
- Protection of all polar bears from 1 July to 31 August, and in the local authority districts of Ittoqqortoormiit and Ammassalik in East Greenland from 1 August to 30 September
- Prohibition on disturbing polar bears in dens
- Introduction of quotas from 1 January 2006 and the possibility that part of the quota may be used for trophy hunting. Special provisions on trophy hunting will be laid down in a separate Executive Order
- Only Greenland residents who hunt as a full-time occupation are allowed to hunt polar bears
- It is mandatory to report all catches, including struck-and-lost polar bears, to the Greenland management authorities
- Fixed-wing aircraft, helicopters, and motorized vehicles including snow machines and boats larger than 20 GRT/15 GT are not allowed in the hunt of for transportation to and from the hunting grounds
- Poison, taps, foot snares, and set-guns are not allowed, and
- Rim-fire rifles, shotguns, or semi- or fully automatic weapons are not allowed. Polar bears may only be hunted using a rifle with a minimum calibre of 30.06 (7.62 mm)

Introduction of quotas on 1 January 2006

The first quota year began on 1 January 2006. The quota was fixed in consideration of international agreements, biological advice, user's knowledge, and after consultation with the Hunting Council. The quota allocation for the first quota year for the whole of Greenland was 50 bears for East Greenland, and 100 bears for West Greenland. Since 2006, the quota has been gradually reduced. In 2009 the quota was 130 bears—50 bears for East Greenland and 80 for West Greenland and South Greenland. The quota is distributed among the local management authorities, which issue and distribute permits and establish sound control practices to ensure that the allocated quota is not exceeded.

After the hunt, permits must be stamped by the local authority or settlement office, and polar bear parts must not be sold unless a copy of the stamped permit furnished with the permit holder's signature accompanies the sale. This counteracts the sale of illegally killed polar bears and increases control of the harvest. A catch reporting form must be delivered to the local authority or settlement office when the permit is stamped. If no polar bear parts are to be sold, a duly completed catch reporting form is still required to be delivered to the local authority or settlement office. The purpose of this is to ensure that all catches are reported, and that the necessary information from the catch reporting form is available for management in connection with setting quotas for the following year. Conditions for the delivery of polar bear parts for biological studies may be laid down in the permit.

All parts from a polar bear killed as a result of necessity or self-defence, in accordance with the provisions of the Criminal Act, are retained by the Government of Greenland and the Department of

Fisheries, Hunting and Agriculture must be informed. In addition, a report must be submitted to the Chief Constable to enable him to evaluate the sequence of events.

Export of Polar Bear Parts

The Executive Order contains a prohibition on the export of polar bear gall bladders or parts thereof. A CITES export permit is required for the export of other polar bear parts from Greenland. Further, a copy of the permit, stamped by the local authority and furnished with the permit holder's signature, must accompany each sale or purchase of polar bear parts. In April 2008, the Government of Greenland introduced a voluntary temporary ban on the export of polar bear products after a negative non-detrimental finding from the CITES authority in Greenland. The export ban can be lifted after reaching sustainable harvest levels, and after new population estimates become available for data deficient areas.

Illegal Hunting

The Minister for Fisheries and Hunting may reduce a local authority's quota for the current quota year or for a subsequent quota year if any illegal hunting of polar bears is discovered in the local authority district. Persons infringing the Executive Order may be held liable to a fine and confiscation. In the event of intentional or repeated instances of grossly negligent infringements of the provisions relating to hunting, the person may also be disqualified under the Hunting Act from having the right to hold or acquire a hunting licence.

National Park

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.

Hunting Statistics

In recent years, the Ministry of Fisheries and Hunting has improved the hunting statistics by developing a new database and a double reporting system. This means that a hunter must be issued a licence before the hunt and immediately following the hunt the hunter must report the catch to the local authority using a standardized form. This standardized form includes information on the name of the hunter(s), place of residence, date, license number, location of kill, and the sex, age, markings, and size of the harvested bear. As an additional control, all hunters must report their annual harvest of all species.

Co-management with the Governments of Canada and Nunavut

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

Management Plan for Polar Bears

After the first four years of the quota system and with steadily reducing quotas on polar bears, the harvest is approaching a sustainable level. With a planned survey in East Greenland in 2010 and the ongoing negotiations for cooperation with Canada and Nunavut, this goal can be achieved.

Research on Polar Bears in Greenland, 2005-2009

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This report summarizes research on polar bears in Greenland since the 14th meeting of the IUCN/SCC International Polar Bear Specialist Group (PBSG) in June 2005 (Aars *et al.* 2006). The research has focused on: 1) testing a new satellite tag for tracking polar bears; 2) studies of individual movements of polar bears in East and West Greenland for environmental impact assessments; 3) interviewing polar bears hunters in north-west Greenland about polar bears, polar bear hunting, and climate change; 4) analysis of various pollutants and their effects on polar bears; and 5) analysis of temporal and spatial variation in pathology and metric asymmetry in polar bear skulls. Polar bear catch data from Greenland are also presented. For names of places in Greenland see Fig. 1.

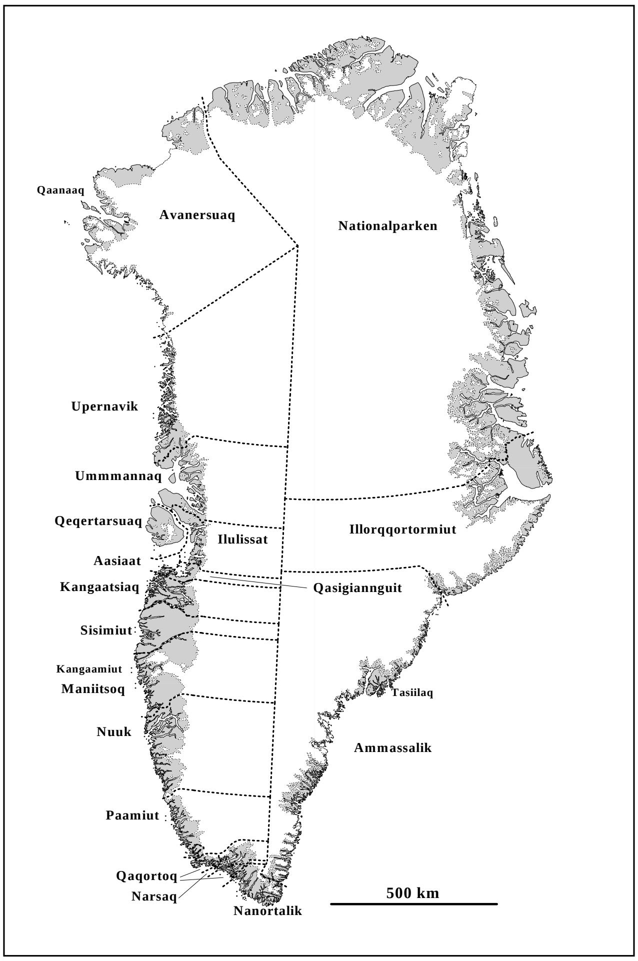

Fig. 1. Map of Greenland with borders of the polar bear management zones, former municipalities and the National Park of North and Northeast Greenland. By January 2009, Greenland was administratively re-organized into four major municipalities. However, for the sake of consistency and to allow the reader to compare data presented here with data in earlier reports, the old municipality border are shown and referred to in this report.

A new satellite-tag for studying movement of polar bears

Studies of movement of polar bears involving satellite telemetry have mainly involved radio collars fitted to adult females (e.g., Messier *et al.* 1992). Although preliminary studies indicated that there was no significant difference in size of activity areas of males and females (Amstrup *et al.* 2001, Taylor *et al.* 2001), there remains a need for detailed information on movement of male bears and subadults in studies of habitat choice and effects of harvest and climate change. During 1996 and 1997, Amstrup *et al.* (2001) tracked seven adult male polar bears with implanted satellite radios for up to 161 d. Subsequent studies where satellite radio tags were attached to the ear of bears have had only limited success (I. Stirling, personal communication, 2009).

In connection with a study of movement of polar bears in East Greenland, the Greenland Institute of Natural Resources (GINR) and the National Environmental Research Institute (NERI) in cooperation with Mikkel Villum (Grevinge Denmark, www.mikkelvillum.com) developed a small satellite radio tag that we attached to 22 polar bears in East and West Greenland during 2007–2009. The radio transmitter is a 32-g SPOT-5 "matchbox" model S227 (Wildlife Computers, Redmond, WA, USA). The tag is cast in epoxy and has a flexible aerial (Fig. 2). The duty cycle of the tag can be programmed and the theoretical life span of the tag can be determined prior to attachment. According to the manufacturer's specifications, two M3 batteries allow for a total of about 50,000 transmissions (Wildlife Computers, personal communication, 24 June 2009); however, the life span of the tags in the field is unknown.

In March 2007, six SPOT-5 tags were fitted to polar bears in the pack ice in East Greenland. To test attachment systems, three tags were glued onto the backs of bears (Fig. 2), and three were attached to ears (Table 1). Before gluing with Araldite 2012 (Huntsman Advanced Materials BVBA, B-3078 Everburg), the hair at the attachment site on the midline of the back caudal to the scapulae was trimmed to 0.5 cm and rinsed with acetone. To attach tags to the external side of the ear we used a 28-g system manufactured by Mikkel Villum that consisted of a stainless steel base plate with a pin attached to the transmitter and a washer that sits on the inner side of the ear. The base plate was glued to the base of the transmitter and the plate, pin, and washer were covered with about 1.0 mm of rubber coating to prevent direct contact between metal and skin or fur. Basically, the satellite radio tag was attached to the ear like a conventional numbered plastic ear tag used in conventional polar bear studies.

Based on the 2007 experience, we decided to attach the tags to ears in subsequent studies. In March 2008, another six SPOT-5 tags were deployed in East Greenland, and in April 2009, 10 tags were fitted to polar bears in the pack ice in north-west Greenland (Table 1). Tags were programmed somewhat differently in different years: 2007 (150 transmissions/d, every day from mid-March to May, subsequently every 4th day, 200 d expected life); 2008 (140 transmissions/d, every day from mid to end of March then every 4th day, 365 d expected life); 2009 (150 transmissions/d, each day from mid-April to the end of May then every 4th day, 300 d expected life).

Fig. 2: SPOT5 "matchbox" satellite transmitter (Wildlife Computers, Redmond, USA) attached to the ear of an adult male polar bear (upper), and glued to the back of a young female polar bear (lower) in East Greenland, March 2007. Photos: E.W. Born

Mean transmission life of ear tag transmitters was 115 d (range 84-158 d) in 2007 and 76 d (range 38-129 d) in 2008. Several of the tags deployed in 2009 were still transmitting as of 16 June 2009; therefore, overall tag performance has not yet been evaluated. However, all tags deployed in 2007 and 2008 ceased transmitting before reaching their expected maximum lifetime. The reasons for transmitter failure are unknown; however, it is possible that the tags were shed during grooming or during the bear's physical activity (e.g., digging into seal lairs, breaking through new ice, fighting with other males). Other reasons might be breakage of the aerial, loosening of the glue between transmitters and the attachment plate, or failure of the electronics.

Table 1: Longevity (preliminary) - last day of location after deployment – by 16 June 2009 of 22 SPOT5 satellite tags attached to polar bears in East and West Greenland, 2007-2009. Three transmitters were glued onto the back; the rest were attached to ears. Bold = still transmitting 16 June 2009.

E/W	**ID**											**Age**	**Satellite radios**		
Green-		Sex	Category	Day	Month	Year	Location					Field	ID	Position	Tag
land							N				W/E	estm.			lomgevity
							Min	Deg	Deg	Min		(years)			(days)
East	D7362	M	Adult	17	3	2007	72	13	19	24	W	12-15	74777	L ear	84
East	D7367	M	Adult	24	3	2007	73	23	20	40	W	15	74778	R ear	103
East	D7368	M	Adult	24	3	2007	73	19	17	3	W	10-15	74779	L ear	158
East	D7369	F	Subad.	24	3	2007	73	33	19	6	W	3-4	74780	*Back*	30
East	D7253	M	Adult	29	3	2007	73	39	17	24	W	8-10	74781	*Back*	29
East	D7255	M	2 yrs	30	3	2007	73	7	17	1	W	2	74782	*Back*	29
East	D7259	M	Adult	12	3	2008	81	5	5	37	E	13-15	74777	R ear	129
East	D7261	M	2 yrs	22	3	2008	73	57	16	49	W	2	68011	R ear	65
East	D7262	M	Adult	22	3	2008	73	56	16	50	W	15+	68012	R ear	81
East	D7263	M	Subad.	25	3	2008	72	54	25	17	W	3-4	68013	L ear	38
East	D7267	F	Subad.	26	3	2008	72	42	22	43	W	(3)4	68014	R ear	53
East	D7271	M	Adult	30	3	2008	77	29	5	23	W	15	74779	R ear	89
West	D7272	M	Adult	8	4	2009	71	1	55	24	W	4	68011	R. ear	**70**
West	D7275	M	Adult	9	4	2009	71	4	56	35	W	10	68012	R. ear	57
West	D7278	F	2 years	10	4	2009	70	34	57	54	W	2	68013	R. ear	29
West	D7277	F	Subad.	10	4	2009	70	34	55	42	W	4	68014	R. ear	**60**
West	D7280	M	Adult	11	4	2009	71	4	54	26	W	7	74777	R. ear	**67**
West	D7281	M	Adult	15	4	2009	70	43	56	13	W	7-8	74778	R. ear	**63**
West	D7282	M	Adult	15	4	2009	71	0	57	6	W	15	74779	R. ear	**59**
West	D7284	M	2 years	15	4	2009	70	57	57	8	W	2	74780	R. ear	**59**
West	D7286	M	Adult	18	4	2009	72	15	56	2	W	25	74781	R. ear	**56**
West	D7288	F	2 years	23	4	2009	71	2	56	45	W	2	74782	R. ear	**55**

Studies of movement patterns

Polar bear movement is being studied in East and West Greenland to provide background information on seasonal and annual variation in habitat use and area of occupancy for environmental impact assessments in relation to oil exploration activities. The study is being conducted by GINR and NERI in cooperation with the Norwegian Polar Institute (Tromsø, Norway), University of Oslo, and Marine Research Institute (Tromsø).

Satellite transmitters (13 Telonics A3610-collars and 12 Wildlife Computers SPOT5 "matchbox" tags) were deployed on polar bears in East Greenland and north-west Svalbard in March (*n* = 12) and July (*n* = 1) 2007, and March (*n* = 9) and April (*n* = 3) 2008. Several of the tags were still functioning as of 16 June 2009, and preliminary results confirm previous studies (Born *et al.* 1997, Wiig *et al.* 2001) that polar bears exploit vast areas of the East Greenland pack ice for the majority of the year (Born *et al.* 2009a; Fig. 3). In April 2009, 15 satellite tags (5 Telonics TAW-4610H collars, 10 Wildlife Computers SPOT5 ear tags) were deployed on polar bears in the pack ice off central West Greenland. The study is a collaborative one involving GINR, NERI, University of Oslo, and the Polar Science Center, University of Washington (Fig. 4).

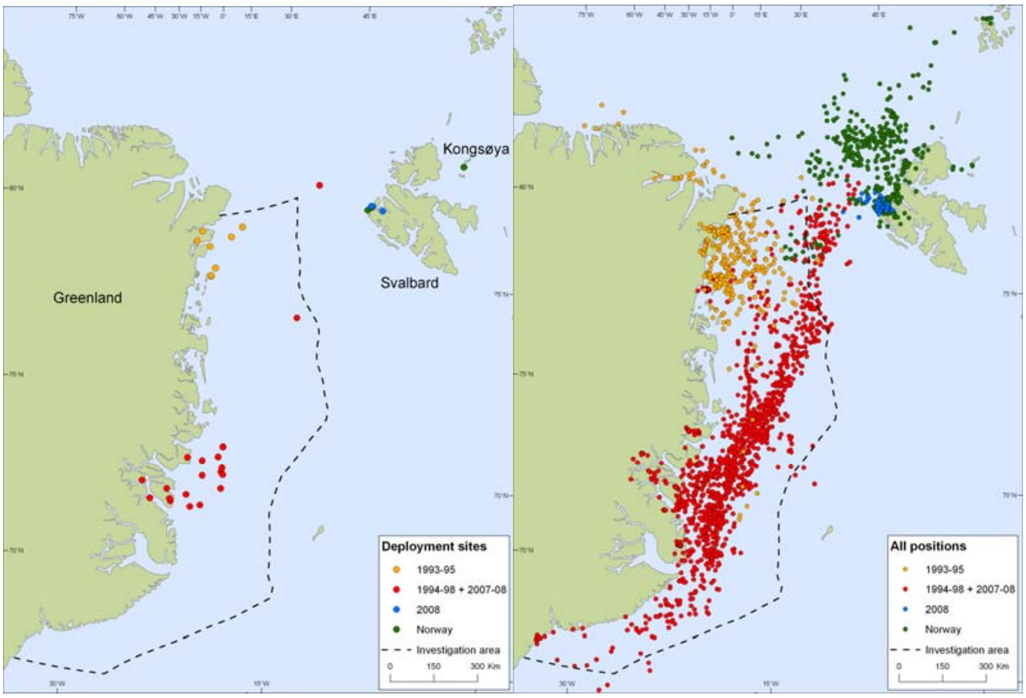

Fig. 3: Locations of 35 polar bears fitted with satellite transmitters in the East Greenland and northwestern and northern Svalbard region, June 1993–May 2008 (left, Born *et al.* 2009a). Yellow: 7 female polar bears tagged in 1993 and monitored until 1995 (Born *et al.* 1997); Red: Polar bears tagged in 1994 and tracked to 1998 (Wiig *et al.* 2001) and during March 2007-May 2008, respectively; Blue: 3 female bears that were instrumented on NW Svalbard in April 2008. Green: 4 adult female polar bears instrumented by Norwegian Polar Institute at Svalbard and Franz Josef Land (2000, 2006, 2007) that made movements towards Northeast Greenland. (Right) Distribution of all locations in the East Greenland–North and Northwest Svalbard region, June 1993–May 2008 of 35 polar bears instrumented with satellite transmitters (Born et al. (2009a).

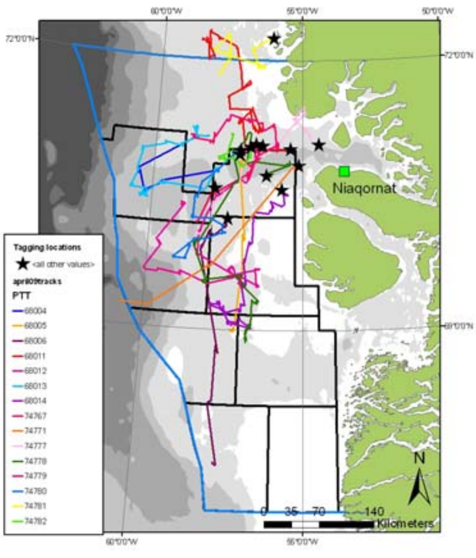

Fig. 4. Locations in West Greenland of 16 polar bears fitted with satellite radio tags (5 collars and 10 ear tags) during April 2009. April movements, borders of concession areas for oil exploration (black) and the environmental impact assessment area (blue) are shown (K.L.Laidre).

An interview survey

The reported catch of polar bears in Northwest Greenland increased markedly during 1993–2005 concurrent with a marked reduction in sea ice cover (e.g., Born and Sonne 2006, Stirling and Parkinson 2006). To explore the reasons for these changes the Greenland Institute of Natural Resources in co-operation with the Inuit Circumpolar Council (Nuuk) interviewed 72 experienced polar bear hunters living in the north-west Greenland in February 2006 (Born *et al.* 2008a, b, 2009b). Hunters were asked about polar bear biology, polar bear catch, climate change, and the effect of these changes on polar bears and the catch. The majority of respondents noted an increased occurrence of bears closer to the coast (i.e., in areas usually used by hunters). About 31% of respondents specified that the reason for this change was an increase in the number of polar bears, whereas 16% of respondents specified it was due to a decrease in sea ice cover. The hunters in Qaanaaq (Fig. 1) were more inclined to believe that a decrease in sea ice cover explained the increase in coastal occurrence of polar bears, whereas the respondents in Upernavik primarily believed it was an increase in the total number of bears. It was not clear from the results when the change in bear density occurred. However, several informants expressed the opinion that polar bears were scarce during the 1960s and 1970s. During recent years, perhaps beginning in the 1990s, the hunters noted marked environmental changes. Most pronounced, and of greatest importance to hunting, was the decrease in sea ice cover. Ice formed later in the fall and broke up earlier in the spring. Sea ice was also reported to have become thinner.

Respondents also reported warmer and more unpredictable weather, including frequent storms and rain during winter, and noted that glaciers retreated and parts of the edge of the Inland Ice Cap recessed. These changes have influenced both travelling and hunting activities in north-west Greenland, in particular in the Qaanaaq area where previous sled routes along glaciers and sea ice can no longer be used. In contrast, the boating season has been extended with increased open water, resulting in an increase in the fraction of polar bears caught from a boat. This change, most pronounced in the southern parts of the Upernavik district, was mentioned by some respondents as an additional reason for the increased catch of bears since the early 1990s (a boat has a larger range and can cover more ground faster than a sled).

About 24% of respondents said that polar bears demonstrated physical changes (e.g., had become thinner either as a result of increased competition or access to less food due to a decrease in sea ice). Thinner bears were more frequently reported in the Qaanaaq area than in the Upernavik area (52% *versus* 10% of respondents). The reason for the regional difference is not clear, but the results may reflect the fact that respondents in Qaanaaq generally had more experience hunting polar bears than those in Upernavik. No respondents suggested that polar bear foraging had changed. In addition, the study presents a variety of observations about the catch of polar bears, polar bear behaviour, and biology. The demography of the catch of polar bears in north-west Greenland during 1952–2005 was described on the basis of a harvest of 754 polar bears.

The catch of polar bears in Greenland

The catch of polar bears in Greenland 1993–2008 was summarized in Born (2009).

The catch during 1993–2005

During 1993–2005 the primary source of information on the catch of polar bears in Greenland was the *Piniarneq* system where every year in September each licensed hunter reported his take of polar bears since the previous September to the Department of Fisheries, Hunting and Agriculture (DFHA) Greenland Home Rule Government (Born and Sonne 2006). The catch was compiled on an annual basis (January to January) by DFHA (Table 2), and based on the location where the catches were reported was tentatively allocated to the three polar bear subpopulations that Greenland shares with Canada (i.e., Kane Basin (KB), Baffin Bay (BB), and Davis Strait (DS); Table 2).

The catch during 2006-2008 under a quota system

Since 1 January 2006 there have been quotas for the catch of polar bears in Greenland (Lønstrup 2006). Since the introduction of quotas some polar bears have been shot either in self-defence or illegally. Kills taken under these circumstances are included in the figures for the "Total kill" of polar bears from the four subpopulations in Greenland (Table 3). In 2006, 2007, and 2008 the total kill of polar bears by Greenlanders from the Kane Basin subpopulation was 9, 5, and 7, respectively (self defence and illegal kills included). The figures for the Baffin Bay subpopulation for the same three years are 79, 76, and 73; for Davis Strait 0, 0, and 1; and for East Greenland 55, 59, and 64 (Table 3).

The sex ratio in the catch

The sex and age category of the polar bear harvest were not reported under the *Piniarneq* system. However, after 2006 it became mandatory to provide this information on special forms for each harvested bear that included other information such as date and site of kill or whether a bear was tagged. Based on this reporting, the sex ratio in the Greenlandic polar bear catch is given by subpopulation in Table 4. It is prohibited to take females with dependent cubs irrespective of the age of the cubs; therefore, the sex and age compositions in Table 4 are those of adult and independent subadults. About two-thirds of the catch consists of males (Table 4).

Table 2. The catch of polar bears in Greenland, 1993–2005 (i.e., before quotas were introduced 1 January 2006) according to the "*Piniarneq*"-system by polar bear subpopulation and local area (former municipality). The reporting is summarized here from 1 January until 1 January. *In litt.* January 2009 from the Greenland Home Rule Government Department of Fisheries, Hunting and Agriculture, Nuuk.

Polar bear population	**Area reporting**	**Year**												
		1993	**-94**	**-95**	**-96**	**-97**	**-98**	**-99**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
	Qaanaaq	24	33	23	30	41	22	21	16	20	35	47	29	50
Kane Basin (KB)	(Qaanaaq - caught in Kane Basin)	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**6**	**10**	**12**	**12**	**9**	**25**[1)]
	(Qaanaaq - caught in Baffin Bay)	14	23	13	20	31	12	11	10	10	23	35	20	25
	Upernavik	43	25	27	40	38	48	49	40	64	72	135	85	87
	Uummannaq	3	0	4	5	2	9	9	6	8	0	18	8	15
	Qeqertarsuaq/Disko	6	1	1	0	0	5	2	7	1	3	0	7	0
	Ilulissat	1	1	2	0	0	1	5	0	1	3	3	3	6
	Aasiaat	4	3	1	0	3	3	8	2	0	3	2	3	0
	Qasigiannguit	0	0	2	0	2	5	3	2	0	0	0	3	0
	Kangaatsiaq	1	6	10	1	2	0	6	0	2	10	10	13	1
	Kangerlussuaq/Sdr. Strom.	0	0	0	0	0	1	0	0	0	0	0	0	0
	Sisimiut	0	1	4	1	1	12	4	1	11	4	3	14	1
Baffin Bay (BB)		**72**	**60**	**64**	**67**	**79**	**96**	**97**	**68**	**97**	**118**	**206**	**156**	**135**
	Maniitsoq	4	0	5	1	4	22	0	0	1	1	1	1	6
	Nuuk	0	0	1	4	0	0	2	0	0	1	0	2	0
Davis Strait (DS)		**4**	**0**	**6**	**5**	**4**	**22**	**2**	**0**	**1**	**2**	**1**	**3**	**6**
	Ivittuut	0	0	0	0	0	0	0	0	0	0	0	0	0
	Paamiut	1	2	1	1	5	1	0	0	1	3	3	0	0
	Narsaq	1	0	0	0	2	0	0	2	0	0	10	0	0
	Qaqortoq	0	0	2	0	0	4	1	3	0	0	0	0	0
	Nanortalik	1	0	6	3	6	9	11	4	1	3	3	2	0
	Ammassalik	15	14	22	23	9	13	14	40	29	35	24	19	26
	Illoqqortoormiut/Scoresbysund	28	35	26	26	34	43	55	35	41	15	19	33	25
E Greenland (EG)		**46**	**51**	**57**	**53**	**56**	**70**	**81**	**84**	**72**	**56**	**59**	**54**	**51**
		132	**121**	**137**	**135**	**149**	**198**	**190**	**158**	**180**	**188**	**278**	**222**	**217**

1: An interview survey conducted in February 2006 indicated that 17(16 adults) bears were taken from the Kane Basin population. Of these, 8 were taken in the Kane Basin proper and the remainder from the eastern Smith Sound region north of Kap York (i.e. ca. 76 deg N).

Table 3. The catch of polar bears in Greenland, 2006–2008, by polar bear subpopulation and local area (former municipality). The reporting is summarized here from 1 January until 1 January. *In litt.* January 2007, 2009 from the Greenland Home Rule Government Department of Fisheries, Hunting and Agriculture, Nuuk.

Polar bear population	**Municipality**	**2006**					**2007**					**2008**				
		Quota	**Catch**	**Self-defence**	**Illegal**	**Total kill**	**Quota**	**Catch**	**Self-defence**	**Illegal**	**Total kill**	**Quota**	**Catch**	**Self-defence**	**Illegal**	**Total kill**
	Qaanaaq	30[1)]	20			20	28	24			25	26	18			20
Kane Basin (KB)	(Qaanaaq - caught in Kane Basin)	**-**	**9**	**0**	**0**	**9**	**10**	**5**			**5**	**8**	**5**	**2**		**7**
	(Qaanaaq - caught in Baffin Bay)	-	11			11	18	19	1		20	18	13			13
	Upernavik	50	60			60	45	45			45	45	45			45
	Uummannaq	2	1			1	10[2)]	2			2	8[2)]	0			0
	Qeqertarsuaq/Disko	2	2			2	-	1			1	-	1			1
	Ilulissat	1	1			1	-	1	1		2	-	0			0
	Aasiaat	2	0			0	-	0			0	-	5			5
	Qasigiannguit	1	0			0	-	0			0	-	0			0
	Kangaatsiaq	2	2			2	-	4			4	-	1			1
	Kangerlussuaq/Sdr. Stromfjord	0	0			0	-	0			0	-	0			0
	Sisimiut	2	2			2	-	2			2	-	1			1
Baffin Bay (BB)		**92**	**79**	**0**	**0**	**79**	**73**	**74**	**2**	**0**	**76**	**71**	**66**	**6**	**1**	**73**
	Maniitsoq	2	0			0	-	0			0	-	1			1
	Nuuk	1	0			0	-	0			0	-	0			0
Davis Strait (DS)		**3**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**2**	**1**	**0**	**0**	**1**
	Ivittuut	0	0			0	4[3)]	0			0	4[3)]	0			0
	Paamiut	1	0			0	-	0			0	-	0			0
	Narsaq	1	0			0	-	1	3		4	-	1			1
	Qaqortoq	1	0			0	-	0			0	-	1			1
	Nanortalik	2	2	1		3	-	0			0	-	3			3
	Ammassalik	14	22			22	20	20	1	1	22	25[4)]	25		4	24
	Illoqqortoormiut/Scoresbysund	36	30			30	30	30	3		33	35[4)]	34			30
E Greenland (EG)		**55**	**54**	**1**	**0**	**55**	**54**	**51**	**7**	**1**	**59**	**64**	**64**	**2**	**4**	**70**
		150	**142**	**1**	**0**	**143**	**139**	**130**	**9**	**1**	**140**	**145**	**136**	**10**	**5**	**151**

1: In 2006 the quota for the Qaanaaq municipality was not divided into a Kane Basin and Baffin Bay portion
2: Total quota for the areas between Uummannaq and Sisimiut (both included)
3: Total quota for the areas between Ivittuut and Nanortalik (both included)
4: Medio 2008 the original quotas of 20 and 30 bears for Tasiilaq and Ittoqqortoormiit, respectively, were raised by 5 each place

Table 4: Sex and age composition of the catch of polar bears in Greenland (2006-2008) by subpopulation (dependent cubs are fully protected and therefore not included). Data provided by the hunters on forms in which they reported each specific kill. *In litt.* January and May 2009 from the Greenland Home Rule Government Department of Fisheries, Hunting and Agriculture, Nuuk.

Population		Total[1)]	Total[2)]	%[3)]	Adult		Young		No age		Unid.[4)]	% M[5)]	% F[5)]
			catch	Sex/age	M	F	M	F	M	F			
Kane Basin	2006	6	9		3	2	0	0	1	0	0		
	2007	5	5		3	2	0	0	0	0	0		
	2008	5	7		4	1	0	0	0	0	0		
	Total	16	21	76,2	10	5	0	0	1	0	0	68,8	31,3
Baffin Bay	2006	69	79		30	14	14	4	1	5	1		
	2007	74	76		38	18	9	6	2	1	0		
	2008	68	73		38	20	8	1	0	1	0		
	Total	211	228	92,5	106	52	31	11	3	7	1	66,7	33,3
Davis Strait	2006	0	0		0	0	0	0	0	0	0		
	2007	0	0		0	0	0	0	0	0	0		
	2008	1	1		1	0	0	0	0	0	0		
	Total	1	1	100,0	1	0	0	0	0	0	0	100,0	0,0
E Greenland	2006	44	55		24	14	2	1	1	1	1		
	2007	51	59		31	9	6	3	2	0	0		
	2008	60	64		24	20	9	3	0	0	4		
	Total	155	178	87,1	79	43	17	7	3	1	5	66,0	34,0

1: Total number of forms received with specific data on sex and age etc.
2: Total number of catches recorded (see Table 2) excluding self-defence and illegal kills
3: Percentage of total catch that had information on sex and age
4: Unid. = Not identified to sex or age
5: All males (or females) i.e. adults, young and "no age given" as percentage of total minus unidentified.

Population status

Four polar bear populations occur in Greenland: Kane Basin, Baffin Bay, Davis Strait, and East Greenland (EG). The KB, BB, and DS subpopulations are shared between Canada and Greenland and are exploited in both countries. The EG population ranges in eastern and south-eastern Greenland and is only hunted in Greenland. For the KB, BB, and EG subpopulations new estimates of abundance have not become available since the 2005 meeting of the PBSG.

A capture-recapture study conducted from 2005–2007 yielded an estimate of 2200 bears (SE = 72) for the DS subpopulation. The population is believed to be stable and abundant at present, but may be at the point of decline because of the combined effect of density dependence, declining harp seals, and a lag effect of declining ice conditions (Peacock 2009).

A capture-recapture study of the BB subpopulation from 1994–1997 yielded a population estimate of 2074 (SE = 266) (Taylor *et al.* 2005). Based on simulations that included the harvest reported in Canada and Greenland, the BB subpopulation was thought to have decreased to 1546 (SE = 428) bears by 2004 (Aars *et al.* 2006). Hence, scientific evidence suggests that this population has been over-exploited for several years and currently is reduced, whereas some hunters in Canada and Greenland believe that the population has increased (Born *et al.* 2008a, b, c). The sea ice in Baffin Bay has decreased significantly during recent decades which may have caused a change in distribution as suggested by Stirling and Parkinson (2006).

An assessment based on capture-recapture data resulted in an estimate of 164 polar bears (SE = 35) in the KB population in 1998 (Taylor *et al.* 2008). This population is also thought to be reduced due to over-exploitation (Aars *et al.* 2006).

A population inventory of the East Greenland polar bear population has never been conducted. Therefore, the size of this population is not known (Aars *et al.* 2006). An estimate of 2000 polar bears for EG was proposed based on professional judgement of the best available information (Lunn *et al.* 2002). Due to the lack of an estimate of the number of polar bears in the EG population, the effect of the hunt on the population cannot be determined (Aars *et al.* 2006, Anon. 2007). This population is also thought to be negatively influenced by high levels of pollution (Aars *et al.* 2006) and decrease in sea ice (Aars *et al.* 2006, Durner *et al.* 2009).

Contaminants studies

Persistent Organic Pollutants (POPs)

***Temporal trends*—**Perfluoroalkyl contaminants (PFCs) were examined in liver tissue from East Greenland polar bears sampled in 19 different years during 1984–2006 (Dietz *et al.* 2008a). The study revealed significant annual increases of eight different PFCs ranging from 2.3 to 8.5%. For four of the PFCs, an even higher rate of increase (9.2 -27%) was detected for the last 6–16 years. Concentrations of ΣPFCs in 2006 exceeded the concentrations of all "conventional" POPs. It was hypothesized that if the PFC concentrations in polar bears continue to increase they are likely to cause cumulative and combined health effects within 5–15 years compounding the already detected threats from POPs. Temporal perfluorooctanesulfonic acid (PFOS) trends in East Greenland polar bears have been linked to climate parameters such as temperature, North Atlantic Oscillation (NAO), and ice extent (Dietz *et al.* 2008b, c). Further analyses will include stable isotopes. In East Greenland polar bears, the concentrations of conventional POPs (i.e., PCBs, DDTs, HCHs, HCB, chlordanes, dieldrin, and coplanar PCBs) showed a decline between 1990 and 2000 (Dietz 2008). A detailed study of temporal trends in POPs in East Greenland polar bears during 1984–2008 is being conducted under the International Polar Year program.

***Geographical trends*—**Clear regional trends in various contaminants in polar bears can be detected within the Arctic region. The East Greenland, Svalbard, and Kara Sea subpopulations still have the highest levels of most lipophilic POPs (Verreault *et al.* 2005, Muir *et al.* 2006). This information can be used to identify maximum human exposure, where possible biological effects due to high levels of contaminants are most likely to occur, and where the lowest exposed animals can be sampled to serve as reference groups. The geographic variation in loads of pollutants is related to differences in global atmospheric and sea current transportation and deposition pattern.

Studies of mercury

Temporal trends—Mercury (Hg) concentrations in polar bear hair sampled in north-west Greenland during 1920–1991 showed a significant increase at 2.1% per year, whereas hair sampled in East Greenland during 1892–1973 showed a 3.1% increase per year (Dietz *et al.* 2006a). These findings are supported by other studies that included hard tissues from humans, belugas, and various birds of prey. In north-west Greenland the increase in Hg has continued up to 2008, whereas in East Greenland a significant 0.8% decrease was detected for the period 1973–2001; after 2001 Hg concentrations started to increase again (Dietz *et al.* 2006, 2009). Comparison of present Hg concentrations in polar bear hair with a pre-industrial polar bear hair sample from 1300 A.D. indicated that present-day Hg exposure is more than 93% of anthropogenic origin. Hair samples from Svalbard and 13 Canadian management regions have been analyzed for mercury concentrations. Final interpretation awaits stable isotopes analysis to provide a large-scale geographical trend in mercury concentrations that accounts for regional differences in feeding. Data will also be evaluated in relation to health and climate change parameters.

Geographical trends—Continued studies of Hg in polar bear hair document that polar bears from north-west Greenland and the central Canadian Arctic have the highest concentrations of Hg, and polar bears at Svalbard the lowest (Dietz 2008, Dietz *et al.* 2009, Dietz *et al.* unpublished)

Contaminants and climate change parameters—Trends in Hg and PFCs have been linked to a number of climate change indices (Dietz *et al.* 2008b, c, 2009) and more studies are underway.

Health effects (POPs and Hg)

Studies of vitamin A and E in liver of male polar bears from East Greenland showed both positive and negative relationships with various POP compounds thereby indicating a risk of oxidative stress and adverse pre- and post-natal health effects (Hansen 2007). Updated histological studies of liver and kidney have shown specific lesions associated with POPs, polybrominated diphenylethers (PBDEs), PFCs, and Hg indicating that these substances may negatively affect the function of these organs (Sonne *et al.* 2005a, 2006a, 2007a, 2008).

Results indicated that POPs may cause a decrease in bone mineral density and size of sexual organs, and may be a co-factor in the development of specific testicular histological changes (Sonne *et al.* 2006b). This suggests that there may be an impact of POPs on the function of the sexual organs of polar bears, perhaps reducing sperm and egg quality or quantity and size or robustness of the uterus and penis. A trans-Arctic study of temporal (pre- vs. post-industrial) and geographical (Canadian High Arctic, Svalbard, East Greenland) trends of polar bear reproductive organ size supported these results (Sonne *et al.* 2007b) as do the results of a study of skull density (Sonne *et al.* 2004).

A second adult female polar bear from East Greenland with an abnormal clitoris was harvested in Scoresby Sound in February 2006 (Sonne, unpublished data). Generally, the morphology of the clitoris and the entire reproductive tract was similar to that of the previously-reported abnormal female polar bear from East Greenland (Sonne *et al.* 2005b). However, the size of the clitoris of the 2006 bear was much smaller than that of the animal from 1999 (2006: 10.6×6×5 mm *vs.* 1999: 27×22×21 mm *vs.* normal average: 6.5×3.8×4 mm). The fact that some adult female polar bears exhibit an enlarged clitoris outside of the mating season indicates that other reasons than mating activity may cause the enlargement. Hence, enlargement may have been induced by endocrine disruption from genetically associated lesions or pollution as previously suggested by Wiig *et al.* (1998).

Biomarkers in the polar bear brain are being analyzed in relation to Hg levels. In polar bears from East Greenland a significant negative correlation between glutamate-NMDA receptor levels and Hg and CH_3Hg in the lower brain stem was found (Basu *et al.* 2009). These studies are now being expanded to include polar bears from north-west Greenland where Hg concentrations are higher. Likewise, 10 functional regions of the brain are being investigated to elucidate any effects in regions with higher exposure than the brain stem. Basu *et al*. (2009) found no significant correlations between chlorinated and brominated contaminants and a series of the neuro-chemical biomarkers measured.

Skull pathology and morphometry

Studies of temporal and geographical variation in bone pathology (periodontitis and tooth wear) and asymmetry have been conducted on polar bears sampled during 1892–2002 in East Greenland and at Svalbard (Sonne *et al*. 2005c, 2007c; Bechshøft *et al*. 2008a, b, c, 2009a). These studies have shown that the East Greenland and Svalbard polar bears differ in skull size and growth patterns and support the conclusions of other studies (e.g., Wiig *et al*. 2003) that these subpopulations should be managed as separate biological units. Bechshøft *et al*. (in press) also investigated skull size and growth in relation to climate fluctuations and POP exposure in East Greenland polar bears. Initial analyses indicated a decrease over time and a possible link to climate variables such as NAO, temperature, and sea ice extension (Bechshøft unpubl.).

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Management of Polar Bears in Norway, 2005–2009

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In the period 2005–2009 several important issues occurred in Norway that had importance for the management of polar bears. There is still a lot of focus on management of the ecosystems of the Barents Sea, both through the Barents Sea management plan and the new management plan for the Norwegian Sea along with several new regulations under the Svalbard Environmental Protection Act from 2001, some of which are relevant for polar bears. Planning for a repeat of the population assessment for the Barents Sea in 2010, the change to the IUCN Red List status in 2006, and making arrangements for a meeting in Tromsø, Norway in March 2009 of the parties to the 1973 Agreement on the Conservation of Polar Bears, were all events that placed polar bear management on the agenda in Norway.

Management plan for the Barents Sea

The integrated management plan for the Barents Sea was finalised and presented to the Norwegian Parliament in March 2006, and was discussed and passed as a legally-binding White Paper shortly thereafter (The Royal Norwegian Ministry of Environment 2006). The purpose of the plan is:

> "...to provide a framework for the sustainable use of natural resources and goods derived from the Barents Sea–Lofoten area and at the same time maintain the structure, functioning and productivity of the ecosystems of the area. The management plan is thus a tool which will be used both to facilitate value creation and to maintain the high environmental value of the area. This requires a clarification of the overall framework for activities in these waters in order to pave the way for the co-existence of different industries, particularly the fisheries industry, petroleum industry and maritime transport. The management plan is also intended to be instrumental in ensuring that business interests, local, regional and central authorities, environmental organisations and other interest groups all have a common understanding of the goals for the management of the Barents Sea–Lofoten area."

Svalbard and the northern part of the Barents Sea (north of Bear Island) are areas where there is not a lot of industrial activity (e.g., petroleum activities are not allowed). The main activity with relevance to polar bear habitats is still tourism (e.g., cruise ship traffic and snowmobiles in feeding areas).

The hope is that the inter-sectoral and integrated management plan will eventually secure critical polar bear habitat as outlined in Article II of the 1973 Agreement. For instance, the marginal ice zone (MIZ) is classified as a "Particularly valuable and vulnerable area", and in these areas "*special caution will be required and special considerations will apply to the assessments of standards for and restrictions on activities*". These are some of the first signals as to how the most critical polar bear habitats will be managed in the future.

Management plan for the Norwegian Sea

In May 2009, the management plan for the Norwegian Sea was presented as a White Paper from the Ministry of Environment (The Royal Norwegian Ministry of Environment 2009). This plan is based on the same approach, principles, and methods as the Barents Sea management plan and the geographical scope includes polar bear habitats west of Spitsbergen (Fram Strait). Although not directly focused on polar bear conservation, the plan includes tools and principles relevant for habitat protection and may therefore contribute to the conservation of the polar bears in the area. The plan passed the Norwegian parliament in June 2009.

New government White Paper in Svalbard

At regular intervals the Norwegian Government releases a White Paper where status and intentions for management of environment and human activities in Svalbard are discussed and expressed. The last one was released in April 2009 (The Royal Norwegian Ministry of Justice and the Police 2009) and passed the Norwegian Parliament 9 June 2009. The White Paper reconfirms the high environmental objectives on Svalbard and highlights the climate change challenges.

The only issue discussed in this document with direct relevance to polar bears is the potential impact of cruise ship traffic on resources and wildlife in the two large nature reserves in the eastern part of Svalbard. There seems to be an understanding among top level decision-makers that tourism and traffic should be more strictly regulated in the future. Since one of the objectives of these nature reserves is to serve as reference areas for research, new initiatives were taken to strengthen the regulations of traffic in the protected areas (see below).

Protected areas in Svalbard

In 2005, a new national park was established in Svalbard: Indre Wijdefjorden National Park. With this last addition there are 29 protected areas in Svalbard. There are seven national parks, six nature reserves, 15 bird sanctuaries, and one geological reserve. The total area of all protected areas is 115,600 km^2. This comprises approximately 77 % of the total area within the territorial borders of Svalbard.

The eastern parts of Svalbard are important areas for polar bears, both for feeding and breeding. These areas, which are totally protected as nature reserves, are also expected to experience the most significant impact of climate change (Førland et al. 2009). Increased traffic from cruise ships and a high level of research activity in these areas call for an increased management effort in times of rapid environmental change. Thus, management plans for all the larger protected areas at Svalbard (including the two nature reserves in the east) are being developed. Management plans for Bear Island and Hopen nature reserves are already endorsed by the Directorate for Nature Management. Hopen is an important denning site for polar bears (Derocher et al., submitted); therefore, the plan is an important means by which to promote the conservation goals.

The environmental authorities have also signalled that more restrictive measures will be implemented in the dispensation practices for activities in protected areas with special focus on securing denning areas for polar bears. For example, a quaternary geology research project was denied a permit to land on Kong Karls Land (Northeast-Svalbard Nature Reserve) in 2008. This decision was made by the Governor of Svalbard and later confirmed by the Directorate for Nature Management.

New regulations

In 2008, the regulations for the Northeast Svalbard and Southeast Svalbard nature reserves were adjusted to exclude tourist ships with more than 200 passengers. However, the most important new adjustment was the prohibition of all heavy ship fuels. No ship can use or bring fuel other than light diesel fuel, class DMA (ISO 8217 Fuel Standard). This will reduce the risk of oil fouling from accidental spills of heavy bunker fuel oils in these core polar bear areas in the future. Although field data are lacking on the effects of oiling on polar bears, experimental studies have shown that oiling can be fatal, both due to toxic effects when bears groom oiled pelts (Øritsland et al. 1981) and from significant loss of insulation (Hurst and Øritsland 1982).

Most of the other new regulations have less relevance for polar bears. For the eastern areas there is an ongoing process to improve the function of the nature reserves as reference areas for research in Svalbard. These planned regulations propose to implement the mirroring principle, and limit the number of sites where cruise ships can land passengers. The intention is to reduce the negative impacts of tourism on vulnerable nature and cultural heritage sites.

Polar bears killed in Svalbard 2005–2009

From 2005 through May 2009 six polar bears were killed in Svalbard (Table 1). The data on polar bears killed in self defence since the ban on all hunting in 1973 do not suggest an increase in human-bear confrontations in recent years (Fig. 1).

Table 1. Polar bears killed in Svalbard 2005–2009.

Date	Place	Cause	Involved	Bear sex & history	Age
2005-Apr-05	Kapp Lee, Edgeøya	SD	S	Male, new	Adult
2006-Jul-31	Storøya	SD	T	Male, recapture	> 20
2007-Jul-27	Giæverneset	SD	S	Male	2-3
2008-Aug-09	Duvefjorden	SD	S	Male	2-3
2008-Aug-31	Hopen	PM	GO	Male	Adult
2009-May-10	Kinnvika, Nordaustlandet	SD	S	Male, recapture	3-4

Source: County Governor of Svalbard, 2009
SD=self defence, AM=act of mercy, PM=precautionary measure, GO=Governor's Office, C=station crew, S=scientist, T=tourist

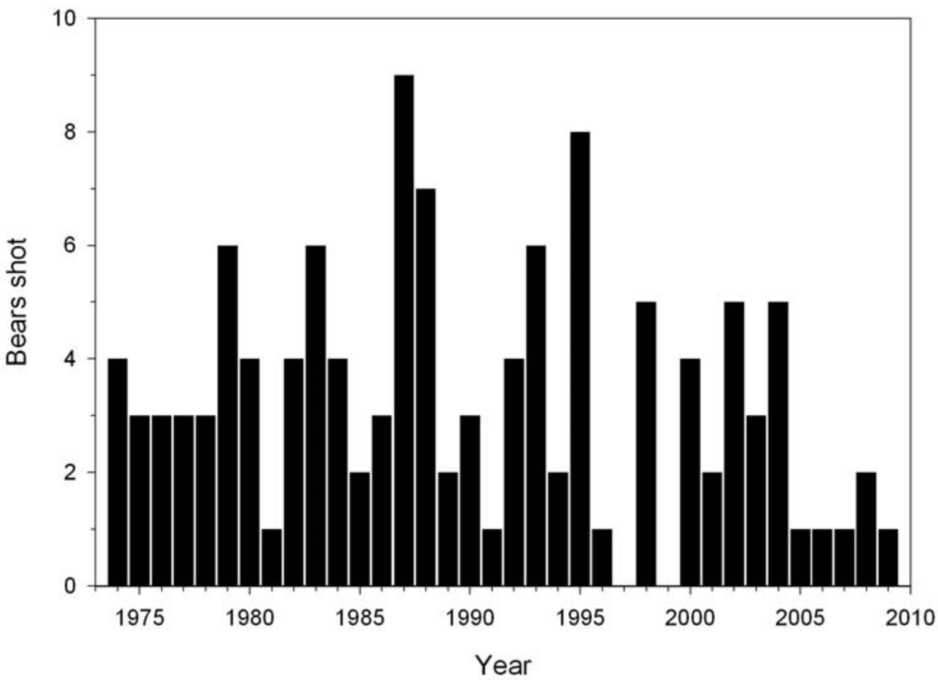

Fig. 1. Annual number of polar bears shot at Svalbard in defence of humans or property, 1974-2009.

Human casualties and human-bear conflicts

There were no human casualties in the period 2005–2009.

As mentioned above, there is no quantitative support for the idea that conflicts between humans and bears are increasing on Svalbard. This may suggest that people are better prepared and do more to avoid confrontations since tourism and other human activity in Svalbard farther away from the main settlements have increased significantly. It may also be that there is less polar bear activity around settlements due to a change in the distribution and condition of sea ice around Svalbard in both winter and summer.

On a few occasions, problem bears have been immobilized and relocated by helicopter to adjacent areas. In fall 2008 and spring 2009, single bears were moved from the weather station at Hopen to Edgeøya, 100 nautical miles to the northwest. The first bear was a thin adult female and the second was a 2-year-old male. Such operations lead to considerable stress on the animals and necessary logistics are extensive and costly. The alternative is usually that the bear is killed in defence of humans or property. It would be useful to develop a common policy among the jurisdictions on this issue as it might be expected that the number of problem bears will increase in the future.

Use and trade of polar bear products

Between 2005 and 2009, Norway exported one fully prepared and complete animal, 39 skins, and close to 1000 pieces of skin for fly fishing flies (Table 2). All these items were re-exports. Imports in the same period were 150 skins (131 from Canada, 5 from Greenland, 10 from Denmark, and 4 from Finland), one bone necklace, one claw, and some scientific samples of premolar teeth and biopsy samples. Exports originating from Norway were all scientific samples. All trade in Norway is controlled by CITES permits administered by the Directorate for Nature Management.

Table 2. CITES permits for import, export, and re-export of polar bear skins and parts of skins in Norway, 2005–2008.

Year	Import	Export (all scientific samples)	Re-export (origin not reported)
2005	30 skins (28 from CA, 1 from GL and 1 from DK), 1 bone necklace and 1 claw from GL	20 hairs and 1 ml blood to FR, 108 x 5 ml blood to US	1 skin each to UK, DK, DE, IT, RU, CN, AU, 4 skins to ES
2006	40 skins (36 from CA, 3 from GL and 1 from DK), 810 premolar teeth from CA (scientific import)	30 skin samples to FR	1 skin each to IR, DK, IT, DE, FI, 2 skins to SE
2007	41 skins from CA	20 fat and plasma samples to CA	5 skins to SE, 1 to UK, 2 to CN, 1 to US (pre-convention 1968 after agreement with USFWS), bits of skin (for fly fishing) 5 x 5 cm: 700 to FI, 150 to UK, 1 leg bone to UK, 1 complete animal prepared
2008	39 skins (26 from CA, 8 from DK, 1 from GL, 4 from FI), 51 biopsy samples from GL (scientific import)	107 tissue samples to JP (origin GL), 8 samples of fossil jawbone to US, 100 blood plasma samples to NL, 75 blood plasma samples to CA	1 skin each to FR, DE, ET, 2 to CN, 7 to RU

Country abbreviations: Australia = AU, Canada = CA, China = CN, Denmark = DK, Estonia = ET, Finland = FI, France = FR, Germany = DE, Greenland = GL, Ireland = IR, Italy = IT, Netherlands = NL, Russia = RU, Spain = ES, Sweden = SE, United Kingdom = UK

Population status

Today, the Barents Sea population has recovered to about 3,000 bears in absence of any hunting in the area after the protection instituted in 1973, (an estimated 2,644 bears; 95% CI: 1,899 – 3,592; Aars et al. 2009). This population has either historically been considerably larger or it had a significant immigration from neighbouring populations in order to sustain the profound outtake of about 300 animals per year by hunting between 1870 and 1970. The population trend is unknown, but it is likely that the population is increasing only slowly or that the population growth has staggered after more than 30 years under protection.

Possible signs of demographic density-dependent effects have been documented (Derocher 2005). A negative effect on reproduction (denning) and body weight has been documented locally (Derocher et al., submitted). It is of further concern that population growth could be inhibited due to effects of high levels of pollutants. Although effects on reproduction or survival have not been proven, a study revealed that high levels of organochlorines may impair the ability of polar bears to produce antibodies against disease agents (Lie et al. 2004).

Threat from climate change

Northern ice-covered areas are sensitive to effects of climate change (global warming) and NorACIA models (Norwegian domestic follow-up of the circumpolar Arctic Climate Impact Assessment program; see http://noracia.npolar.no) indicate that the most significant change on Svalbard will occur in the northeastern part of the archipelago (Førland et al. 2009). Climate change will both reduce critical polar bear habitat and improve access for human activities (tourism, research, resident traffic). Derocher et al. (submitted) studied the denning ecology of female polar bears at Hopen Island. It was concluded that climate change may be negatively affecting the denning ecology of polar bears at the southern extent of their range in the study population.

It is likely that polar bears will be lost from many areas where they are currently common and also that the remaining population will become more fragmented (Wiig et al. 2008). It is expected that polar bear habitat in the Barents Sea will decline substantially during the 21st century (Durner et al. 2009).

Threats from industrial developments

The southern part of the Barents Sea was legally opened for oil and gas developments in 1989. As previously mentioned, petroleum exploration is still prohibited in the northern part of the Barents Sea, north of Bear Island.

In the south, the large gas field of Snøhvit has produced liquefied natural gas since 2007. This is the first developed gas field in the Barents Sea. Gas has been the main discovered hydrocarbon reserve in the region until an oil discovery was made in the Goliat block in 2000, 30 nautical miles southeast of Snøhvit. This is the first oil field to be put in production in the Barents Sea and production is planned to start in 2013. It is located only 30 nautical miles off the Norwegian coast.

The immediate risk to polar bears from petroleum activities are thus still only from acute oil spills from tourist ships, fishing vessels, research vessels, or ice breakers with conventional fuel.

Threats from tourism and disturbance

Tourism is still, and will continue to be, one of the main commercial activities in Svalbard. Tourism activities are increasing, both in winter and summer and there is concern that polar bears are disturbed in sensitive areas and during sensitive periods. Pilot studies of disturbance from snowmobiles have shown that females with cubs seem to be more easily disturbed than males and single females (Andersen and Aars 2008). Other studies have shown both behavioural and physiological impacts on wildlife from motorised traffic (Dyck and Baydack 2004, Creel et al. 2002, Overrein 2002). The real negative impacts from disturbance from tourism and other activities are unknown. Should future studies indicate that such impacts are significant, it might be necessary to regulate tourism activities stronger to reduce the total pressure on polar bears.

Harvest

The polar bear has been protected in Norway since 1973, and thus there is no harvest of the

Barents Sea population in Norwegian territories. However, there are still concerns related to possible illegal harvest in north-west Russia. In East Greenland, harvest is set without a population estimate, so whether this harvest is sustainable is still unknown. Unpublished telemetry data from both East Greenland (Born, pers. comm.) and Svalbard suggest that bears from north-west Svalbard and East Greenland overlap in distribution in parts of the year, and thus that some interaction is likely. Population genetics studies indicated that gene flow is very high between the populations (Paetkau et al. 1999).

Threats from pollution

It is still a concern that population growth could be inhibited due to effects of high levels of pollutants (Derocher 2005).

National Red Listing

In 2006, a Norwegian Red List of threatened species was prepared in accordance with the IUCN criteria by the Norwegian Biodiversity Information Centre (http://www.biodiversity.no). The polar bear was listed as Vulnerable according to criteria A3c: a suspected population reduction during the coming three generations (45 years) based on a decline in the area of occupancy, extent and habitat quality. This is the same as the worldwide assessment (Schliebe et al. 2006). The change of status on the Norwegian Red List does not have any immediate practical consequence for the management of polar bears in Norwegian territory since the bears have been totally protected since 1973.

Meeting of the Parties to the 1973 Agreement

Norway invited the Contracting Parties to the 1973 polar bear Agreement to a meeting of the parties in Tromsø 17–19 March 2009 (http://www.polarbearmeeting.org). The five Contracting Parties met last time in Oslo in 1981 and decided then that the agreement would be valid indefinitely. The purpose of the 2009 meeting was to: 1) provide an update on the conservation status of polar bears; 2) review implementation of the polar bear Agreement ; 3) identify useful polar bear conservation strategies; and 4) discuss mechanisms for enhanced implementation of the polar bear Agreement. The main outcome of the meeting was the conclusion that: *Climate change has a negative impact on polar bears and their habitat and is the most important long term threat facing polar bears.*

The Parties also recognized that the technical support and scientific advice on polar bear conservation provided by the IUCN/SSC Polar Bear Specialist Group (PBSG) to the Parties supports the 1973 Agreement, and is a vital part of the decision making process. The Parties agreed to ask the PBSG to accept the role of scientific advisory group to the Parties and welcomed the offer by the PBSG chair to bring this to the PBSG for their consideration. The Parties also agreed to ask the PBSG to provide input to a circumpolar action plan for the conservation of polar bears. The PBSG agreed to consider this at the 2009 PBSG meeting in Copenhagen.

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Polar Bear Research in Norway, 2005–2009

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Movements, habitat use and behaviour

Polar bear research in Norway is lead by the Norwegian Polar Institute (NPI). A large program of satellite telemetry collaring of adult females was initiated in 1988 and is still ongoing with 10 to 15 collars being deployed annually. Earlier work showed that polar bears in the south-eastern parts of Svalbard can be divided into two different groups with regard to movement patters. Some bears move locally close to the archipelago throughout the year (have small home ranges), whereas others move out into the Barents Sea during parts of the year (have large home ranges). During recent years, collars have also been deployed on female polar bears from other parts of the population, and this has shown that bears from the northern parts of Svalbard also may be either very local or more pelagic with longer seasonal migrations. Furthermore, satellite telemetry has shown that the more pelagic polar bears in the northern areas typically move north to the Arctic Ocean pack ice in summer, but then return to the fjords in fall. The collaring of polar bears in more areas of Svalbard has also confirmed what has been indicated earlier, that there is little movement of bears between southern and northern areas. The pelagic bears in the north typically follow the retreating ice edge northwards in spring and summer, whereas bears in the south follow the retreating ice to the east and north east.

There is limited information about movements of polar bears in East Greenland, and the potential exchange between Greenland and Svalbard. Therefore, a cooperative project was initiated and field work conducted in 2007 and 2008. Twenty satellite radiocollars were deployed during the project, most of them in the East Greenland pack ice and a few to the north in the Svalbard archipelago. Data from the NPI satellite telemetry database has also been included in the project. The analyses are ongoing, but preliminary results show that home ranges for Greenland and Svalbard polar bears overlap in the Fram Strait (Born *et al.* 2009).

Beginning in 2002, high resolution GPS collars were employed in addition to the conventional Argos location collars. The GPS collars provided more detailed habitat use and movement patterns than the conventional collars, recording up to 6 locations per day. The high accuracy of the GPS locations and the higher data acquisition rate makes detailed studies of behaviour possible, and when used for calculation of some standard movement parameters clearly shows that conventional tags with low sampling intensity underestimate the parameters significantly (Andersen *et al.* 2008). In total, 31 collars of this type have been deployed in the Svalbard area to date.

The satellite telemetry program on polar bears in Norway has a long term strategy with the aim to study movements and habitat use over time; data are thus used in a variety of studies and projects. Data from the Norwegian area were included in the circumpolar analysis on polar bear habitat use and its development under different climate change scenarios (Durner *et al.* 2009). In that analysis, the Barents Sea population was found to be one of the most vulnerable to the reduction in sea ice habitat. Another project analysing telemetry data on a smaller, more local scale has been initiated as a Master's thesis by Julia Tchernova, with the aim to describe movements and habitat use of female polar bears during the time after den emergence.

Recently, the NPI has been involved in the development of two new types of tags for recording polar bear behaviour. Staff at the Sea Mammal Research Institute, St. Andrews, Scotland built a tag that recorded swimming and diving that was tested in 2005 and 2006. Antenna problems hindered satellite transmission of data except for the first few months, and a project is recently ongoing to sort out these problems. Data transmitted via satellite in addition to data from recovered tags show a large variation in time spent in water by polar bears through the season, large variation between individuals, and that females with small cubs avoided being in the water in spring. Females frequently dive several meters, and several dives below 10 meters were recorded, although the deeper dives were very infrequent. Another manufacturer, SIRTRACK, from New Zealand, produces a proximity tag that when deployed on females records the presence of her cubs by communicating with small transmitters built into the cubs' ear tags. We deployed these on 4 family groups; however, currently the tags cannot send the proximity data via the satellite system, and the families were not recaptured in 2009 so the performance of the tags has not yet been evaluated. The next step will be to build a tag that can transmit data by satellite and so provide information on cub behaviour and survival.

Population ecology

The population ecology of polar bears at Svalbard, Norway, based on live-captured animals from 1988 to 2002 was examined by Derocher (2005). The mean age of both females and males increased over the study, litter production rate and natality declined, and body length of adults decreased. Dynamics of body mass were suggestive of cyclical changes over time, and variation in body mass of both adult females and adult males was related to the Arctic Oscillation index. Similarly, litter production rate and natality correlated with the Arctic Oscillation index. The changes in age-structure, reproductive rates, and body length suggest that recovery from overharvest continued for almost 30 years after harvest ended in 1973, and that density-dependent changes are perhaps now being expressed in the population. A later evaluation of age determination concluded that some of the trend of increased average age was explained by inconsistency in the determination between different laboratories, but that there likely still had been a real increase in the ages (Christensen-Dalsgaard 2006, Christensen-Dalsgaard *et al.* 2010). Further research is needed to establish linkages between climate and the population ecology of polar bears.

In a study by Derocher *et al.* (2005) sexual dimorphism was examined from live-captured polar bears in Svalbard. In mature animals, sexual dimorphism was greatest in mass, followed by foreleg guard hair length, head width, body length, and head length. Foreleg guard hair length was age related and hypothesized to be a form of ornamentation. Geographic variation in sexual dimorphism was evident for mass and body length for seven different populations.

Denning ecology

NPI has a GIS database of more than 500 maternity dens with positions that have been recorded from 1972 until present in the Svalbard area. In one of the denning areas on the island Hopen (SE Svalbard), the number of dens is strongly negatively correlated with the date of sea ice arrival in the autumn, indicating a potential for serious impacts of warmer climate on population growth in the Barents Sea subpopulation in the future (Derocher *et al.* submitted). Farther north, Kongsøya is the most important denning area in Svalbard (Larsen 1985).

A team surveyed the island of Kongsøya on skis from 3–28 April 2009, partly to evaluate to what extent areas with more sea ice than Hopen are affected by climate, and partly to evaluate to what extent helicopter den surveys are likely to yield useful information on numbers of dens. The study showed that at least in some areas sign of the den may disappear within a short time after den emergence, indicating that to be useful den helicopter surveys must be timed to the peak period for activity around the den (i.e., the first few days after the bears emerge). There is considerable asynchrony in the timing of emergence and the time spent around dens is typically limited to a few days (Hansson and Thomassen 1983). Therefore, helicopter surveys may be adequate to estimate relative densities in areas and trends in denning density over time, but are less suited for total counts, unless repeated several times over a few weeks within an area. An alternative may be to use a forward-looking infrared scanner (Amstrup *et al.* 2004) in the period before polar bears break the dens to increase detection, but success of this technique is weather dependent (i.e., it does not work in sunlight) which may restrict the use in the most northern areas.

Diet

Polar bear scats have been collected in Svalbard in spring of each year since 2003, and a Master's student has started analysing the scat samples for prey contents. DNA-analyses may be used to increase our ability to detect prey in scats. Earlier studies on polar bear diet from Svalbard were from observations, and from collection of remains from kills (Lønø 1970, Derocher *et al.* 2000, 2002).

Aerial surveys

A large study on the size of the Barents Sea polar bear population was conducted in August 2004 in the area between Svalbard and Franz Josef Land and along the ice edge to the north. The most recent analysis concluded that about 2650 (CI approximately 1900-3600) polar bears live in the Barents Sea area (Aars *et al.* 2009). In connection with this study, we evaluated methods to measure distances from a transect to a bear from the helicopter, and concluded that using a GPS that records a track when flying, then taking a new way point just above the position where the bear was first seen, was far superior to the use of a clinometer that resulted in considerable bias in measured distances (Marques *et al.* 2006). This project was a collaborative study involving polar bear scientists from the NPI, the All-Russian Research Institute for Nature Protection, and the University of Oslo, and statistical expertise at University of St. Andrews, Scotland.

Systematics

During recent fieldwork in Svalbard, a well preserved subfossil left mandible of a polar bear was discovered (Ingolfsson and Wiig 2009). Age determination with infrared-stimulated luminescence—together with the stratigraphic position of the bone—suggests that it is of Eemian–Early Weichselian age; i.e., 130–110 Ky old. This makes the find the oldest remains of a polar bear ever discovered. Morphological analysis of the mandible suggests that it comes from a fully grown male that was similar in size to extant male polar bears. The comparative study of other available subfossil polar bear remains did not reveal any significant change in size of polar bears during the Late Quaternary. A genetic study of the find is ongoing.

Genetics

A Ph.D. student (E. Zeyl) at the Natural History Museum, University of Oslo, has been working on the genetics of polar bears at Svalbard in a cooperative study involving the NPI, University of Tromsø, and University of Oslo. In Zeyl *et al.* (2009*a*) the kin structure and dispersal pattern of polar bears of the Barents Sea was investigated during the spring mating season based on analysis of microsatellites related to field information. Our results showed that the polar bear, which has a high dispersal potential, lives in a highly unstable environment, and migrates seasonally, is still able to exhibit a distinct kin structure during the mating season.

In another paper (Zeyl *et al.* 2009*b*) we used the result of parentage analyses based on microsatellites to study the mating system of polar bears in the Barents Sea area. Our results indicate that the mating system of polar bears is promiscuous, usually with a single successful father siring full-siblings within a year, but with successive litters of a mother being fathered by different males. One case of multiple paternity within a litter was confirmed. Another study of denning ecology based on genetic data is ongoing. We routinely obtain samples for genetic analysis (tissue from ear taken when holes are made for ear tags), and now have a database with DNA profiles from about 600 polar bears from Svalbard.

Ecotoxicology

Research on ecotoxicology in polar bears in the Norwegian Arctic is a priority activity. Levels and effects of persistent organic pollutants (POPs) in polar bears from Svalbard were studied in the past two years during the International Polar Year (IPY) project BearHealth Norway (http://www.biologi.no/bearhealth-eng.htm). BearHealth Norway is a joint project involving the Norwegian University of Science and Technology, the NPI, the Norwegian School of Veterinary Sciences, the National Veterinary Institute in Norway, the University of Oslo, the National Environmental Research Institute in Denmark, the All-Russian Research Institute for Nature Protection, and the National Wildlife Research Centre in Canada. Blood samples, fat samples, and skin biopsies were obtained from 122 polar bears from Svalbard during spring 2007 and spring 2008. Plasma samples have been analyzed for a range of persistent organochlorine pesticides (OCPs), polychlorinated biphenyls (PCB) and their hydroxylated metabolites (OH-PCB), and brominated flame retardants (BFR).

The aim of the BearHealth Norway project is to study combined interacting effects of anthropogenic pollutants and climate variables on the health status of polar bears at Svalbard. Hence, a range of molecular, biochemical, cellular, and physiological variables has also been analyzed in blood samples and biopsies of the animals. In addition, age, morphological variables and reproductive status of the animals have been recorded. Effects of POPs on the biological variables will be examined using multiple statistical methods, such as principal component analysis (PCA) and partial least squares regression (PLS).

So far, the data have been analyzed in two M.Sc. theses. Haugestøl (2009) examined relationships between the complex mixture of POPs in the plasma of male polar bears and testosterone. PLS was used to rank the relative importance of single contaminants, biological variables, and capture position on plasma testosterone. The results confirm those previously reported by Oskam *et al.* (2003), that POPs have a negative effect on the plasma testosterone of polar bear males. The PLS model identified that several persistent PCB congeners, two OCPs, and two polybrominated diphenyl ethers (PBDEs) were the compounds that had the largest negative effect on testosterone levels (Haugestøl 2009). OH-PCBs were not identified as significant predictors of plasma testosterone in the model. Some biological variables related to plasma lipid status had a negative effect on testosterone in the model. In addition, capture latitude had a significant effect on testosterone, with declining testosterone levels farther north. The other biological variables included in the model (age and size) were not identified as significant predictors in the model. Currently we are incorporating the animals sampled in 2008 in the PLS model.

Bertinussen (2009) examined effects of OH-PCBs on thyroid hormone levels in mother-cub pairs of polar bears. Plasma concentrations of PCB-OHs and thyroid hormones (total and free triiodothyronine [T3] and thyroxine [T4]) were analyzed in mother-cub pairs from 1997–1998 (*n* = 13 females, 17 cubs) and 2008 (10 females, 16 cubs). Plasma levels of PCB-OHs were significantly lower in 2008 than in 1997–1998. There were significant changes in the thyroid hormone status of the bears from 1997–1998 to 2008, indicating that the thyroid health of the animals has improved during the last ten years. However, it is also possible that the changes are due to selection of animals that are resistant to thyroid related effects of POPs.

A Master's thesis on asymmetry in polar bear skulls in relation to pollution in East Greenland and Svalbard polar bears was finished at the Natural History Museum, University of Oslo, by T. Bechschøft in 2006. The project was conducted in collaboration with National Environmental Research Institute, Denmark. The results, which have been published in several papers (Bechschøft *et al.* 2008 *a*,*b*,*c*, 2009), indicated that Svalbard bears generally had a higher level of fluctuating asymmetry (FA) than those of East Greenland. Overall, the study showed no substantial evidence of a linkage between levels of FA and levels of organo-halogens. Instead, the indications were of subpopulations with generally declining levels of FA over time, suggesting the existence of positive population level effects powerful enough to overrule the negative influence of stress caused by global warming, pollution, and over-harvesting. In another study by Sonne *et al.* (2007) we found a clear age–sex link and geographical differences but no evidence for an association between skull pathology and exposure to organochlorines in East Greenland and Svalbard polar bears.

Disease and parasites

Disease and parasite surveys were conducted by the NPI in collaboration with the Department of Arctic Veterinary Medicine, the Norwegian School of Veterinary Science, Tromsø, Norway. Serum samples from polar bears from Svalbard and the Barents Sea were assayed for antibodies against *Toxoplasma gondii* using the modified agglutination test (Oksanen *et al.* 2009). Oksanen *et al.* (2009) found that in samples among subadults and adults there were similar prevalence among females from Svalbard and Greenland, but a high frequency among Svalbard males as compared to Greenland males. The sex-population interaction term is believed to be connected to area- and sex-specific feeding ecology. The prevalence of antibodies was high compared to previously reported findings in polar bears from Russian and Alaskan areas. The Svalbard samples in this study were mainly from the late 1990s.

A Master's thesis studied prevalence of *T. gondii* among polar bears sampled about ten years later in Svalbard (2007-2008), and among some sea mammal prey species (Jensen *et al.* 2010). The prevalence among bears had nearly doubled over the last decade, and was as high as 52% among males and 39% among females. Furthermore, it was found that the prevalence among ringed seals (19%, no age effect) and adult bearded seals (67% among adults) was high, despite *T. gondii* being absent among 48 ringed seals in an earlier Svalbard study (Oksanen *et al.* 1998). *T. gondii* is prevalent in the terrestrial ecosystem in Svalbard (Prestrud *et al.* 2007), but it seems that a marine transmission route with recent increase in waterborne oocycts could explain the recent increase in prevalence in polar bears. Oocycts may be transferred by sea water from Norway, and filtered by mollusks later eaten by seals. Studies of polar bear parasites are ongoing including analyses of *Trichinella sp.*, that have a high prevalence among Svalbard bears.

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Polar Bear Management and Research in Russia, 2005–2009

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Management

Legislative basis for protection and management of polar bear subpopulations

Federal and regional laws and statutory acts dealing with rare and endangered species form the legislative basis for polar bear management in Russia. For the Chukchi Sea polar bear subpopulation, 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" (signed on 16 October 2000 in Washington, DC, USA and came into force on 23 September 2007) is now a major part of this legislative basis. The Ministry of Natural Resources and Ecology of the Russian Federation (MINPRIRODY) is responsible for fulfilling the obligations of the Russian Federation invoked by this Agreement.

The polar bear is listed in the Red Data Book of the Russian Federation (2001). The subpopulations of the Barents Sea and the Kara Sea (the Kara-Barents population according to the Red Data Book of Russia) are designated Category IV (uncertain status taxa and populations), the subpopulation of the Laptev Sea and the western East Siberian Sea (Laptev subpopulation) is designated Category III (rare taxa and populations), the subpopulation inhabiting the eastern part of the East Siberian Sea, Chukchi Sea, and the northern portion of the Bering Sea (Chukchi subpopulation) is designated Category V (recovering taxa and populations). According to the Decree of the Russian Federation Government (1996) "On the Red Data Book of the Russian Federation" the polar bear like any other animal species listed in the Red Data Book is subject to special protection. According to Article 24 of the Federal Law of the Russian Federation "On the Animal World" actions that can cause death or decline in the abundance of the species listed in the Red Data Book are prohibited. Thus, according to Russian domestic law, organisations and individuals carrying out economic activity in areas inhabited by polar bears are responsible for protection of this species.

The MINPRIRODY is responsible for the development of state policy and the legislative basis for polar bear conservation in Russia. Management of the species (conservation, control, and management) is the responsibility of another governmental body, the Federal Supervisory Natural Resources Management Service (ROSPRIRODNADZOR), which is within MINPRIRODY. The ROSPRIRODNADZOR is responsible for monitoring, abundance assessment, and inventory of animal species in federal Natural Protected Areas (NPA). Outside federal NPAs, monitoring, abundance assessment, and inventory of animal species is the responsibility of regional authorities (subjects of the Russian Federation) that have to provide results of these functions to the ROSPRIRODNADZOR.

In 2007, WWF Russia proposed to the MINPRIRODY to develop a state strategy on polar bear conservation in Russia. The Ministry supported the initiative. At present, the Strategy and Action Plan are at the final stage of development.

Protection

As a Red Data Book species, the polar bear is under state protection throughout Russia. Additional special protection of the species and its habitats is secured on NPAs. In the Russian Arctic, the NPA network consists of State Nature Reserves (zapovedniki), state sanctuaries (zakazniki), the Beringia Nature Park, the Russian Arctic National Park, and several regional NPAs (Table 1). Absolute protection of polar bears and their habitat is provided in State Nature Reserves. In polar bear range, these are the Wrangel Island, Ust-Lenskiy, Great Arctic, Gydanskiy and Nenetskiy State Nature Reserves. In NPAs of other categories, industrial activity is totally prohibited and other types of economic activity are limited.

The Russian Arctic National Park was established by a decree of the Government of the Russian Federation on 15 June 2009. The total area of the park is 1,426,000 ha including the northern part of the Severnyi Island (Novaya Zemlya archipelago) and 793,910 ha of marine area (inland and territorial waters 12 nm along Severnyi Island and adjacent islets).

Table 1. Natural Protected Areas in polar bear range in Russia.

Name	Type of Protected Area
Wrangel Island State Nature Reserve	Federal
Beringia Nature Park	Regional
Cape Vankarem Nature monument	Regional
Ust-Lenskiy State Nature Reserve	Federal
Chaunskaya Guba State Sanctuary	Regional
Wildlife refuges in Sakha (Yakutia) Republic	Regional
Great Arctic State Nature Reserve	Federal
Severozemel'skiy State Sanctuary	Federal
Taimyrskiy State Nature Biosphere Reserve	Federal
Yamal'skiy State Sanctuary	Regional
Franz Josef Land State Sanctuary	Federal
Vaigach State Sanctuary	Regional
Russian Arctic National Park	Federal
Gydanskiy State Nature Reserve	Federal
Cape Kozhevnikov Nature Monument	Proposed Regional

Polar bear kill

Legal take

In the last half century, the only permitted take of polar bears has been limited to catching cubs for public entertainment and education (zoos and circuses). In 2005–2009, no permits for catching cubs were issued. In 2006, the Moscow Zoo adopted 1 orphan cub from Chukotka. Polar bears are occasionally killed to protect people. In 2005–2007, officially, 5 problem polar bears were killed in Russia.

Illegal harvest

Although it is difficult to estimate the scale of polar bear poaching in Russia, such indices as the number of polar bear hides for sale on the Internet and anecdotal information on polar bear kills suggest that in 2005–2009 the illegal take of this species was at previous levels or slightly lower. It appears that the main reason for this negative trend in polar bear poaching is the rapid decrease of their availability in coastal Chukotka. In 2006, one poacher was convicted of killing 5 polar bears in the Dikson area, and two poachers were convicted of killing 3 polar bears in Chukotka. These were the only convictions in the last 30 years.

Research

Assessing polar bear sea ice habitat in conditions of global change based on multi-sensor satellite monitoring

This research was conducted within the framework of the Area V US/Russia Environmental Agreement (project 02.05-7105 "Applications of Contemporary Technologies in Ecological Studies of Large Mammals"). Participants were the Institute of Ecology and Evolution, Russian Academy of Sciences, Moscow, Russia and USGS Alaska Science Center, Alaska Biology and Geography Sciences, Juneau, AK, USA. Recent studies (Belchansky et al. 2005*a,b,c*, 2007*a,b*, 2008) focused on understanding polar bear sea ice habitat relationships and developing new methods for mapping sea ice parameters (including low sea ice concentration and single ice floes) for a polar bear distribution study in the East Siberian, Chukchi, and Beaufort Seas and adjacent parts of the Arctic Ocean. This work is especially important due to recent critical changes of this primary habitat for polar bears resulting from global climate change. To this end, methodologies and data sets were developed for studying long-term sea ice habitat variability that can serve to improve the ability to discriminate and monitor change, and to better understand the underlying mechanisms.

The framework of our research includes: 1) developing monthly perennial sea ice concentration datasets (1979–2009) using neural networks (NN) algorithms and investigating spatial and inter-annual variability in multi-year sea ice distribution with respect to broad-scale environmental forces; 2) developing algorithms to monitor monthly changes in sea ice age structure (1979–2006) and investigating spatial and inter-annual changes in age structure; 3) developing algorithms to estimate sea ice thickness based on a characterization of each pixel's dynamic and thermodynamic environment and investigating spatial and inter-annual variability in thickness distributions (1982–2006); 4) developing melt and freeze onset datasets (1979–2008) and estimating spatial and inter-annual variability of melt onset dates and melt duration; and 5) developing passive microwave melt pond fraction and surface broadband albedo datasets (1979–2007).

Our results show that the Arctic summer sea ice extent declined by 7% per decade over the past 30 years. In September 2007, sea ice area decreased to 4.3×10^6 km^2; by contrast in 1980 it was 7.5×10^6 km^2. In the East Siberian–Alaskan sector the sea ice edge receded beyond 82° N so that it was 1000–1200 km north of the continental shelf. Since 2002, the multi-year sea ice area has continuously decreased, with minimal values over the Arctic Ocean in 2007 (2.50×10^6 km^2), 2008 (2.08×10^6 km^2), and 2009 (1.70×10^6 km^2). The most dramatic multi-year sea ice declines occurred in 2008 and 2009. Average January 2009 multi-year sea ice cover showed substantial losses in the sector 150° E–140° W covering the East Siberian and Chukchi Seas and adjacent parts of Arctic Ocean. The marginal zone of high inter-annual ice flux expanded northward eroding the central Arctic's multi-year ice.

Analysis of the variability in the appearance and disappearance of seasonal sea ice during 1979–2008 showed that every year 9.22×10^6 km^2 of sea ice disappears in the Arctic, and only 9.16×10^6 km^2 of sea ice appears. The seasonal sea ice extent increases $>20 \times 10^3$ km^{2}yr^{-1}.

We analyzed melt onset dates in the regions where sea ice was present during every spring from 1979–2008. We found that melt onset in 2008 was earlier overall in the Northern Hemisphere. The dramatic change (-0.4 days/yr) in melt onset dates was observed in 2006 in the northern part of Chukchi Sea, where there has also been considerable variability in melt onset date. Our results for July show negative albedo trends and corresponding positive melt-ponding trends in the Chukchi Sea, consistent with this region's well-established decline in summer ice cover. The July 2007 albedo and melt-ponding anomalies were widespread in the East-Siberian and Chukchi Seas sector of the Arctic, also consistent with this region's extensive ice loss that has been observed in recent years.

Coastal network of polar bear monitoring and management

Beginning in the autumn of 2006, WWF Russia and the Russian Marine Mammal Council started a project on coastal monitoring and management of polar bears in the Russian Arctic—*Belye medvedi.RU* (Polar Bear.RU). This project is aimed at facilitating conservation, research, and management of polar bears in Russia. One of the important components of the project is the Polar Bear Patrol Program (Boltunov and Nikiforov 2008). The main object of this community-based program is to build a network of locales for observing polar bears on the Arctic coast in the vicinity of human developments such as settlements and weather stations. Depending on the probability of polar bear presence the following three activities may occur at each locale: 1) routine monitoring of the presence of polar bears in the immediate vicinity of a settlement; 2) active collection of information on polar bears (collection of anecdotal data, regular inspection of settlement vicinity); 3) special actions on controlling the coastal areas during certain critical periods (for example period of emerging from dens, period of coastal aggregations); and 4) anti-poaching activity and actions to prevent polar bear–human conflicts.

By spring 2009, the network comprised 11 locales. At five points, not only routine collection of information is ongoing, but also regular patrols to inspect the coastal area around settlements. The most experienced local hunters are involved in this activity. Data are forwarded for analysis to a group of experts formed by WWF and the Marine Mammal Council. Partners of the Polar Bear Patrol program also include the federal state nature reserves of Wrangel Island and the Great Arctic, the Ministry of Nature Conservation of Sakha (Yakutia) Republic, and the Directorate of Nature Protected Areas of Nenetskiy Autonomous District.

In 2008–2009, inspection of primary polar bear denning habitats in the eastern Russian Arctic was conducted under the *Belye medvedi.RU* project. The area from Medvezhyi (Bear) Island to the Bering Strait was covered (> 1,000 km of coastline). In 2008, the survey was performed using ground transportation, whereas in 2009 the coast from Cape Schmidt to Aion Island was surveyed by helicopter.

Observations of polar bears in the Arctic Basin

Observations of polar bears in the Arctic Basin by the Aerial Ice Survey Service (AIS) during1958–1995, the North Pole drifting stations (NP:1954–1991), and from ice-breakers in 2000–2007 have been summarized (Gorbunov and Belikov 2008; in 2005 and 2007 Ovsyanikov collected observations from icebreakers). Here we define the Arctic Basin as that part of the Arctic Ocean situated beyond the generally adopted boundaries of the other Arctic seas. This region includes the deep-water region, accounting for the bulk of the basin, bounded by the northernmost parts of the continental shelf.

Although polar bears and their tracks in the Arctic Basin were observed throughout the year, the greatest number of sightings occurred in August and September, when the edge of the drifting ice recedes far northward. During the last 6–7 years, polar bears and their tracks have been frequently sighted in summer from onboard ice-breakers sailing to high latitudes, including the near-Pole regions. Presumably, this is facilitated by climate warming causing the ice edge to recede beyond the marginal seas.

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Polar Bear Research on Wrangel Island and in the Central Arctic Basin

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This report summarizes preliminary results of polar bear research undertaken on Wrangel Island and in the Central Arctic Basin since the 14th IUCN/SSC PBSG meeting in Seattle in June 2005.

Polar bear research on Wrangel Island

Wrangel Island has been a Category Ia (IUCN classification) nature reserve since 1976. It includes Wrangel and Herald islands and the surrounding marine area, protecting both terrestrial and marine polar bear habitats. The nature reserve encompasses a total of 56,616 km^2, including 7,620 km^2 of land (7,608.7 km^2 on Wrangel Island; 11.3 km^2 on Herald Island) and 48,996 km^2 of marine area (11,543 km^2 of which is a "strict" nature reserve and 37,453 km^2 of which is a marine buffer zone). No changes in status or size of this protected natural area were made during 2005–2008.

Polar bear research on Wrangel Island has been ongoing since 1990 and includes two major parts: 1) monitoring of the local population during late summer-autumn periods, and 2) research on polar bear population and behavioural ecology. Monitoring focuses on basic population parameters: 1) the abundance and distribution of polar bears on Wrangel Island; 2) the demographic composition of bears during the ice-free season—thought to be a segment of the Chukchi-Alaskan population; and 3) physical condition. Research focuses on the processes and factors that may affect population dynamics and health. Objectives of the research are to document: 1) bear spatial distribution on the island, on-shore movements, and terrestrial habitat use; 2) changes in demographic structure during the ice-free seasons in relation to conditions of the season; 3) foraging activity and hunting behaviour; 4) social behaviour; 5) behaviour during encounters with humans; 6) reaction to disturbances caused by human activities; and 7) changes in bear physical condition and mortality during the ice-free season.

Methods used were based on survey routes across the island and stationary observations at traditional sites of polar bear concentration, which are related to walrus haulout sites. The number, frequency, and length of survey routes, as well as the sites and duration of stationary observations depend on conditions of the season, and in particular on polar bear distribution and activity. The most common routes and three major points of stationary observations are shown in Fig. 1. Surveys were conducted on the island from mid-July through September, from 2005 to 2008. Approximately 2,500 km was traversed on all-terrain vehicles (ATV) every season.

The number of polar bears recorded on Wrangel Island during the late summer-autumn season in 2005–2008 varied from approximately 200 to 600 (Table 1). Demographic composition of stranded polar bears also varied over years (Table 2). Estimated proportions for 2006 are less detailed than for other years as there was a gap in systematic surveys during that year due to technical reasons. The lower proportion of adult males recorded in 2006 may be due to lack of surveys along the western coast of the island, where the number of adult males is usually higher. The actual proportion of adult females is thought to be higher, as females that are ready for denning at this time of year have already left for denning areas on inland slopes. These females are sleeping on slopes and can be observed only from a long distance; therefore, exact identification of the animal is usually impossible. Thus, a proportion of adult pregnant females may fall into the "lone unidentified adult bear" category. Young males may also be represented in this category, when observed from a long distance.

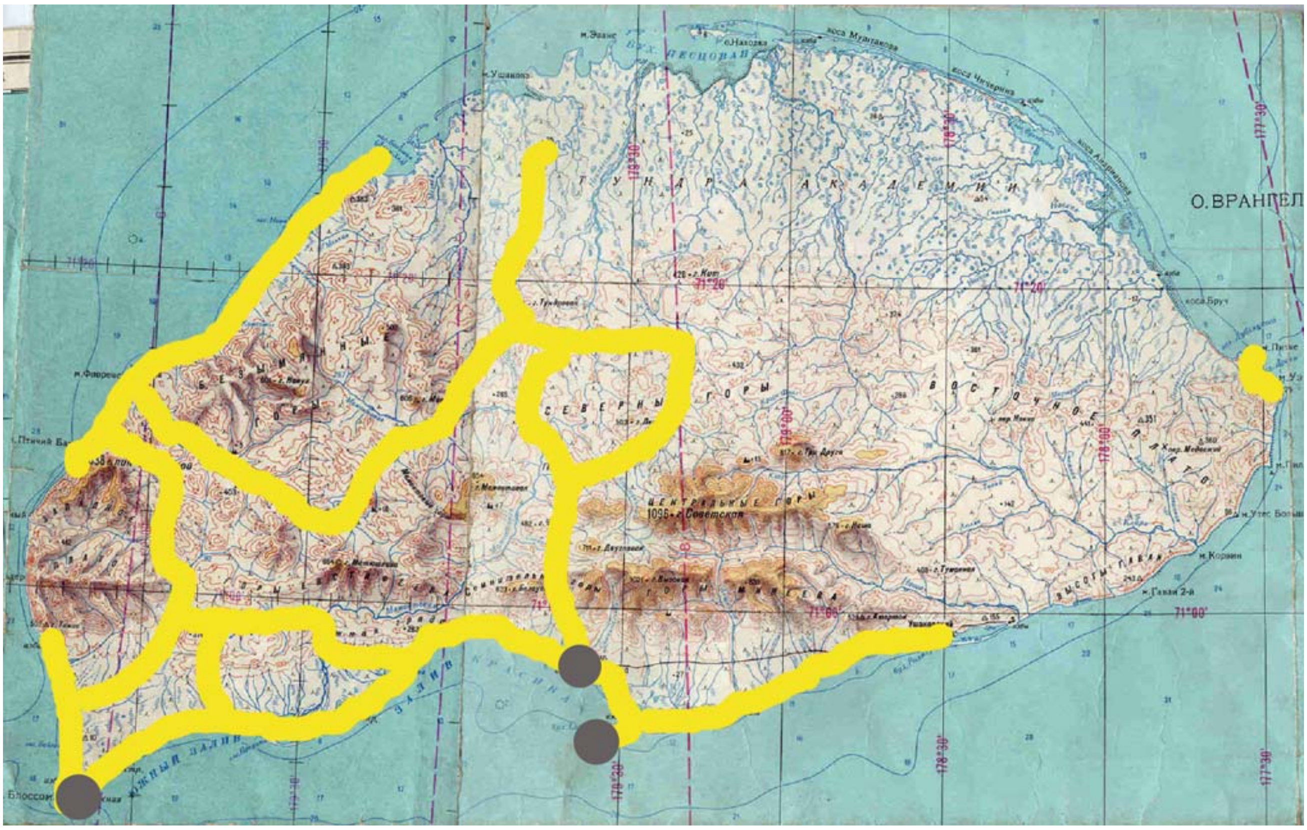

Fig. 1. Survey routes and points of stationary polar bear observations on Wrangel Island.

Table 1. Number of polar bears recorded on Wrangel Island, 2005–2008.

Year	Maximum number of bears in congregation at Cape Blossom at one time	Total polar bear count	Estimated number of bears
2005	18	104	150–200
2006	2	99	150–200
2007	11	391	550–600
2008	5	200	250–300

Table 2. Demographic composition (percentage of total) of polar bears on Wrangel Island during the ice-free period, 2005-2008.

Year	Adult male	Adult female	Fe-males with COY	Females with year-lings	Fe-males with 2-YR	Encum-bered fe-males with unidentified cubs	Adult bear (unknown sex)	COY	Year-lings	2-YR with adult female	Unidenti-fied litter with adult female	Subadult	Total number of bears
2005	16.3	9.6	13.7	1.0	4.8	1.0	13.7	24.0	1.0	7.7	1.0	6.7	104
2006	2.9	5.8	9.7	7.8	3.9	0.0	36.9	15.5	8.7	5.8	0.0	2.9	99
2007	19.6	8.6	9.3	3.4	1.2	2.5	29.7	13.2	4.4	2.0	2.5	3.7	391
2008	15.5	5.5	13.0	2.0	2.5	0.5	13.5	23.5	2.5	3.0	0.5	18	200

The physical condition of polar bears on land on Wrangel Island during the ice-free season was estimated using a 5-point scale (Ovsyanikov 2006) in 2005 (n = 87), 2006 (n = 61), 2007 (n = 239), and 2008 (n = 132). The highest proportion of bears in poor physical condition was recorded in 2007 (4.6%), but this was lower than in the period 2001–2004, when the number of bears in poor condition varied from 6 to 15% (Ovsyanikov 2005). A detailed analysis of the dynamics of physical condition will be conducted in the future to compare within- and between-year variation of this parameter in relation to sea ice conditions and food availability. Preliminary results suggest that during the last 5 years foraging conditions for polar bears in the region of Wrangel Island improved and that the polar bear response to such an improvement was immediate.

Litter size was estimated during the late summer-autumn period, 2005–2008, for litters of all age categories (Fig. 3). In addition, in 2005 and 2007, spring surveys were conducted on the island to estimate polar bear activity during the period of female emergence from maternal dens. Systematic spring maternal den surveys were ended on Wrangel Island in 1997, due to concerns regarding den disturbance. However, in spring 2007 a single den survey session was conducted on the island; a group of two observers counted maternal dens at Cape Warring from March 16 through May 1. In 2009, a survey on spring polar bear activity on the island was conducted from March 26 through April 6. These spring surveys were limited to ground observations at only one location each year: in 2007 at Cape Warring and in 2009 at Thomas mount. Surveys were conducted by foot along the periphery of denning areas to avoid disturbance to family groups. In addition to observations at denning areas, snowmobile surveys were conducted along river valleys inland, and along the southern and western coasts of the island to count tracks of polar bear families heading towards the sea ice.

During spring surveys in 2007 at Cape Warring, 7 maternal dens were located, 5 bear families observed, and a total of 39 family groups recorded leaving the island (by both tracks and animals sightings). In 2009 at Thomas Mount, we found only 1 maternal den, whereas in the early 1990s we recorded from 5–8 dens/yr within the same area. In 2009, a total of 24 family groups

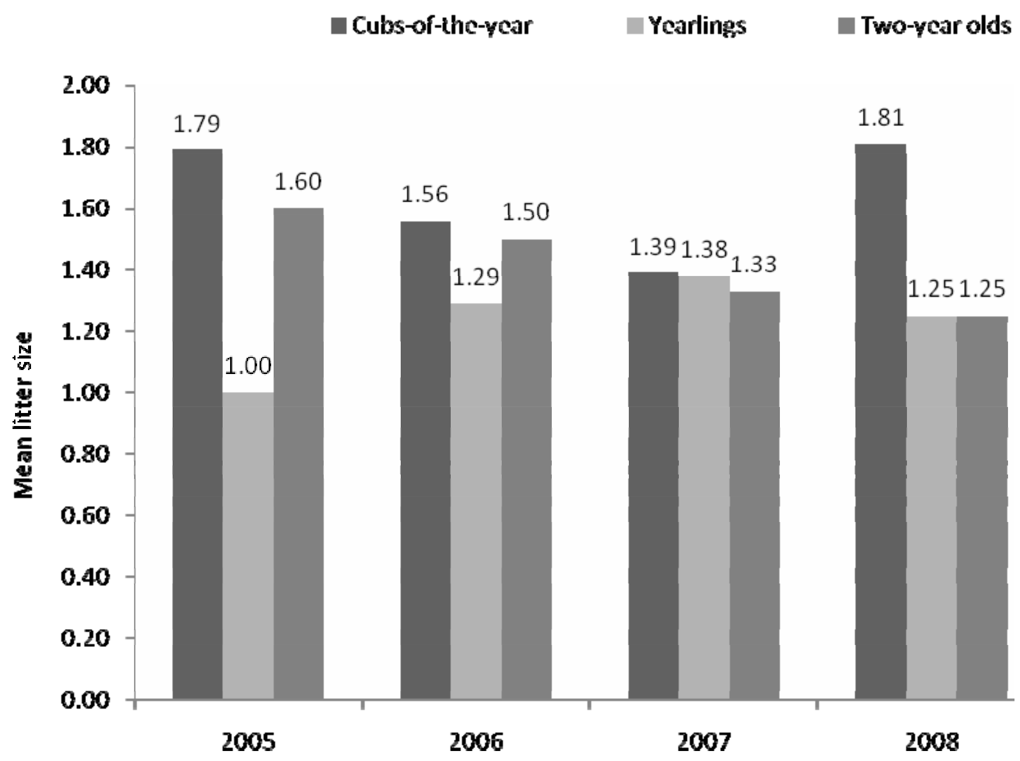

Fig. 3. Mean litter size during the autumn on Wrangel Island, 2005-2008.

were recorded leaving the island (5 observed, 19 by tracks) during the 2-week survey period.

The average litter size in spring was 1.90 (*n* = 39) in 2007 and 2.17 (*n* = 24) in 2009. Spring litter size for cubs-of-the-year was higher than recorded during autumn. However, in 2008, it was the highest recorded during the autumn for the last decade. In spring 2009 the number of family groups leaving the island was at least 4 times lower than for the same time period and the same area as in the early 1990s; however, average litter size was the highest recorded on the island since early 1990s (Ovsyanikov 1993, 2006). In other words, fewer females were denning on the island during recent years compared to the 1990s, but those few that were denning were in relatively good condition and produced larger litters on average. This may reflect an improvement in foraging opportunities in the region of Wrangel Island during the last few years (perhaps due to better ice conditions during the spring-early summer hunting season) or an immediate response of polar bears to local improvement in food availability. More detailed analysis in relation to ice dynamics and further monitoring is needed to assess these hypotheses.

Alternative food resources are available for polar bears on Wrangel Island during the ice-free period. Since the summer of 2005 I recorded feeding on, or attempts to hunt, the following prey: walruses (*Odobenus rosmarus*; both alive and washed up carcasses), grey whale (*Eschrichtius robustus*) carcasses, Arctic cod (*Boreogadus saida*) carcasses, dead and alive salmon in lagoons, moulting snow geese (*Chen caerulescens*), lemmings, reindeer (*Rangifer tarandus*) carcasses, musk oxen (*Ovibos moschatus*) carcasses (a few unsuccessful attempts to chase or follow musk oxen were observed as well), washed up marine invertebrates (shellfish) and other carrion, such as dead birds, and Arctic fox (*Vulpes lagopus*) carcasses.

Large gatherings of polar bears on shore (coastal aggregations) were not observed on the island during the last 5 years. The multi-year accumulation of old walrus skins and bones at the spit of Cape Blossom, known as "field of bones", which was a strong attraction for polar bears that concentrated there even in the absence of walrus haulouts, no longer exists. Beginning in 2004, the "field of bones" has been gradually washed out by late-autumn storms, and the last portion of walrus remains was washed out in autumn 2007. Since this attraction has disappeared, polar bears do not show any preference for Cape Blossom. All local polar bear gatherings (lesser aggregations) were recorded on the island only in relation to walrus haulouts or whale carcasses, and did not exist long after the available food was finished.

The most usual activity pattern during the ice-free period is the alternation between sleeping and slow walking along the coast or inland in search of food. When encountering humans on the coast, polar bears escape into the sea, and swim out to sea or along the shore some distance (from a few tens of meters to a few kilometres), wait for humans to pass, and then come ashore again. The same escape tactic is observed when polar bears are disturbed by an ATV or any other vehicle: escape into the sea, wait for the vehicle to pass, and get back onto land. Since the beginning of our research in 1990, we have never observed a bear leaving the island for the open sea before ice is visible from the coast. As soon as the ice returns from the north or the surrounding sea is frozen to the stage where it can support a walking or crawling bear, the majority of bears leave the land for the ice and in 2–3 days almost all bears are out on the ice hunting. Most polar bears leave areas with intensive ATV traffic (often near base camp, for instance) moving to more remote parts of the coast where they are not disturbed.

Polar bear survey in the Central Arctic Basin in 2005 and 2007

Two polar bear surveys were conducted in the Central Arctic Basin (CAB) from the expedition research ship "Academic Fedorov" in 2005 and 2007. The 2005 survey was conducted northward from Wrangel Island on both sides of the 180° meridian, up to 79°15´ N. The second expedition in 2007 sailed from Franz Joseph Land to the North Pole and back. On both surveys observations were carried out from the bridge 24 hours a day (by N. Ovsyanikov, the ice surveying team, and marine officers on duty). For each polar bear sighting, the observer on duty recorded the number of animals (including cubs), their position (coordinates), type of ice, bear physical condition, sex (when possible), and activity.

In 2005, 18 bears were seen on sea ice north of Wrangel Island, 12 of which were observed north of the edge of continental shelf (above 75° N), including 8 bears north of 77° N. Ten of the bears were in 4 family groups, including 3 family groups observed north of the continental shelf. One female with 2 two-yr-old cubs (all with a fat index of 4) were at 77º 04.10´ N, 178º 26.50´ W. One female and 1 cub-of-the-year (fat index, 4) were recorded feeding on a killed seal at 78°50.20´ N, 177° 27.40´ W (sea depth at this position was 1500 m). All bears observed in 2005 were in good physical condition: 16.7% were of average healthy body index (3); 83.3% were fat (9 with a fat index of 4, one with a fax index of 5). In addition, 7 polar bear track lines (lone bears) were recorded north of 75° N (i.e., north of the edge of continental shelf).

In 2007, in the western sector of the CAB, 7 polar bears were sighted, and 61 polar bear track lines were recorded along both legs of the route. As in 2005, all bears were in good physical condition: 85.7% were fat (5 bears of each sex) or very fat (1 adult female), and only one bear was in category 3 (average). A particularly high concentration of tracks was recorded between 82º 25.30´ N and 82º 22.00´ N. One female, with a condition index of 4, was observed at the North Pole. Based on her behaviour, she was not simply transiting through the area near the North Pole (Fig. 4). During both surveys, all bears recorded in CAB were observed on fields of substantial ice.

During both surveys in CAB all sightings of seals were recorded. In 2005, ringed seals (*Pusa hispida*) were recorded at all parts of the route across ice north of Wrangel Island—from 75° through 79°15´ N. In 2007 ringed seals were recorded up to the North Pole (Fig. 5.)

The long-term observational study on polar bear behavioural ecology on Wrangel Island may provide essential information for understanding how polar bears respond or may respond in the future to global environmental change. I suggest that processes observed on Wrangel Island may illustrate a strategy for polar bears to survive ice-free seasons in coastal ecosystems. When the Arctic pack ice recedes northward beyond the edge of the continental shelf during the summer

Fig. 4. Adult female polar bear recorded at the North Pole, August 1–2, 2007. (Photo credit: S. Khvorostov).

season, bears that hunt on the remaining ice fields in the marginal zone south from the edge of the main pack ice are forced ashore as this marginal ice splits from the main pack and melts. These bears are stranded on land where they conserve energy accumulated during the spring hunting season and may exploit alternative food resources. Under certain circumstances, such as were observed on Wrangel Island in 2007 (Ovsyanikov and Menyushina 2008, Ovsyanikov *et al.*, 2008), resources available in coastal ecosystems may be so abundant that polar bears are able to feed on them more successfully than while hunting on the sea ice. Bears that stay on the main pack ice while it is receding move to the CAB where they spend the summer. Our observations in 2005 and 2007 suggest that ringed seals also move to the CAB with the receding pack ice, thus providing opportunities for polar bears to hunt in habitats that were not optimal during normal ice conditions in the Arctic. During the winter-spring-early summer season, when marine areas in the continental shelf zone are covered by annual ice, polar bears return to these areas to forage on the rich resources of this most productive marine zone. As the ice melts during summer, this cycle repeats.

Based on this descriptive model, I speculate that the same strategy may have helped polar bears to survive periods of interglacial global warming during the Pleistocene epoch. This strategy possibly could be modified in different geographic areas by variations in local conditions. However, an understanding of the behavioural response of polar bears to various factors may not only explain the drivers in observed processes, but also predict potential scenarios for population trends under various conditions.

Based on our current understanding of polar bear behaviour and processes in this local population, the actual and potential reactions of the species to global environmental change, if current trends continue, may be summarized as follows: 1) Decrease of polar bear numbers, some populations may disappear; 2) Global redistribution of polar bears, seasonal shift of some bears from continental shelf zone into CAB; 3) Increase of gene flow between some populations; 4) Seasonal geographic isolation of some populations; 5) Extended periods of stranding on land and a switch to a terrestrial lifestyle; 6) Seasonal switch to alternative food resources; 7) Forced maternity denning on drifting pack ice in CAB (for females that cannot return to land in time for hibernation); 8) Increased social interaction during periods of stranding; and 9)

Increased nutritional stress in terrestrial habitats and the probability of cannibalism.

Some of these reactions are confirmed by observations during recent years. For example, the Chukchi-Alaskan population now apparently splits every year into four seasonally isolated parts: Wrangel, Chukotka, Alaska, and CAB. Some of the hypotheses presented could be tested in further research. Under current environmental trends, further research and monitoring of polar bear populations in different sectors of the Arctic is critically important for understanding ongoing processes, drivers, and trends for defining major threats and implementing the appropriate conservation measures.

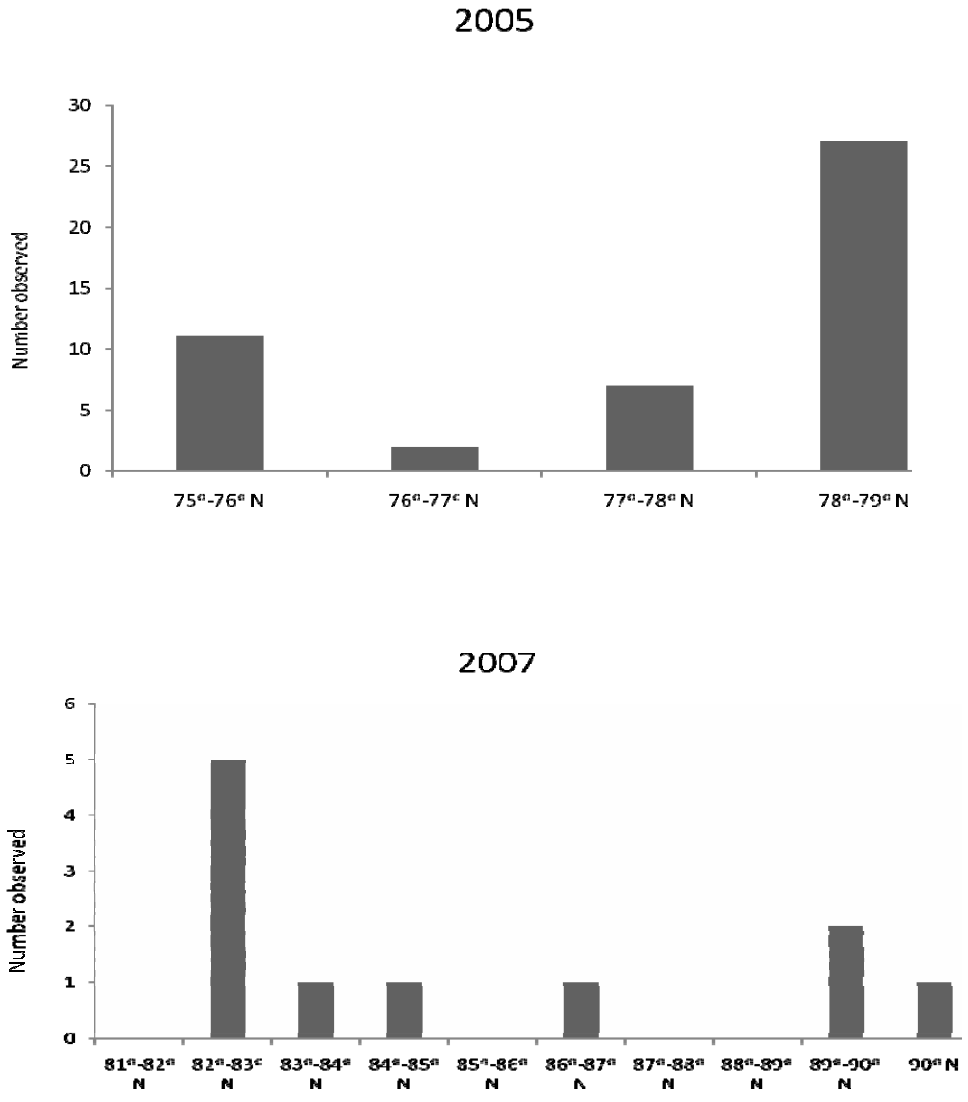

Fig. 5. Observations of ringed seals (*Pusa hispida*) in the Central Arctic Basin, 2005 and 2007.

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Polar Bear Conservation in the United States, 2005–2009

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Significant accomplishments have occurred in polar bear (*Ursus maritimus*) conservation in the United States since the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group (PBSG) in 2005. Notably, on 15 May 2008, the US Fish and Wildlife Service (USFWS) published a Final Rule in the Federal Register listing the polar bear as a threatened species under the Endangered Species Act of 1973 (ESA). The USFWS also published on that date an Interim Final Rule for the polar bear under Section 4(d) of the ESA. The ESA requires that, to the maximum extent possible, the Secretary of Interior designate critical habitat at the time the species is listed. However, the USFWS determined that additional time was needed to evaluate a potential critical habitat designation, and did not publish a proposed designation concurrent with the Final Listing Rule. In June 2010, the USFWS anticipates proposing to designate 519,403 km^2 (200,541 mi^2) of critical habitat for polar bears within the boundaries of the United States.

The USFWS, in collaboration with the US Geological Survey (USGS), initiated a capture-recapture study in the Chukchi Sea in 2008. The immediate goals of this project are to identify the best methodology for estimating vital rates (i.e., survival and breeding probabilities) and to understand the health and demographic structure of the population. The long-term goals are to evaluate population status and trend, and to understand how polar bears are distributed in the region and how they use the sea ice habitat.

In 2007, the President of the United States signed into law the implementing legislation for the *Agreement between the United States of America and the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population* (Agreement). The Agreement was originally signed between the United States and the Russian Federation in 2000 to ensure the long-term conservation of the Chukchi Sea polar bear subpopulation. Both the United States and the Russian Federation have appointed Commissioners for the Agreement, and an initial meeting of the Commission was set for September 2009 in Moscow, Russia. In May 2008, the US Secretary of the Department of the Interior, Dirk Kempthorne, and the Canadian Minister of the Environment, John Baird, signed a Memorandum of Understanding to facilitate and enhance conservation and management of polar bears between the two countries. Also in 2008, the USFWS and the Alaska Department of Fish and

Game (ADF&G) signed a Polar Bear Coordination Agreement committing the USFWS and the ADF&G to collaborate to ensure the continued conservation of polar bears in Alaska.

The USFWS continued to work with oil and gas operations in Alaska to minimize impacts on polar bears. Implementation of the ESA and use of the Incidental Take Regulations established under the US Marine Mammal Protection Act (MMPA) are important tools. Also, the USFWS continued to implement the 1994 amendments to the MMPA which, prior to the listing of the polar bear under the ESA, allowed polar bear trophies legally taken in approved Canadian subpopulations by US hunters to be imported into the USA. A summary of the effect of the ESA listing on the import of polar bear trophies is included in this report and Table 1 shows the number of trophies authorized to be imported into the USA. Additionally, the USFWS continued financial support to the Alaska Nanuuq Commission through section 119 of the MMPA, and continued to work with the Inupiat/Inuvialuit Game Council by providing technical assistance supporting the agreement for management of the Southern Beaufort Sea polar bear subpopulation. Harvest monitoring and the collection and analysis of harvest specimens for contaminants have also continued.

Most recently, following the direction of the Polar Bear Range States at their meeting in Tromsø, Norway in February 2009, the USFWS along with Tor Punsvik, Environmental Advisor, Office of The Governor of Svalbard, Norway, and Dag Vongraven, Senior Adviser, Norwegian Polar Institute, Tromsø, Norway, are developing a polar bear–human interaction initiative to address the anticipated increase in interactions as a result of more polar bears coming ashore and staying for longer periods due to climate change.

Endangered Species Act (ESA)

Listing of Polar Bears as a Threatened Species under the ESA

The USFWS listed the polar bear as a threatened species under the ESA on 15 May 2008. At that time the USFWS also issued an interim final rule under section 4(d) of the ESA for the polar bear and accepted comment on that interim 4(d) rule. The ESA listing of the polar bear was based on the best available scientific information, which showed that loss of sea ice threatens and will likely continue to threaten polar bear habitat. This loss of habitat puts polar bears at risk of becoming endangered in the foreseeable future, the standard established by the ESA for designating a threatened species.

The USFWS finalized its protections for the polar bear under the ESA with the publication of a Final Rule under Section 4(d) of the ESA on 16 December 2008. The final 4(d) rule took effect on 15 January 2009. The Special Rule: 1) in most instances, adopts the conservation regulatory requirements of the Marine Mammal Protection Act of 1972 and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as the appropriate regulatory provisions for the polar bear; 2) provides that incidental take of polar bears resulting from activities outside the bear's current range is not prohibited under the ESA; 3) clarifies that the Special Rule does not alter the Section 7 consultation requirements of the ESA; and 4) applies the standard ESA protections for threatened species when an activity is not covered by an MMPA or CITES authorization or exemption.

The 4(d) rule does not change the status of polar bear trophy importation. Under the MMPA, when the polar bear was listed as a threatened species in May 2008, no further imports other than for scientific research or enhancement were allowed. This moratorium remains unchanged by the special 4(d) rule.

The USFWS is undertaking a number of actions subsequent to the threatened listing of the polar bear. These include: designation of critical habitat, establishing guidelines for human–bear interactions, and development of a Polar Bear Conservation Plan.

Polar Bear Critical Habitat Proposed under the Endangered Species Act

The USFWS anticipates publishing a draft proposed determination of critical habitat for polar bear populations in the United States in early 2010. The proposal would designate what

Table 1 Number of polar bear importation permits issued to US hunters by year[a]

Status	Subpopulation	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008 [d]	Total
Approved Subpopulations	Southern Beaufort Sea	32	12	16	18	9	5	13	14	10	6	9	1	145
	Northern Beaufort Sea	41	4	8	9	16	8	13	16	16	16	30	3	180
	Viscount Melville Sound	5	4	0	0	1	4	5	4	0	3	8	0	34
	Lancaster Sound	17	16	104	31	32	28	29	30	25	36	49	4	401
	Norwegian Bay	0	0	1	1	2	4	0	1	2	3	3	0	17
	Western Hudson Bay	0	2	2	2	3	3	4	9	4	6	12	6	53
Subpopulation Approval Withdrawn	M'Clintock Channel[b]	23	13	10	14	7	0	1	0	0	0	0	0	68
Deferred subpopulations[c]	Gulf of Boothia	3	2	0	0	0	0	1	7	0	0	0	2	15
	Kane Basin	0	0	0	0	0	0	0	0	0	0	0	0	0
	Baffin Bay	3	2	0	0	0	0	0	8	2	0	0	0	15
	Foxe Basin	5	2	0	0	0	0	1	14	2	1	2	0	27
	Davis Strait	3	3	1	1	0	0	1	5	0	0	0	0	14
	Southern Hudson Bay	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	132	60	142	76	70	52	68	108	61	71	113	16	969

[a]Bears may have been harvested in previous years

[b]Approved only for bears taken before June 1, 2000

[c]Bears taken prior to February 18, 1997

[d]For approved subpopoulations, permits issued through May 15, 2008 (effective date of ESA listing)

terrestrial and offshore habitat in northern Alaska is essential to the conservation of the species. These designations would only apply to the lands and waters of the United States

The ESA requires that, to the maximum extent possible, the Secretary of the Interior designate critical habitat for the species at the time it is listed. However, the USFWS determined that additional time was needed to conduct a thorough evaluation and peer review of a potential critical habitat designation and thus did not publish a proposed designation concurrent with the final listing rule. This decision was the first ESA listing by the USFWS in which the primary threat to the species, loss of sea ice habitat, had been linked to climate change; therefore, the USFWS took the necessary steps to ensure that the finding represented the best data available.

Critical habitat receives protection under Section 7 of the ESA which prohibits destruction or adverse modification of critical habitat with regard to actions carried out, funded, or authorized by a federal agency or occurring on federal land. A critical habitat designation does not affect non-federal entities when there is not a federal nexus. For example, many activities normally conducted by a landowner or operator of a business which do not involve federal funding, permitting, or authorization would not be affected. Critical habitat is determined after taking into consideration the economic impact it could cause, as well as any other relevant effects. The Secretary of the Interior may exclude any area from critical habitat if the benefits of exclusion outweigh the benefits of inclusion, as long as the exclusion would not result in the extinction of the species.

Polar bear kills

Alaska Harvest Summary

The total Alaska harvest of polar bears from July 2004 to June 2008 was 259 (Table 2) with a mean of 65 bears/yr (range 34-89; Table 2). In addition to the subsistence harvest there was one research handling mortality. The 2007–2008 polar bear harvest (n = 34) was the lowest recorded state-wide harvest since 1980–1981 (the first harvest for which the USFWS has reliable records). The total harvest between 2004 and 2008 declined by 66 bears, with a reduction of 16 bears in the mean annual harvest from the previous 4-yr period (as reported at the 2005 PBSG meeting). Compared with the previous 4-yr period, July 2000 to June 2004, the mean annual harvest from the Southern Beaufort Sea subpopulation declined from 39 to 32 and for the Chukchi/Bering Sea subpopulation from 42 to 41. There is a significant ($t = 2.64$, $P < 0.02$) downward trend in the Alaska harvest when compared between two periods 1980–1990 ($\bar{x} = 132$) and 1990–2008 ($\bar{x} = 79$), due mostly to declines in Chukchi/Bering Sea harvest. During the 1980s, 66% of the Alaska polar bear harvest typically came from the Chukchi/Bering Sea subpopulation, whereas since 2000 only 57% of the total harvest came from the Chukchi/Bering Sea subpopulation. The reported polar bear harvest from the Chukchi/Bering Sea subpopulation declined 47% from the 1980s ($\bar{x} = 92.1$, SE = 16.4, n = 10) to the 1990s ($\bar{x} = 49.2$, SE = 7.4, n = 10) and continues to decline in this century (2000−2008, $\bar{x} = 42.4$, SE = 7.0, n = 8). During the past two harvest years (2006–07 and 2007–08) the polar bear harvest from the Southern Beaufort Sea subpopulation was 21 and 13 bears, respectively, below the long-term (1980−2008) mean annual harvest of 35 bears.

Information on population dynamics in the Chukchi/Bering Sea subpopulation is lacking and it is uncertain whether the decline in the harvest reflects a population decline. The decline in the polar bear harvest in western Alaska may be due to changes in movement of the sea ice due to wind and tidal currents, and to an increase of less stable first-year ice and a decrease in the more stable multi-year pack ice, which may affect both bear distribution and the availability and accessibility of bears to hunters. Information to detect population trends in the Chukchi/Bering Sea subpopulation is unavailable. Research was initiated by the USFWS in 2008 to collect information on vital rates, health, and the sex and age structure of the population. In contrast, there is robust population information for the Southern Beaufort Sea subpopulation. The decline in survival rates of adult females and juvenile polar bears (Regehr *et al.* 2009), and a recent lower population estimate (Regehr *et al.* 2006), suggest that the Southern Beaufort Sea subpopulation is declining (Hunter *et al.* 2007). The relatively low harvest during the last two years may be a reflection of the decreased number of bears or

Table 2. Number of polar bears killed in Alaska by village, harvest year[a,] and sex.

Village	2004/05[b c]			2005/06			2006/07			2007/2008			Total		
M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	
Atqasuk[c]	-	1	-	-	-	-	1	-	-	-	-	-	1	1	-
Barrow[c]	12	1	-	13	10	1	8	6	4	6	3	1	39	20	6
Fort Yukon[c]	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-
Gambell	1	2	-	9	3	-	7	3	-	-	-	-	17	8	-
Kaktovik[c]	-	4	5	-	-	-	-	-	-	-	1	-	-	5	5
Kivalina	-	1	1	-	-	-	1	1	-	-	-	-	1	2	1
Kotzebue	-	-	-	-	-	-	-	-	-	-	1	1	-	1	1
Little Diomede	4	3	-	6	5	1	5	3	-	-	1	-	15	12	1
Nome	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-
Noorvik	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-
Nuiqsut[c]	1	1	-	3	-	-	-	-	1	-	-	-	4	1	1
Point Hope	7	2	1	9	-	2	7	2	-	5	5	6	28	9	9
Point Lay	3	1	-	-	-	1	-	1	-	-	-	-	3	2	1
Prudhoe Bay	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Savoonga	2	1	1	6	5	-	5	5	2	-	1	-	13	12	3
Shishmaref	-	-	-	2	1	4	3	-	1	-	-	-	5	1	5
Wainwright[c]	1	2	2	3	2	-	-	-	1	-	-	1	4	4	4
Wales	3	-	1	3	-	-	2	1	-	-	-	-	8	1	1
Sub Total	35	19	11	54	26	9	40	22	9	12	13	9	141	80	38
Annual Total		65			89			71			34			259	

[a] Harvest year is from July 1 to June 30

[b] Subsistence harvest does not include 1 research mortality [c]

[c]Villages harvesting polar bears from the Southern Beaufort Sea population

may be an indication of increased conservation efforts to protect polar bears.

In the last two years, three polar bears were killed at inland locations. One bear was killed 400 km inland from the Beaufort Sea coast at Fort Yukon and two bears were killed at Noorvik and Noatak, which are approximately 48 km inland from the Chukchi Sea coast. As polar bears cope with changing sea ice conditions, we expect more bears to be nutritionally stressed and to spend more time on land during the open water period. This will likely lead to an increase in human–bear interactions, potentially more dangerous encounters if bears are nutritionally stressed, and more bears harvested.

The sex ratio of known-sex bears harvested since 1980 has remained fairly consistent at 66% males and 34% females, although annual variation by region exists. The harvest age class composition from 2005 to 2008 (Table 3) showed a slight increase in the proportion of cubs and adults and a decrease in the number of subadults harvested compared to the long-term average since 1980 (17% cubs, 32% subadults, and 51% adults). The decline in the number of subadults harvested is concurrent with apparent reduced recruitment in this subpopulation (Regehr *et al.* 2009, Rode *et al.* 2009).

In Alaska, harvests occurred in all months during 2005−2008. The greatest monthly harvest for the period occurred during January (22.0 %). The combined months of November to May, when the pack ice is close to shore, accounted for 87.3 % of the harvest. The months of June to September, when the pack ice is retreating to its minimum, accounted for only 12.7% of the harvest which was an approximate 5% decline since 1995–96. Differences in the chronology of the harvest were evident between the Beaufort Sea region and the Chukchi/ Bering Seas (CS). The harvest from the Southern Beaufort Sea and the Chukchi Sea (CS) subpopulations were 52.6% and 4.9% during the fall-early winter period (September to December), and 40.2% and 93.2% in the spring (January to May), respectively. The surge in spring harvest in northern Alaska is associated with whaling activities near the open lead systems. The January to May 2005–2008 harvest from the CS population in western Alaska, which coincides with the arrival of the pack ice, increased from the previous four year period (93.2 % vs. 81.1%). Since 1980, significantly more bears have been harvested in the fall (October–December) in the Southern Beaufort than in the Chukchi Sea ($\chi^2 = 175.3$, df = 2, $P < 0.001$). Polar bears from both Alaskan populations remain with the pack ice throughout the year. Overall, the chronology of the harvest has remained the same since 1980 with the peak harvest occurring in the spring and fall for the SB subpopulation and during the spring in the CS subpopulation. The pack ice is generally absent from coastal areas during the summer months (July and August) and as a result, few bears are harvested during this time (3.5% of total harvest). A reduction of harvest numbers in both populations in recent years may be an indication that the populations are declining, or that change in the sea ice conditions in the Beaufort, Chukchi, and Bering Seas is altering polar bear distribution and the accessibility of polar bears to hunters.

Southern Beaufort Sea Harvest Summary

The total Alaska harvest, from July 2004 to June 2008, by Alaska villages party to the Inuvialuit Game Council and North Slope Borough management agreement, was 97 polar bears, averaging 24 bears/yr (range 13–32) from an annual quota of 40 (Table 4). This was a decline of 59 bears since the last USFWS polar bear management report in 2005. One additional known death (research mortality) was not included in the harvest tallies.

The sex ratio of the harvest from 2005–2008 was 60:40 males to females. Complete information on the age and sex of harvested bears was available for 85% of the harvest. Net mean annual removal of females was calculated by summing the known-sex females, adding 50% of the unknown sex bears for the 2000–2004 period and dividing the sum by the number of years. The mean annual removal of females (10.0) for this period was below the sustainable yield calculation (SY = 13.2) which is based upon a 2:1 male to female sex ratio. The harvest age class composition from 2005 to 2008 was 16.0% cubs, 44.0% sub-adults, and 40.0% adults. The state-wide harvest from the Southern Beaufort Sea occurred in all months, and showed a bimodal distribution between September to January (49.1%) and April to May (29.3%).

Bio-monitoring

Although baseline levels of most organic and inorganic contaminants are fairly well documented for the Alaskan populations, more information is needed on the biological effects on polar bears and their prey. Although there is no evidence that contaminant concentrations are currently having population level effects, this may change if populations decline and individuals become more nutritionally stressed. Samples continue to be collected from all sex and age classes through the Polar Bear Bio-Monitoring Program for contaminant analysis, genetic analysis, food habitat studies, assessment of physiological parameters, and long-term archival through the Alaska Marine Mammal Tissue Archival Project (AMMTAP). The USFWS supports continued long-term storage through programs such as the AMMTAP because it allows for analysis of samples when funding becomes available, testing for new contaminants of interest, testing for new compounds as new analytical techniques are developed, and temporal and geographical comparisons. In addition to contaminant analysis, these samples can be used for genetic, fatty acid, and viral analyses.

Alaskan samples were provided to Canadian researchers as part of a circumpolar contaminant study to document spatial and temporal trends in

Table 3. Numbers of polar bears harvested in Alaska, 2004/05-2007/08[a], in relation to age class. Ages are based on cementum annuli in the first premolar tooth (cubs, 0–2.3 yrs, subadults, 2.33–4 yrs; adults, ≥5 yrs). Percentages are in parentheses.

	2004/05	2005/06	2006/07	2007/08[b]	Total
Cubs	4	9	8	0	21
(%)	(13.3)	(22.5)	(26.7)	(0.0)	(20.4)
Subadults	10	7	7	1	25
(%)	(33.3)	(17.5)	(23.3)	(33.3)	(24.3)
Adults	16	24	15	2	57
(%)	(53.3)	(60.0)	(50.0)	(66.7)	(55.3)
Total	30	40	30	3	103

[a] Harvest year is from July 1 to June 30
[b] Ages have yet to be determined for 11 additional tooth

Table 4. Number of polar bears harvested from the Southern Beaufort Sea 2004/05–2007/08 by village, harvest year, and sex. M = Males, F = Females, U = Unknown

	2004/2005[a]			2005/2006			2006/2007			2007/2008[b]			TOTAL		
Village	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U
Atqasuk	-	1	-	-	-	-	1	-	-	-	-	-	1	1	-
Barrow	12	1	-	13	10	1	8	6	4	6	3	1	39	20	6
Fort Yukon	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-
Kaktovik	-	4	5	-	-	-	-	-	-	-	1	-	-	5	5
Nuiqsut	1	1	-	3	-	-	-	-	1	-	-	-	4	1	1
Prudhoe Bay	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Wainwright	1	2	2	3	2	-	-	-	1	-	-	1	4	4	4
Subtotal	15	9	7	19	12	1	9	6	6	6	5	2	49	32	16
Total		31			32			21			13			97	

[a] Harvest season extends from July 1 to June 30.
[b] Subsistence harvest does not include 1 research mortality

organic and metal contaminants in polar bears throughout the Arctic. Results from the Northern Contaminants Program (NCP) were presented at a workshop held in Yellowknife, NT on 22–25 September 2008 by R. Letcher and M. McKinney. The title of the presentation was *Temporal and Spatial Trends of Legacy and Emerging Organic and Metal Contaminants in Canadian Polar Bears.* The objective of this study was to determine and monitor the spatial and temporal trends (e.g., concentrations and congener patterns), bioavailability, fate, and toxico-kinetics (e.g., biotransformation and tissue distribution) of legacy and "new" persistent pollutants (persistent organic pollutants [POPs], chlorinated, brominated, and fluorinated), persistent degradation products, and metals in polar bears from the seven Canadian Arctic management zones with extension to bears from other circumpolar Arctic regions (Alaska, Svalbard, and Greenland).

Factors that affect spatial trends of contaminants are diet, inter-population variation, inter-individual variation, age, sex, and reproductive status, and nutritional condition (fasting, body condition). Combining information on spatial and temporal trends of organic and inorganic contaminants with information on fatty acid profiles, and stable isotopes, the researchers were able to document that exposure to specific contaminants is directly linked to diet. Preliminary results were consistent with what has been found previously: concentrations of ClBz, Chlordanes (CHL), Σ-PBDEs, PFCs, and Σ-PCBs are lowest in Alaska compared to the other Canadian subpopulations, Svalbard, and East Greenland. The one exception is the high concentrations of β-HCH in Alaska populations which are only exceeded by concentrations in Foxe Basin and the Gulf of Boothia. The presence of a broader array of PBDE congeners and the high concentrations of β-HCH in the Chukchi/Bering Sea subpopulation suggest that this subpopulation may be strongly influenced by Asian sources. Analysis of temporal trends indicated that Σ-PCBs, Σ-PBDE, Σ-CHL, and Σ-DDT generally decreased in Alaskan subpopulations.

Perfluorooctane sulphonate (PFOS), which was first reported in polar bears in 2001, are commonly used in clothes, carpets, and furniture for water and stain repellence. Although PFOS concentrations were 10 times greater in polar bear livers from eastern Hudson Bay than Alaska, in the Chukchi/Bering Seas subpopulation PFOS were the most abundant compound followed by PCBs, chlordanes, HCH, DDT, and PBDEs. In the SB subpopulation chlordanes were the most abundant compound followed by PCBs and PFOS (about equal), HCH, DDT and PBDEs. The unique toxicological properties of PFOS, its environmental persistence, and increasing concentrations reported in polar bear livers from 1972 to 2002 are of concern. The toxic significance of PFOS concentrations in polar bear livers as well as the distribution of PFOS concentrations in other tissues is currently not known.

Population status and trend

Assessing the Ecological Status of Polar Bears in the Chukchi and Bering Seas

There is an urgent need to obtain information on the status of the polar bear population in the Chukchi and Bering Seas. A recent study estimated that the Chukchi Sea subpopulation has experienced an 8% decline per decade in polar bear habitat (Durner *et al.* 2009)—one of the highest rates of loss in the Arctic. Similar, but less severe, losses of sea ice habitat have been associated with reduced survival and population growth rate for polar bears in the adjacent SB subpopulation (Regehr *et al.* 2009). Recent reports from Russia suggest that poaching occurs at an unsustainable level along the Chukotka coast (Aars *et al.* 2006). In addition, the CS subpopulation faces potential increased interactions with industry due to expanding oil and gas activities off the northwest coast of Alaska. Despite these conservation challenges, information on population size, survival, reproduction, nutritional status, and habitat use, and knowledge of the variability in these parameters, are largely unavailable. The most recent CS population size estimate of 2000 polar bears was based on expert opinion (Aars *et al.* 2006). Prior to studies initiated by USFWS in 2008, the most recent research in this region occurred from 1987−1994 and focused on polar bear movements and habitat use (Garner *et al.* 1990, Arthur *et al.* 1996, Amstrup *et al.* 2004, Durner *et al.* 2006,).

Concern over the status of the CS polar bear population led the USA and Russia to sign the *Bilateral Treaty for the Conservation and Management of Polar Bears* in 2000. This treaty established a joint US–Russia Commission, with federal and native members from both countries, responsible for making management decisions concerning polar bears in this region. At its first meeting in 2009 the Commission will identify a scientific advisory council to provide scientific information and traditional knowledge. In anticipation of the Commission's information needs, a meeting between US and Russian polar bear specialists was held in Anchorage, AK, in 2007 to discuss research and management priorities and to initiate planning. The following research goals were identified:

Long-term research goals: 1) determine a population estimate; 2) determine population vital rates and the ecological processes that drive them (this information can be collected using capture-recapture methods); 3) population delineation. New information is needed to determine current distribution, particularly with respect to the western boundary of the Chukchi Sea and the changing sea ice conditions; 4) determine seasonal distribution (e.g., is one segment of the population more susceptible to harvest?); 5) determine essential terrestrial and sea-ice habitat.

Short-term research goals: 1) initiate capture-recapture pilot studies in Alaska and Russia. The goal is to apply radiocollars to 40 adult female polar bears (20 in Alaska and 20 in Russia); 2) conduct risk analysis for harvest allocation. Using a range of population estimates and vital rates develop a range of options, from no harvest to various allowable levels of harvest, and the associated risks and assumptions for each option (i.e., population estimate and selected vital rates); 3) conduct feasibility studies for capture-recapture and aerial surveys. Currently a feasibility study is being conducted for aerial surveys. Information from capture-recapture pilot studies may be used in this effort.

In 2008, the USFWS and the USGS initiated live capture and radiotelemetry studies to gather biological and demographic information on polar bears in the US portion of the Chukchi and Bering Seas. The USFWS continued this effort in 2009 and plans future studies through 2014. The goals of this project are to: 1) evaluate polar bear distribution and habitat selection; 2) quantify the size, condition, diet, and health of polar bears; 3) evaluate demography, including indices or estimates of population size and vital rates; and 4) determine the best methods to address information needs under the Bilateral Treaty. These goals will be evaluated relative to seasonal and annual variation in sea ice dynamics. In addition, movement patterns and habitat use will be examined with respect to potential overlap with industrial activities off the US Chukchi Sea coastline. Important insights into changes in the ecology and status of this subpopulation will be gained by comparing contemporary data on movements, habitat use, body measurements, diet and fasting behaviour, and demography with data collected during capture work led by Gerald Garner in 1987–1994.

In March and April 2008, the USFWS and the USGS captured 35 polar bears and deployed 11 satellite radiocollars on adult females in the US portion of the Chukchi Sea (Fig. 1). All bears were given individual markings (ear tags and lip tattoos). A suite of physical measurements and biological samples was collected to evaluate diet (*via* stable isotopes and fatty acids), fasting behaviour (*via* urea/creatinine levels and cholesterols in blood), health (disease and contaminants), and condition (*via* measures of total body fat, body mass, and condition indices). In March–May 2009, the USFWS captured 39 polar bears and deployed 10 satellite radiocollars. Although additional years of data are needed to address study objectives, several interesting observations were made in 2008 and 2009: 1) No first year cubs were observed. This supports historic information suggesting that females in the Chukchi Sea subpopulation den primarily in Russia, on Wrangel Island and the Chukotka coast. Two females collared in 2008 appear to have denned in these areas; 2) Adult males accounted for 40% and 51% of captured bears in 2008 and 2009, respectively, compared to approximately 25% of polar bears captured in the southern Beaufort from 2001-2006 (Regehr *et al.* 2006); 3) One marked bear was recaptured in 2008 and three previously marked polar bears were recaptured in 2009; 4) A relatively large number of ringed seals (*Phoca hispida*) and bearded seals (*Erignathus barbatus*), and sites where polar bears had killed seals, were observed; 5) Measures of total body fat, body condition indices, and body mass suggest that bears were in good nutritional condition. Urea/creatinine levels in 2008 suggest that all 35 captured bears were actively feeding.

This contrasts with the 21−29% of bears fasting in the Southern Beaufort Sea during March–May in 2005 and 2006 (Cherry *et al.* 2009). Preliminary examination of fatty acid results, support that polar bears in the Chukchi Sea may consume more bearded seal and walrus than their Southern Beaufort Sea neighbours. Further years of study will determine whether these observations are representative of polar bears in this region during this time of year.

Polar bears in the Chukchi and Bering seas occupy large areas, frequently move across international boundaries, and depend upon habitats in both the USA and Russia for critical aspects of their life history (Fig. 2). However, patterns in seasonal and geographic fidelity make it unlikely that polar bears observed at any single place or time will be representative of the larger biological population. In October 2008, a workshop with US and Russian polar bear specialists was held in Odessa, Ukraine to discuss ongoing research and to identify new opportunities for live-capture and radiotelemetry studies in Russia (meeting minutes available). Three main options to capture polar bears and deploy satellite tags in Russia were considered: land-based captures on Wrangel Island or the eastern Chukotka coast (e.g., Vankaarem), and helicopter-based captures on the western Chukotka coast. In spring 2009, Nikita Ovsyanikov participated in polar bear studies led by the USFWS in the US portion of the Chukchi Sea. Coordinated research programs in the USA and Russia are important to the sound management of this subpopulation under the Bilateral Treaty.

Coastal Surveys and Mark-Resight Studies in the Southern Beaufort Sea

In most years since 2000, the USFWS has monitored polar bear use of the southern Beaufort Sea coastline during the late summer open water period. Weekly aerial surveys were conducted during September and October, to determine trends in bear counts and distribution on the coast between the community of Barrow and the Canadian border. An analysis of data collected from 2001–2005 (Schliebe *et al.* 2008) concluded: 1) on average, 3.7 ± 1.8% of the estimated 1,526 polar bears in the SB subpopulation were observed onshore in the fall; 2) 80% of bears onshore occurred within 15 km of subsistence-harvested bowhead whale carcasses, where large congregations of polar bears have been observed feeding; 3) sea ice conditions affected the number of bears on land and the duration of time they spent there.

Starting in summer 2009, the USFWS will coordinate coastal surveys in the southern Beaufort Sea with onshore capture efforts led by the USGS. Recently captured bears will have numbers painted on their backs with fur dye. The ability to identify individual animals permits the use of non-invasive mark-resight methods, to estimate abundance (in contrast to simple counts) and other demographic parameters (White and Shenk 2001).

Knowledge of the proportion of the SB subpopulation that spends the ice-retreat season on land, in conjunction with ecological information collected by the USGS, will enable evaluation of the population-level effects associated with longer Arctic summers. It will also provide wildlife managers with information to anticipate and mitigate human-polar bear interactions.

Developments in Satellite Telemetry

Starting in 2009, the USFWS field tested non-radiocollar satellite telemetry devices on polar bears. These consist of small (e.g., 41×30×18 mm; 33-g) Platform Transmitter Terminals deployed as ear-mounted or glue-on tags. Historically, movement data could only be obtained for adult female polar bears because radiocollars cannot be effectively applied to adult males or juveniles. Ear-mounted and glue-on tags may overcome this limitation and provide new information on polar bear movements and distribution. These tags also respond to a growing need for non-radiocollar telemetry solutions, due to concerns about bear welfare and a negative perception of collars among people living in polar bear country.

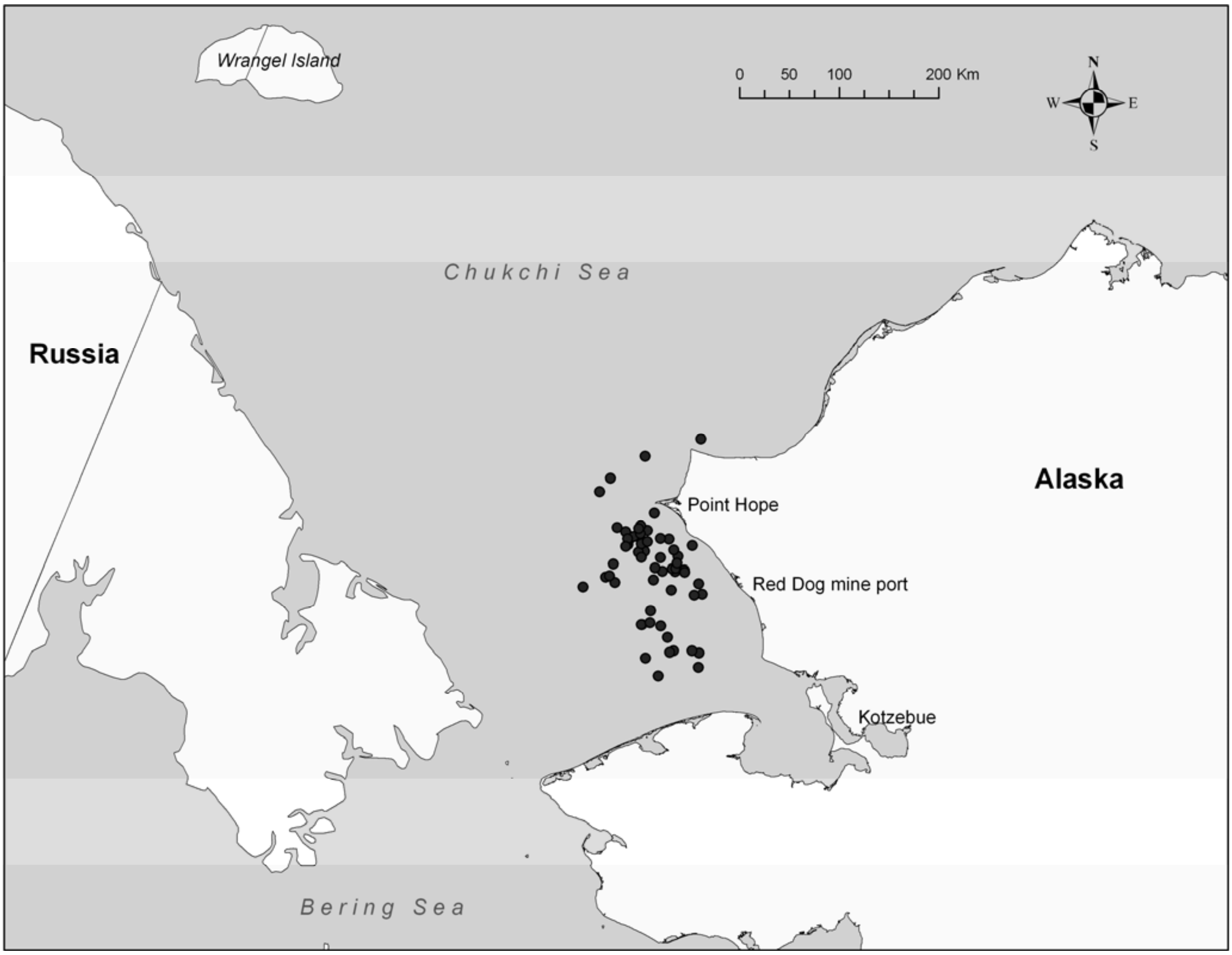

Fig. 1. Capture locations for bears captured in 2008 (n = 35) and 2009 (n = 39) in the Chukchi Sea by the USFWS and USGS.

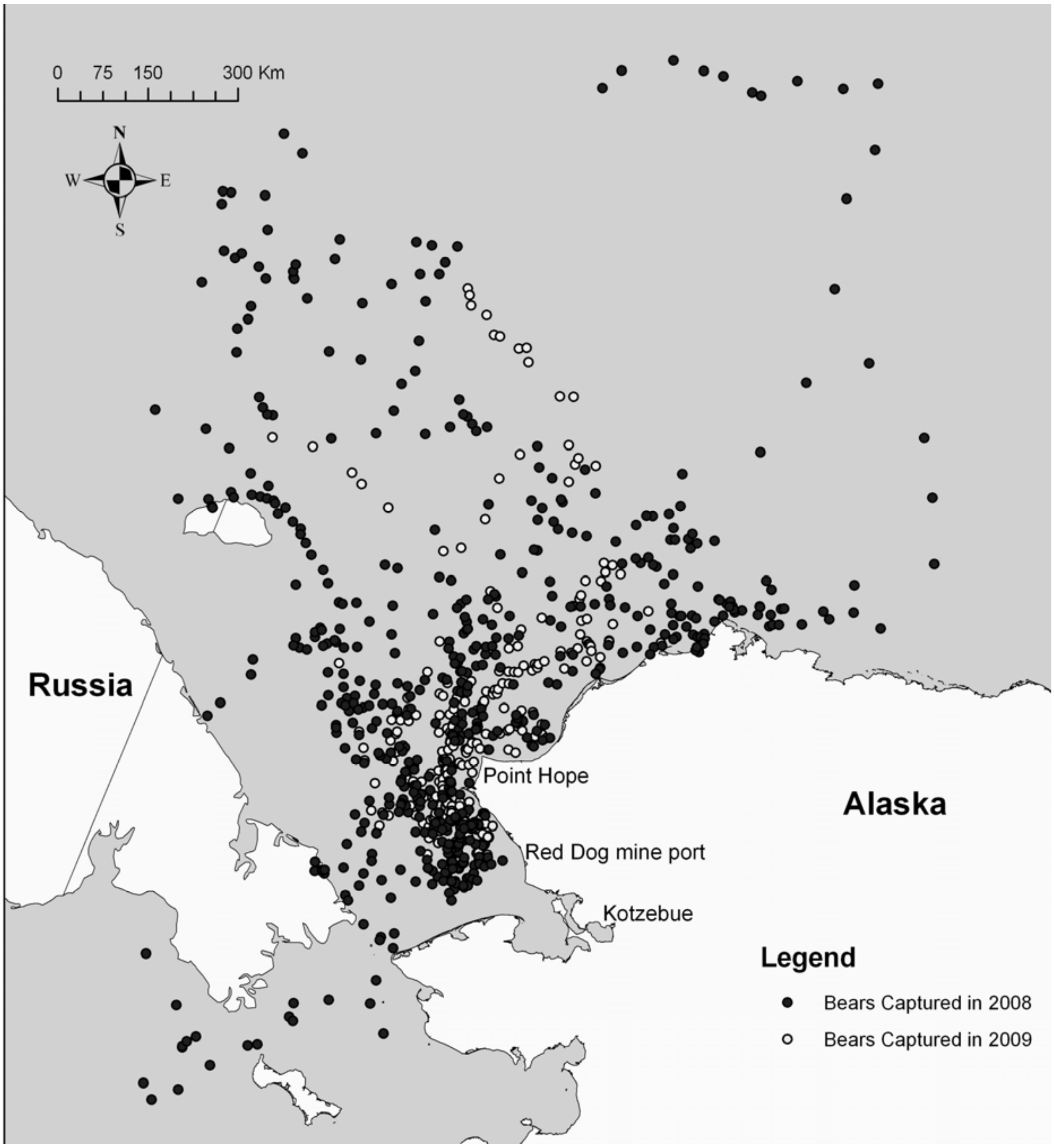

Fig. 2. Locations of 21 collared adult females in the Chukchi Sea between March 2008 and June 2009. Of females fit with radiocollars in 2008, 7 had lost or failed collars by December 2008. The ten females captured had retained functioning collars as of June 2009. Collars in 2008 transmitted locations every 3 days and were set to last 2 years and collars in 2009 transmit locations every 2 days to last 1 year.

Polar Bear Demography in the Southern Beaufort Sea

Three recent publications by the USGS evaluate the demography and status of polar bears in the Southern Beaufort Sea subpopulation (Hunter *et al.* 2007; Regehr *et al.* 2009; Rode *et al.* 2009). In 2010, the USFWS will release a report that builds on these USGS studies to evaluate the impacts of different harvest scenarios on the future status of this subpopulation. The USFWS is also evaluating the potential for polar bear movements to affect estimates of demographic parameters (e.g., survival, population size) derived from capture-recapture studies.

Captive Feeding Trials to Improve the use of Fatty Acids and Stable Isotopes for Diet Determination in Polar Bears

A project has been initiated in collaboration with Greg Thiemann (York University), Seth Cherry (University of Alberta), and Charles Robbins (Washington State University) and with the assistance of Randi Meyersen (Polar bear species survival plan for the American Zoological Association) and Megan Owen (San Diego Zoo) to improve estimates of stable isotope fractionation values and fatty acid calibrations required for quantifying prey items consumed by free-ranging polar bears. Though these techniques have been used to estimate polar bear diets, results have had wide confidence intervals (Bentzen *et al.* 2007) and been based on assumptions that metabolism and deposition is similar across most mammal species (Iverson *et al.* 2004). Controlled studies examining polar bear fat metabolism and deposition and stable isotope fractionation are needed to ensure the accuracy of diet estimation based on these techniques and to identify ways in which the unique physiology of polar bears (e.g., walking hibernation) could affect application of these methods. Brown bears will be used as a model species for polar bears in addition to polar bears at zoos to conduct a series of feeding trials. Trials are expected to begin in fall of 2009 and continue through 2011.

Incidental Take and Intentional Take Programs

The Incidental and Intentional Take Program has expanded in recent years. The MMPA allows for incidental, non-intentional take of small numbers of marine mammals by US citizens who engage in a specified activity within a specified geographical area. The incidental taking of marine mammals may be allowed if the USFWS finds, based on the best scientific evidence available, that the total of such taking associated with the specified activity will have a negligible impact on the species or stock and will not have an immitigable adverse impact on the availability of the species or stock for subsistence uses. The USFWS operates the incidental take program under Section 101(a)5(A) of the MMPA. Currently, the oil and gas industry has been the only "citizen group" to request incidental take authorization for polar bears. The USFWS administers an Incidental Take Program through Letters of Authorization (LOA) that enable polar bear managers to work co-operatively with oil and gas operators to minimize impacts of their activities on polar bears. The USFWS evaluates LOAs with special attention to mitigating impacts to polar bears, such as limiting industrial activities around barrier island habitat, which is important for polar bear denning, feeding, resting, and seasonal movements.

Incidental Take Regulations (ITR) have been issued since 1993 in the Beaufort Sea. The regulations typically extend for a five year period and the current regulatory period for the Beaufort Sea is 2006 to 2011 (71 FR 43926). The five year regulatory duration is to allow the USFWS (with public review) to periodically assess whether the level of activity continues to have a negligible impact on polar bears and their availability for subsistence uses.

During 2008, in the Beaufort Sea region, 14 LOAs were issued to oil and gas companies for marine, terrestrial, and on-ice activities along the North Slope of Alaska. Ten companies observed 313 polar bears from 186 sightings. The highest number of bears was observed during the ice-free months of August and September, where 87 sightings totalling 162 bears were observed in August. The sighting trend was similar to bear sightings observed in 2007, where there were 321 bears were observed in 177 sightings and the highest number of bears was recorded in August as well (90 sightings totalling 148 bears). The high number of bear sightings for both years was most likely the result of an increased number of bears using terrestrial habitat, multiple marine projects occurring near barrier islands, and increased compliance and monitoring of industry projects, especially during August and September, where some repeat sightings of individual bears and family groups occurred. Though the observational data have not been thoroughly analyzed, this trend in observations supports increasing use by bears of terrestrial habitat during ice-free months.

In 2006, oil and gas exploration activities expanded into the Chukchi Sea. Exploration activities had not occurred in the Chukchi since the mid 1990s, when Shell Oil operated under the first incidental take regulations (1991-1996; 56 FR 27443). In order to address this increased interest in the Chukchi Sea, USFWS issued Incidental Harassment Authorizations (IHA) in 2006 and 2007 as an interim measure prior to the development of ITRs for the region. IHAs are one-year authorizations for specific activities and were authorized under Section 101(a)5(D) of the MMPA. In 2006, four IHAs were issued for exploration activities in the Chukchi Sea. Only one IHA was issued in 2007. In 2006, three operators observed a total of 21 polar bears (12 observations). In 2007, the single operator observed four bears on three separate occasions.

Oil and gas activities continued in the Chukchi Sea region during 2008. Incidental take regulations were promulgated in June 2008 (73 FR 33212). Three companies were issued LOAs to conduct exploration activities during the open water period (June to November). Overall, there were 28 sightings of 40 individual polar bears during the open-water season in the Chukchi Sea. Though the majority of sightings occurred in the marine environment in the Chukchi Sea Lease Sale 193, bears were also observed on the mainland. Seven sightings of 13 polar bears were recorded near support operations at Wainwright, AK.

The USFWS also issues intentional take authorizations, where citizens can be authorized to take polar bears by harassment (non-lethal deterrence activities) for the protection of both human life and polar bears while conducting activities in polar bear habitat. Intentional take is authorized under sections 101 (a)(4)(A), 109(h), and 112(c) of the Marine Mammal Protection Act (MMPA). The USFWS provides guidance and training as to the appropriate harassment response necessary for polar bears. Intentional take authorizations have been issued to the oil and gas industry, the mining industry, local North Slope communities, scientific researchers, and the military. From 2005 to 2008, 45 intentional take authorizations were issued (nine in 2005, 18 in 2006, 11 in 2007, and seven in 2008).

Amendments to the MMPA in 1994 provided authority for the USFWS to issue guidelines to the public for the deterrence of marine mammals provided that the activities under the guidelines do not result in serious injury or death to the marine mammal. The USFWS will publish such guidelines for the polar bear in 2010. These guidelines for safely deterring polar bears will provide information on acceptable types of deterrence actions, such as preventative and passive deterrence measures.

The USFWS continues to work with oil and gas companies and other groups, such as the mining industry and military to improve polar bear monitoring and mitigation procedures within and around the North Slope to limit disturbance to bears and subsistence uses. These include polar bear awareness programs such as safety and deterrence training, guidance with industry and community plans of co-operation and human–polar bear interaction plans, and creating a train-the-trainer curriculum for both polar bear deterrence and polar bear den detection surveys, such as forward-looking infrared (FLIR) imagery.

In conclusion, the incidental take program provides a mechanism for the USFWS to work closely with stakeholders such as the oil and gas industry in order to minimize the effects of anthropogenic activities on marine mammals. Additionally, monitoring programs allow the USFWS to obtain important information on polar bear distribution, movements, and interactions in regards to humans and industrial activities.

Marine Mammal Protection Act

Importation of Polar Bear Trophies

The MMPA was enacted in 1972 for the protection and conservation of marine mammals and their habitats, including polar bears. Under the MMPA, marine mammals, such as the polar bear, are considered "depleted" species once they are listed as threatened or endangered species under the ESA; therefore, the polar bear was automatically considered a depleted species when it was listed as threatened under the ESA on 15 May 2008. Although Congress had amended the MMPA in 1994 to allow US hunters to import polar bear trophies, provided certain criteria were met, the MMPA sets further restrictions on activities that are allowed for species that are classified as depleted. For a depleted species, only imports for purposes of scientific research or for the enhancement and survival of the species can be authorized or allowed. Importation of polar bear parts taken in sport hunts in Canada is not one of the exceptions to the restrictions on depleted species. However, the MMPA continues to allow for the import of sport-hunted polar bear trophies that were legally taken in Canada prior to 18 February 1997.

Therefore, as of the effective date of the final listing of the polar bear under the ESA on 15 May 2008, importation of a sport-hunted polar bear trophy taken in Canada after 18 February 1997 is prohibited under the terms of the MMPA, even if the polar bear was taken in a hunt prior to 15 May 15 2008. Given the species' depleted status, a waiver of the MMPA's moratorium on importing polar bears is not available. Unless expressly provided for by the US Congress, no provision in the ESA may take precedence over a more restrictive provision in the MMPA. A congressional amendment to the MMPA would be needed in order to allow the import of sport-hunted trophies taken in Canada after 18 February 1997. The MMPA has not been reauthorized since 1994, when authority to carry out the provisions of the Act was extended through 1999. Major amendments to the MMPA are typically made during the re-authorization process, although the Act may also be amended at other times. Two bills regarding the importation of polar bear trophies were introduced in the US House of Representatives in February 2009, but, as of this report, have not been adopted. If passed, H.R. 1054 would amend the MMPA to allow the importation of trophies sport hunted in Canada prior to the date of the ESA listing, whereas H.R. 1055 would reinstate the importation of polar bear trophies sport hunted in Canada.

As stated above, Congress had amended the MMPA in 1994 to allow the importation of trophies under specific conditions. Before the listing of the polar bear under the ESA, the USFWS could authorize the importation of sport-hunted trophies by permit for bears legally taken by US hunters, from six approved Canadian polar bear subpopulations: 1) Southern Beaufort Sea; 2) Northern Beaufort Sea; 3) Viscount Melville Sound; 4) Western Hudson Bay; 5) Lancaster Sound; and 6) Norwegian Bay. A previous approval for the M'Clintock Channel subpopulation was withdrawn in 2001 and only bears hunted on or before 31 May 2000, could still be imported at the time of the ESA listing. A total of 967 polar bear trophies was imported between April 1997, when regulations authorizing these imports went into effect, and 15 May 2008, the effective date of the listing of the polar bear under the ESA. An additional two import permits were issued in December 2008 under the MMPA exception for trophies legally taken prior to 18 February 1997 (Table 1). The 1994 Amendment to the MMPA established that a $1,000USD permit issuance fee be collected from each applicant when a permit is issued. These fees (approximately $969,000USD collected since 1997), support conservation initiatives for polar bear stocks shared between the USA and Russia, and have been dedicated 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.

Co-Management: Alaska Nanuuq Commission

The Alaska Nanuuq Commission (ANC) is a non-profit organization that was formed in 1994 to represent Alaska Native interests on issues related to the conservation and subsistence uses of polar bears. The ANC has representatives from the communities of Barrow, Brevig Mission, Gambell, Kaktovik, King Island, Kivalina, Kotzebue, Little Diomede, Nuiqsut, Point Hope, Point Lay, Savoonga, Shishmaref, Wainwright, and Wales, and maintains its headquarters in Nome, Alaska. The ANC is funded primarily through a cooperative agreement with the USFWS, as set forth by the MMPA. Each year, the ANC and the USFWS work together to identify scopes of work that will be conducted by ANC as part of our mutual co-management goals.

In 2005–2009, the co-management accomplishments included organization of annual meetings in January 2005, December 2005, December 2006, February 2007, January 2008, and August 2009, and several meetings of the Executive Committee. These meetings allow for discussion and information exchange on a regular basis on issues that are significant to polar bear conservation such as harvest management, human–bear conflicts, and the listing of polar bears as Threatened under the ESA. Additionally, ANC staff also participated in other meetings relevant to the conservation of polar bears and their subsistence use. For example, the ANC is an important part of the Indigenous Peoples Council for Marine Mammals (IPCoMM), a state-wide organization that advocates at state and Congressional levels for more adequate funding and more active involvement by Alaska Natives in co-management.

Another important scope of work is the ANC's continued involvement in development and implementation of the US/Russia Polar Bear Treaty. ANC leaders made several trips to Washington D.C. to meet with congressional delegates and encourage passage of enabling legislation that was needed to bring the Treaty into effect (it was ratified in October 2000 but still lacked implementing legislation in the USA until 2007). ANC leaders also traveled to Russia to meet with Russian partners, and on several occasions provided funding for representatives from the Association of Traditional Marine Mammal Hunters of Chukotka (ATMMH) to attend ANC annual meetings in the USA. At the 2008 ANC meeting in Nome, ANC and ATMMH signed the Native-to-Native Agreement and appointed their commissioners to the Joint Commission that will oversee implementation of the US/Russia Polar Bear Treaty.

The ANC also continued their efforts to further research and monitoring of ice-loving seals. An Ice Seal Committee was formed under the ANC in 2004; in 2005–2006 they initiated two studies, one involving collecting and processing of polar bear and ice seal tissue samples, and the other to study diets of polar bears in Alaska using fatty acid analysis to determine if any change in prey foraging species is occurring. Tissue samples were collected from several communities and provided to both long-term archives as well as on-going contaminant studies. Funding cuts in 2007 have prevented completion of the fatty acid study to date. An Ice Seal Research Plan was also developed.

Other activities included: 1) providing funding to minimize human–bear conflicts in Alaskan villages; 2) development of the ANC web site at www.nanuuq.info; 3) development of an interactive CD for elementary, middle, and high school audiences on polar bear conservation; 4) development of a report entitled "Nanuuq: cultural significance and traditional knowledge among Alaska Natives" (Russel *et al.* 2005); 5) providing technical assistance to ATMMH to complete a project on the cultural knowledge of indigenous people of Chukotka about polar bears. ATMMH was later able to produce an educational video and a children's book regarding these efforts to ensure the long-term preservation and passage of these materials to future generations.

Community-based Conservation Activities at Barter Island

Due to the relatively high density of polar bears on shore at Barter Island during the fall open water period, the USFWS has been monitoring polar bears there since 2002. A report summarizing results from the feeding ecology study conducted in 2002–2004 is available (Miller *et al.* 2006). Monitoring efforts were continued in 2005–2007 but modified to allow for initiation of a second study to document interactions among polar bears, brown bears and humans (bear interaction study). Similar and concurrent to previous monitoring efforts, vehicle-based observations were conducted between dusk and dawn in 3-hr systematically-selected sessions at the study area known as the "bone pile", where unused portions of bowhead whale remains from subsistence whaling are deposited. All occurrence sampling was used to document interactions involving an overt response by polar bears or brown bears. As in previous years, daily whole island counts were conducted to obtain an estimate of all bears in the area, and for long-term documentation of bear use trends. The objectives and methods of all field work were communicated annually to residents of Kaktovik (located on Barter Island) through council meetings, open houses, and school visits, as well as through conversations with people visiting the study sites.

Due to an increasing number of bear-viewing visitors to Barter Island, the USFWS is currently focusing its field efforts on developing a more community-based conservation program, with the intent to improve safety for residents, visitors, and bears. In 2008 we started working with a local resident volunteer who assumed responsibility for conducting fall monitoring (daily counts) of bear numbers. Fig. 3 presents results from daily whole island counts conducted since 2002; counts will continue in future years.

In addition to engaging a local resident in data collection, a major focus of our conservation activities was to assist the Native Village of Kaktovik (NVK) in their efforts to develop a plan to minimize human–bear conflicts in and around the village. The NVK received a tribal grant in 2007 to address this issue, and in 2008 began implementing the grant by hiring a coordinator and creating a local Bear Committee. The Bear Committee met several times to address the best way to minimize attractants, implement a polar bear deterrence program (polar bear patrols), address polar bear viewing, and identify education and outreach needs. Having an organized, funded, local effort to address bear issues has led to positive results. During the peak bear season, polar bear patrols were up and running, resulting in successful hazing of polar bears out of the village area. Improvements in handling and storage of whale meat were made through the Bear Committee's coordination with whaling captains. Educational brochures, posters, and signage aimed at both residents and visitors have been created and distributed. In 2009, the Bear Committee plans to continue polar bear patrols (deterrence), develop bear viewing guidelines, and investigate additional options for improving meat and trash storage. The USFWS will continue to play an active role in these endeavours.

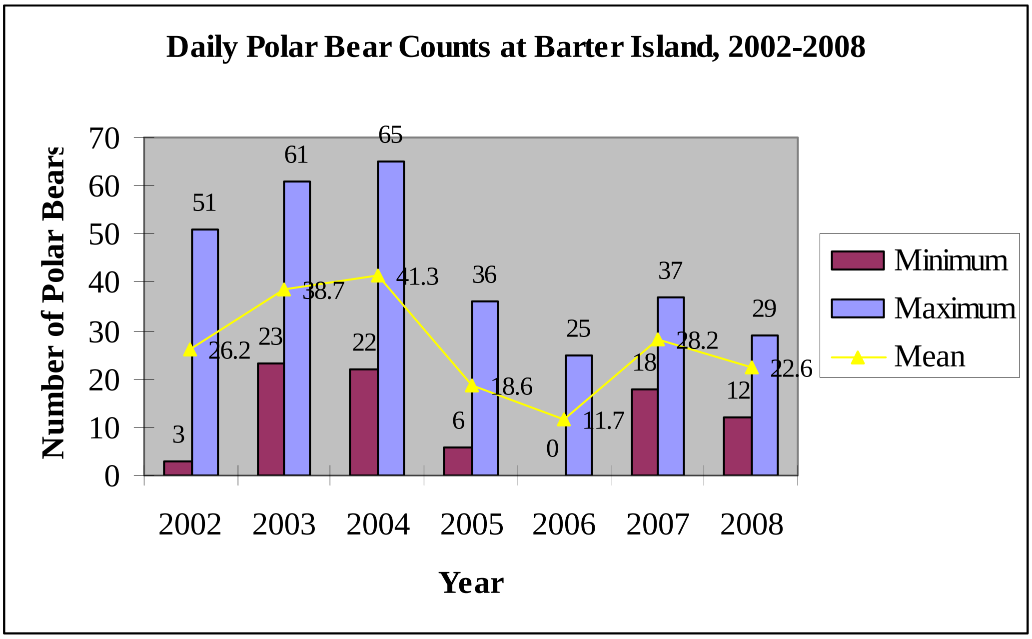

Fig. 3. Minimum, maximum and average number of polar bears observed at Barter Island, Alaska, 2002-2008.

An important issue that has arisen at Barter Island is the concern from villagers regarding potential injury to collared bears, as well as the effects of capture on polar bears and the potential for "research" bears to become problems in the village. Over the last few years the USFWS has engaged colleagues from both the USA and Canada who are conducting research in the Southern Beaufort Sea to increase their awareness of these concerns, and to solicit their help in response efforts. In the USA, researchers have recently agreed to adjust their capture methods by not placing collars on bears that have a history of going to Barter or Cross Islands, and by experimenting with new technology such as using glue-on tags instead of collars. Due to an increase in land-based capture research being conducted in the Southern Beaufort Sea, it remains a USFWS priority to ensure that studies are conducted in a way that both meet research needs and minimize stress to polar bears, and that researchers communicate about their studies to local residents

International Treaties and Conventions

US/Russia Bilateral Agreement

On 12 January 2007, the President of the United States signed into law the implementing legislation for the *Agreement between the United States of America and the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population* (Agreement); this Bi-Lateral Agreement was originally signed between the United States and the Russian Federation in 2000. The primary purpose of the Agreement is to assure long-term conservation of the Chukchi Sea polar bear subpopulation using the best biological information available. The Agreement calls for a Joint Commission, consisting of a representative of the government and a representative of Native people of each country that will design, coordinate, and evaluate management and research programs and activities. Both the United States and the Russian Federation have appointed Commissioners for the Agreement. For the United States they are Geoff Hackett, the US Fish and Wildlife Service's Region 7 Director and Charlie Johnson, Executive Director of the Alaska Nanuuq Commission, and for the Russian Federation, they are Amirkhan Amirkhanov (Russian Federal Government) and Vladilen Kavry (Native People of Chukotka). The initial meeting of the Commission occurred in September 2009 in Moscow, Russia.

Canada/United States Memorandum of Understanding

On 8 May 2008, a Memorandum of Understanding (MOU) was signed by the US Secretary of the Department of the Interior, Dirk Kempthorne, and the Canadian Minister of the Environment, John Baird. This agreement was set to facilitate and enhance co-ordination and co-operation for the conservation and management of polar bears between the two countries. This MOU builds upon existing agreements and ongoing collaborations and is not intended to supersede previous and significant contributions by the Inupiat and Inuvialuit people, the USFWS, the Canadian Wildlife Service, the USGS, and Environment Canada, for the conservation and management of polar bears.

The MOU establishes the Bilateral Oversight Group in recognition of the need to leverage rather than duplicate the polar bear expertise and management experience of agency and Alaska Native and aboriginal people of both countries. The MOU also identifies the need to establish a Scientific Working Group to assess the available scientific information and aboriginal traditional knowledge of North American polar bear populations, and the establishment of other working groups as necessary to advise Environment Canada and the US Department of the Interior on polar bear management and conservation. Representatives from entities outside the Oversight Group may be invited to participate in the Group's deliberations, and where appropriate, the MOU encourages the Oversight Group to facilitate cooperation with such entities.

Inuvialuit Game Council/North Slope Borough Agreement

The Inuvialuit Game Council and the North Slope Borough (IGC/NSB) held their annual meetings on the *IGC/NSB Agreement on the Management of Polar Bears in the Southern Beaufort Sea* in 2005, 2006, 2008, and 2009. Each year the commissioners agreed to continue to maintain the harvest level within the existing quotas, 40 for each jurisdiction, and to work towards increasing marking, tagging, and reporting compliance in all the villages. Collection of specimens for verification of sex and age and harvest information continues to be excellent in Canada. Recent evidence including a reduction in the population estimate from 1800 to 1526, decreased survival of cubs, and decreased weights and skull measurements in adult males, suggest that the SB subpopulation may be declining. Management decisions are becoming more complex due to the combination of a declining population, boundary issues, and increased likelihood of more human–bear interactions along the coast. The technical advisors, which include managers and researchers, to the IGC/NSB have presented information that should help guide the decision-making process. Conservative management practices may include establishment of harvest quotas, protection of key habitat areas, and new guidelines to help minimize negative impacts of human–bear interactions.

The total harvest from the SB subpopulation from 2004–2005 to 2007–2008 (4 years) was 156 bears with an average of 39.0 bears per year which is well below the sustainable harvest level of 80 bears. The sex ratio of known-sex bears harvested in 2004–2008 was 64% (88/138) male and 36% (50/138) female. The net mean annual removal of females (known-sex bears plus 9 (50%) of the unknown sex bears) in 2001–2004, was 15 bears. This is less than the sustainable yield calculation of 28 bears, which is based on 2:1 male to female sex ratio in the harvest. Information was available for the sex of 89% of the animals harvested during this period. This agreement has been effective at maintaining harvest at or below the sustainable harvest levels.

Polar Bear Coordination Agreement

In November of 2008 the USFWS and the Alaska Department of Fish and Game (Department) signed a Polar Bear Coordination Agreement. The Agreement commits the USFWS and the Department to work together (along with the USGS and others), consulting and collaborating to the greatest extent feasible, to ensure the continued conservation of polar bears in Alaska. Because of their shared desire to closely monitor Alaska's polar bear populations and to increase interagency communication and understanding, the USFWS and the Department recognized three possible areas of collaboration: 1) human–bear interactions (to develop strategies to reduce the take of bears for defense of life and property); 2) education and outreach (strategies for developing joint materials that address subsistence harvest and deterrence issues); and, 3) research and monitoring (strategies for planning, conducting, and evaluating cooperative field research and monitoring efforts). The Agreement with the Alaska Department of Fish and Game is part of the US Fish and Wildlife Service's ongoing effort to seek out all potential strategies to effectively conserve polar bears.

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U.S. Geological Survey polar bear research, 2005–2009

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Overview

Since the 14th Working Meeting of the Polar Bear Specialist Group in 2005, the U.S. Geological Survey (USGS) continued its studies directed towards understanding the status of the subpopulation of polar bears in the southern Beaufort Sea. Research objectives are targeted at quantifying polar bear movements and distribution, habitat use, the health of individuals, and the impacts of climate change. USGS continues this research in order to address the information needs of management agencies within the Department of the Interior (DOI), including the U.S. Fish and Wildlife Service (USFWS), Minerals Management Service (MMS), and Bureau of Land Management (BLM). This research also serves to inform the co-management agreement between the Inuvialuit Game Council in Canada and the North Slope Borough in the United States.

In 2006, non-governmental organizations petitioned the USFWS to consider listing the polar bear under the U.S. Endangered Species Act (ESA), and in January 2007, the U.S. Secretary of the Interior proposed listing the polar bear as a "threatened species" (U.S. Fish and Wildlife Service 2007). Classification as a "threatened species" under the ESA requires a determination that the species in question is likely to become "endangered" within the "foreseeable future" throughout all or a significant portion of its range. An endangered species is any species that is in danger of extinction throughout all or a significant portion of its range. By U.S. law, during a 1-year period before the final listing decision is made, all relevant scientific information is assembled and public comments are solicited.

To inform the final polar bear listing decision, the Secretary of Interior requested that the USGS conduct additional analyses based on existing data of polar bears and their sea ice habitats. In response to that request, the USGS assembled a team of scientists from in and outside of the USGS to analyze data from a variety of sources and forecast the future status of polar bears. In September 2007, this team produced nine reports targeting specific questions identified as pertinent to the final decision by the USFWS. These reports described and explained the present-day relationships between polar bears and a warming Arctic, and extrapolated what was learned to forecast the future welfare of polar bears worldwide. Several of those reports have been, or will soon be, published in peer-reviewed journals. On May 15, 2008, the Secretary of Interior officially listed the polar bear as a threatened species throughout its range. The USGS-led research was a substantive foundation for informing this decision.

Since 2007, the USGS has continued research on the relationship between polar bears and their changing environment. Much of our previous and continuing long-term research has employed standard mark-recapture and radio-tagging methods. New research has recently begun to further reduce the uncertainty of population forecasts.

Present and future research

Southern Beaufort Sea Subpopulation

Current USGS polar bear research is focused on mark-recapture and radio-tagging efforts that are aimed at developing new indices of population vital rates in the southern Beaufort Sea (SB) subpopulation, and improving our understanding of how polar bears use their environment. The USGS is committed to describing and explaining the environmental mechanisms that determine the status and trend of polar bear populations. Specifically, the USGS plans to enhance forecasting models for polar bear populations in Alaska and neighboring regions. We continue to be interested in international collaborations that could help reduce the uncertainty of forecasts for those polar bear subpopulations for which there are limited data.

Each year since 2001 the USGS has conducted mark-recapture field work in the SB during late-March through mid-May (spring). The primary focus is to maintain a consistent data stream for continued future assessments of age and sex composition, survival, and recruitment. The spring capture work also provides valuable body condition and physiological data representative of the SB subpopulation. Radio-tagged bears are used to assess movements and habitat, and distribution and timing of maternal denning in the Beaufort Sea. This intensive mark-recapture and radio-tagging program has been the foundation of the information provided to managers and stakeholders in Alaska and neighbouring areas for more than 25 years.

Characteristics of the SB spring capture

During spring field work in 2006-2009, we captured an average of 87.8 ± 13.7 (SD) polar bears per year. This is less than the 102.6 ± 21.5 SD individuals captured each year during 2001-2005 when the USGS and the Canadian Wildlife Service were actively pursuing a new population assessment for the SB. When a polar bear is immobilized, we assess body condition using a subjective index defined by Stirling et al. (2007), in which condition 1 represents a bear in very poor condition and condition 5 represents an obese bear. Over the 9 years of SB spring captures, the proportion of independent sub-adult (< 5 years old) and adult bears (without dependent young) in condition 1, 2, 3, and 4 was 0.34, 15.2, 68.4, and 16.0 %, respectively (no condition 5 bears have been observed in the SB during spring). Although there was considerable fluctuation of proportions within each category, no condition 4 bears were observed during spring 2009 (Fig. 1).

The proportion of bears in the spring capture by major age class for each year is presented in Fig. 2. Since 2006, a large proportion of the captures have been adult bears. The proportion of cubs-of-the-year (COY) has remained relatively unchanged. Since 2004, the proportion of 2-yr-old and subadult (< 5 yr) animals has declined in the captures, and no 2-yr-old bears were observed in 2009.

The annual proportion of recaptures by total captures for adult (≥ 5 years) polar bears captured by standard search in SB during spring is shown in Table 1.. The proportion of recaptures has largely increased since 2002. The percentage of recaptured bears in 2009 was 74%, the greatest recorded in 9 years of spring field work during 2001-2009.

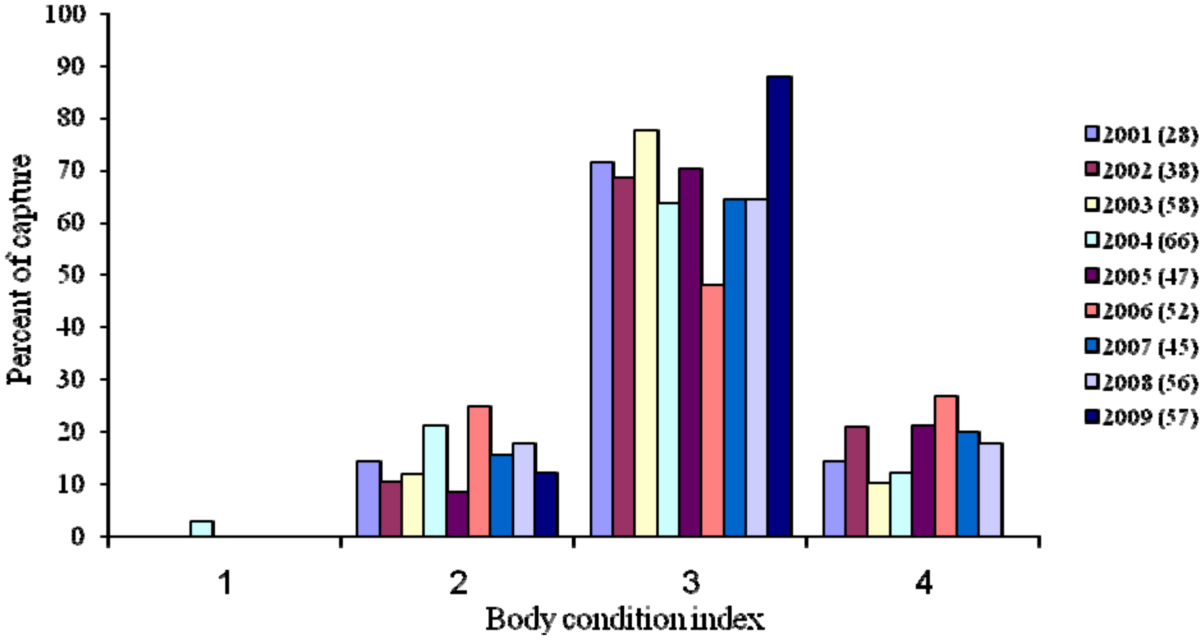

Fig. 1. Composition of adult and sub-adult polar bears by subjective body condition index in the USGS spring (March-May) Southern Beaufort Sea capture, 2001-2009. Note that no condition level 4 bears were observed during spring field work in 2009. Data includes all capture types and does not include adult females with dependent young.

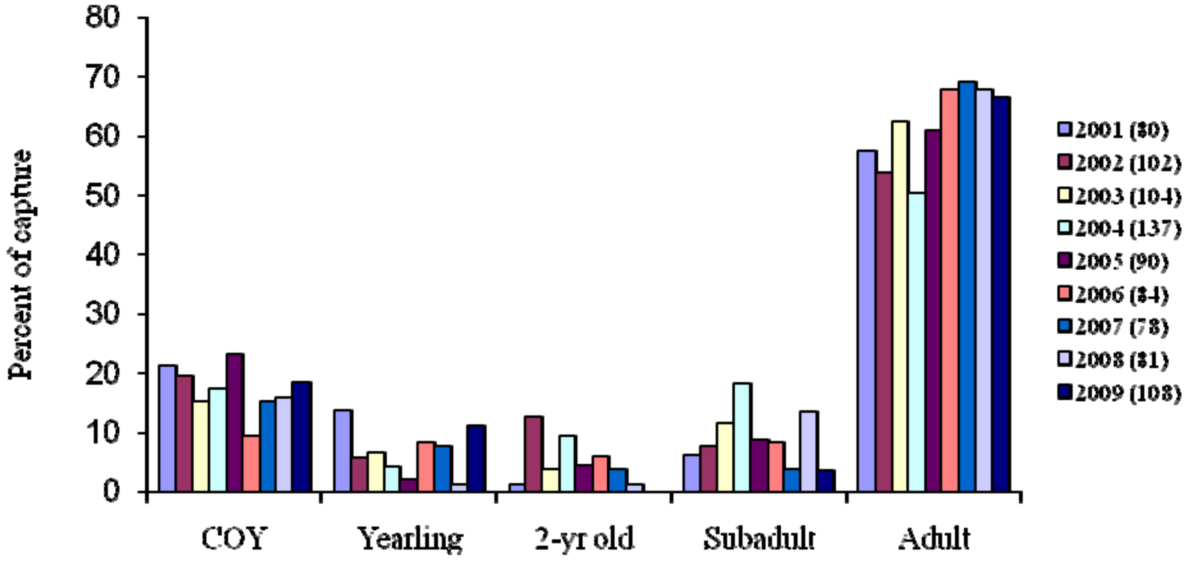

Fig. 2. Composition of polar bears by major age category in the USGS spring (March-May) southern Beaufort Sea capture, 2001-2009. Proportion of 2-yr-old bears has declined since 2004 and none were present in the 2009 capture. Only 4 subadult polar bears were captured in 2008. Data includes all captures.

Table 1. Proportion of recaptures of adult (≥ 5 years old) polar bears captured by standard search by the USGS during spring mark-recapture in the southern Beaufort Sea, 2001-2009.

Year	Total Captures	Recaptures	Proportion recaptured
2001	58	29	0.50
2002	42	13	0.31
2003	54	14	0.26
2004	71	35	0.49
2005	54	32	0.59
2006	57	38	0.66
2007	54	33	0.61
2008	57	36	0.63
2009	57	42	0.74

Summer survival strategies of land- and ice-bound polar bears

New focal research by USGS seeks to elucidate survival strategies of polar bears that use the Arctic Ocean adjacent to Alaska and its coastal regions during protracted summer sea ice melt. To conduct this research the USGS began collaborative research with the University of Wyoming, which received support from the National Science Foundation, and the USFWS. Extensive and prolonged losses of summer-time sea ice have occurred in the southern Beaufort Sea and throughout much of the Arctic for the last 10 years. Additionally, sea ice forecasts derived from general circulation models indicate continued loss of sea ice throughout the 21st century. Of the approximately 1500 polar bears in the SB subpopulation, at least 8% remain on land during the extensive summer melt seasons that have become typical of the southern Beaufort Sea during the last decade (Schliebe et al. 2008). However, the majority of the subpopulation follows the sea ice as it retreats northward beyond the more productive waters over the continental shelf. This raises an important question: What are the relative costs or benefits to polar bears to remain ashore versus following the sea ice off the shelf during years of extensive summer ice melt? Most available scientific information suggests polar bears are, in general, unlikely to find sufficient food on land to maintain body weight. Alaska's Beaufort Sea region may be somewhat of an exception to this because large volumes of subsistence-hunted bowhead whale carcasses are often available in predictable locales. One of our research goals is to understand the significance of this and other food sources to polar bears that spend the summer on the northern Alaska coast. No observations have ever been made on the feeding behavior of polar bears that summer on the pack ice over the deep waters of the Arctic basin. Limited data and observations of ringed (*Pusa hispida*) and bearded (*Erignathus barbatus*) seals in the Beaufort and Chukchi seas suggest that seals may not follow the sea ice north beyond the continental shelf. Also, ringed seals rarely haul out on land, but may remain pelagic during the summer season. Except for the bears that consume bowhead whale carcasses discarded by subsistence hunters, we hypothesize that polar bears, whether they are stranded on land or follow the ice north, are experiencing periods of food deprivation. Thus, because our understanding of polar bear energetics during summer in the southern Beaufort Sea is very limited, we are actively engaged in a new summer ecology research study.

The study seeks to compare the feeding ecology and activity of polar bears that occupy the ice pack over deep water with those bears that occupy land during extended periods when the sea ice in the southern Beaufort Sea has melted north of the continental shelf. The study will determine the level of food deprivation experienced by polar bears, and help us understand the energetic consequences. We hope to gain an understanding of how polar bears retain skeletal muscle protein and strength and how polar bears in the southern Beaufort Sea may differ in these traits from the well-studied bears of Hudson Bay. Ultimately, these data will inform models describing the potential population implications to polar bears based on the proportions of bears that adopt one of two different summer survival strategies (occupy the sea ice or summer on land). The present working hypothesis is that ice-bound polar bears will retain fat and muscle protein more effectively than land-bound polar bears (i.e., that ice-bound polar bears will be better able to accommodate prolonged and extensive sea ice loss than land-bound bears).

Because this research is comparing the relative costs and benefits of two different strategies used by SB polar bears (i.e., summering on pack ice versus summering on land), the study design requires repeated captures of individuals. An initial capture of select polar bears was made prior to (spring 2009) or just at the beginning of the melt season (summer 2008 and 2009) on offshore waters or on land. Subject bears were instrumented with a GPS radiocollar, and we collected standard linear body measurements, body mass, a muscle biopsy, and samples of blood and breath. We also implanted a temperature logger adjacent to the abdominal wall or on the rump. Autumn captures (2-6 months after first capture) targeted previously captured bears either on land (October 2008 and 2009) or on the sea ice (October 2009). Autumn captured bears undergo a second set of measurements and sample collections, identical to the set of measurements collected during the first capture, to compare changes in condition between bears that used land versus those that used pack ice during the summer. The temperature logger and radio collar are retrieved from each subject. Data derived from measurements, tissue samples, temperature loggers, and radio collars enable us to quantify the degree of fasting, activity, and resulting changes in body composition of polar bears from the beginning of the ice-minimum season to the end of the ice-minimum season.

This study examines levels of feeding through analysis of blood plasma triglycerides and cholesterols (through measures of Low Density Lipoproteins [LDL] and Very Low Density Lipoproteins [VLDL]), and for omega-3 fatty acid levels, and through analysis of $^{13}C/^{12}C$ ratios in breath and blood. Changes in body composition are assessed through measures of individual weights recorded at the start and end of each summer, through Bioelectrical Impedance Analysis, and through analysis of protein composition in muscle tissue. Muscle biopsies are collected through surgical extraction from the vastus lateralis muscle of the hind leg. Movement and activity levels and distribution are assessed by GPS radiocollars and activity sensor count data. Body temperature is measured through a temperature logger implanted subcutaneously adjacent to the linea alba.

Presently, funding for field sampling for this study is guaranteed only through 2009. The USGS is pursuing funding to continue the research on land-bound polar bears through 2013. Projected research for the following 4 years will use primarily non-surgical methods of measuring body condition. Additionally, the USGS is working with USFWS to assess the utility of glue-on and ear tag radios, as a substitute for radiocollars, for collecting data on the movements and activity of polar bears that occupy land during summer.

Other research

We have continued to explore models of polar bear-sea ice relationships, especially during the most recent summers of anomalous sea ice conditions. By comparing model results between the recent years of extreme ice melt to past years of relatively complete summer ice cover, we will learn more about how polar bears are responding to the rapid changes in their sea ice habitats and how those responses may be influencing survival or reproduction. Analysis is presently underway for a Beaufort Sea resource selection function that includes 10 years of polar bear radio-location and sea ice data (1999-2008). Movement data are also being examined to identify long distance swimming events by polar bears in the Chukchi and Beaufort seas.

Observations have been made of distributional changes in Pinniped species in association with changes in Arctic sea ice (Iverson et al. 2006). Our future work will assess distributional shifts of traditional and new prey species in the southern Beaufort Sea. We are collecting tissue samples from captured polar bears for fatty acid analysis, and we are opportunistically collecting prey item tissue samples from polar bear kill sites, to determine whether polar bear diets and Arctic food webs may be changing.

We have presently discontinued our assessments of Radio-frequency Identification (RFID) tags after initially considering them as an alternative mark-recapture method. Ideally, RFID tags have the potential to increase mark-recapture observations and reduce the handling of animals. Fifty-three RFID tags were deployed in 2006, 18 tags in spring 2007, 16 tags in the spring 2008, and another 12 in October 2008. Our preliminary results, and those of Richard Schideler, Alaska Department of Fish and Game, on brown bears, indicate that signal detection distances of 1 km are possible between tagged bears and receiver-equipped aircraft. For a mark-recapture study, this could enhance data collection and reduce project costs. However, of the 15 re-observations of tagged bears >6 months following RFID application, only 3 had retained functioning tags and 12 had lost their tags. Thus, tag retention is an obvious limiting factor. In 2007 and 2008 we deployed tags that were considerably smaller than those deployed in 2006, hoping that retention would be improved. At present we feel that smaller RFID tags must be designed or have a different means of attachment in order to achieve tag retention rates that our adequate for our needs. We are also waiting until longer detection ranges are developed for semi-passive tags (which are smaller than RFID tags) before we re-examine the potential utility of this technology.

In addition to USGS research in the SB, the USGS worked with the USFWS in 2007 and 2008 in a pilot study to explore the potential for a long-term mark-recapture program of polar bears in the Chukchi Sea. The USGS and USFWS are also collaborating on developing ear-tag and glue-on tags as an alternative to traditional radio-collars.

Published research findings, 2005-2009

Results of the USGS efforts to inform the listing process of the U.S. Endangered Species Act:

Addressing US Department of Interior (DOI) information needs for the US ESA decision was the focus of USGS research in 2007. Of the nine reports submitted to the Secretary of the Interior, several have been published in peer-reviewed journals or are under journal review. Other reports and publications address population status and trends of southern Beaufort Sea and Hudson Bay polar bears, cannibalism in polar bears, feeding ecology, maternal den habitat, oil spill impacts, sea ice changes, as well as a rebuttal to a published critique of the USGS-led reports that informed the ESA listing decision. Summaries of each report or publication are provided below. Full citations are provided after each abstract. Full text reports, as presented to the Secretary of Interior are also available at: (http://www.usgs.gov/newsroom/special/polar_bears/).

A Bayesian Network Modeling Approach to Forecasting the 21st Century Worldwide Status of Polar Bears

To inform the USFWS decision, whether to list polar bears as threatened under the ESA, we projected the status of the world's polar bears for decades centered on future years 2025, 2050, 2075, and 2095. We defined four ecoregions based on current and projected sea ice conditions: seasonal ice, Canadian Archipelago, polar basin divergent and polar basin convergent ecoregions. We incorporated general circulation model projections of future sea ice into a Bayesian network (BN) model structured around the factors considered in

ESA decisions. This first-generation BN model combined empirical data, interpretations of data, and professional judgments of one polar bear expert into a probabilistic framework that identifies causal links between environmental stressors and polar bear responses. We provide guidance regarding steps necessary to refine the model, including adding inputs from other experts. The BN model projected extirpation of polar bears from the seasonal ice and polar basin divergent ecoregions, where ca. 2/3 of the world's polar bears currently occur, by mid century. Projections were less dire in other ecoregions. Decline in ice habitat was the overriding factor driving the model outcomes. Although this is a first-generation model, the dependence of polar bears on sea ice is universally accepted, and the observed sea ice decline is faster than models suggest. Therefore, incorporating judgments of multiple experts in a final model is not expected to fundamentally alter the outlook for polar bears described here.

Amstrup, S. C., B. G. Marcot, and D. C. Douglas. 2008. A Bayesian Network Modeling Approach to Forecasting the 21st Century Worldwide Status of Polar Bears. Pages 213-268 In Eric. T. DeWeaver, Cecilia M. Bitz, and L.-Bruno Tremblay Eds. Arctic Sea Ice Decline: Observations, Projections, Mechanisms, and Implications. Geophysical Monograph 180. American Geophysical Union, Washington DC.

Predicting Movements of Female Polar Bears between Summer Sea Ice Foraging Habitats and Terrestrial Denning Habitats of Alaska in the 21st Century: Proposed Methodology and Pilot Assessment

Polar bears require the relative warmth and stability afforded by snow dens for successful reproduction. Pregnant bears must travel from foraging habitats on the sea ice to land in autumn to establish winter dens. Data of sea ice extent and composition from satellite-acquired passive microwave (PMW) imagery show a reduction in summer sea ice extent throughout the Arctic from 1979-2006. Additionally, General Circulation Models (GCM) predict that Arctic sea ice extent will continue to diminish throughout the 21st century. Greater energetic demands will be placed on pregnant polar bears in the future if they travel greater distances from summer forage habitats to traditional denning habitats on land. We developed an approach for estimating how much these distances may change by modeling autumn movement paths of polar bears using the observational PMW record of sea ice distribution and sea ice projections of 5 GCMs during the 21st century. Over the 1979-2006 PMW record, polar bears returning to Alaska to den have experienced an annual increase in travel of > 6 km/year—an increase of >168 km over the 28 year period. Based on GCM sea ice projections during 2001-2060, the average increase in the distance required to reach traditional Alaskan denning regions was estimated to increase > 16 km/year. Distances traveled, and therefore, energetic demands, will likely vary among the different circumpolar sub-populations of polar bears.

Bergen, S., G. M. Durner, D. C. Douglas, and S. C. Amstrup. 2007. Predicting movements of female polar bears between summer sea ice foraging habitats and terrestrial denning habitats of Alaska in the 21st century: Proposed methodology and pilot study. USGS, Alaska Science Center, Anchorage, Alaska. Administrative Report. 20 pp.

Uncertainty in Climate Model Projections of Arctic Sea Ice Decline: An Evaluation Relevant to Polar Bears

This report describes uncertainties in climate model simulations of Arctic sea ice decline, and proposes a selection criterion for models to be used in projecting polar bear habitat loss. Uncertainties in model construction are discussed first; both for climate models in general and for their sea ice component models. A key point in the discussion is that the inherent climate sensitivity of sea ice leads inevitably to uncertainty in simulations of sea ice decline. The ability of climate models to simulate gross properties of Arctic ice cover, including the annual mean, seasonal cycle, and recent trends, is then assessed, followed by a review of model projections of 21st Century decline. The proposed selection criterion selects models with less than 20% error in their simulations of present-day September sea ice extent, where extent is defined as the area of the Arctic with at least 50% ice cover. Of the 10 models satisfying this criterion, all lose at least 30% of their September ice extent, and 4 lose over 80% of their September ice by the middle of the 21st Century (years 2045 to 2055). By the end of the 21st Century (years 2090 to 2099), seven of the models are essentially ice free in September.

DeWeaver, E. 2007. Uncertainty in Climate Model Projections of Arctic Sea Ice Decline: An Evaluation Relevant to Polar Bears. USGS, Alaska Science Center, Anchorage, Alaska. Administrative Report. 41 pp

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Predicting 21st-century polar bear habitat distribution from global climate models

Projections of polar bear sea ice habitat distribution in the polar basin during the 21st century were developed to understand the consequences of anticipated sea ice reductions on polar bear populations. We used location data from satellite collared polar bears and environmental data (e.g., bathymetry, distance to coastlines, and sea ice) collected from 1985 to 1995 to build resource selection functions (RSFs). RSFs described habitats that polar bears preferred in summer, autumn, winter, and spring. When applied to independent data from 1996 to 2006, the RSFs consistently identified habitats most frequently used by polar bears. We applied the RSFs to monthly maps of 21st-century sea ice concentration projected by 10 general circulation models (GCMs) used in the Intergovernmental Panel of Climate Change Fourth Assessment Report, under the A1B greenhouse gas forcing scenario. Despite variation in their projections, all GCMs indicated habitat losses in the polar basin during the 21st century. Losses in the highest-valued RSF habitat (optimal habitat) were greatest in the southern seas of the polar basin, especially the Chukchi and Barents seas, and least along the Arctic Ocean shores of Banks Island to northern Greenland. Mean loss of optimal polar bear habitat was greatest during summer; from an observed 1.0 million km^2 in 1985–1995 (baseline) to a projected multi-model mean of 0.32 million km^2 in 2090–2099 (-68% change). Projected winter losses of polar bear habitat were less: from 1.7 million km^2 in 1985–1995 to 1.4 million km^2 in 2090–2099 (-17% change). Habitat losses based on GCM multi-model means may be conservative; simulated rates of habitat loss during 1985–2006 from many GCMs were less than the actual observed rates of loss. Although a reduction in the total amount of optimal habitat will likely reduce polar bear populations, exact relationships between habitat losses and population demographics remain unknown. Density and energetic effects may become important as polar bears make long-distance annual migrations from traditional winter ranges to remnant high-latitude summer sea ice. These impacts will likely affect specific sex and age groups differently and may ultimately preclude bears from seasonally returning to their traditional ranges.

Durner, G. M., D. C. Douglas, R. M. Neilson, S. C. Amstrup, T. L. McDonald, I. Stirling, M. Mauritzen, E. W. Born, O. Wiig, E. DeWeaver, M. C. Serreze, S. E. Belikov, M. M. Holland, J. Maslanik, J. Aars, D. A. Bailey, and A. E. Derocher. 2009. Predicting 21st century polar bear habitat distribution from global climate models. Ecological Monographs 79:25-58.

Polar Bears in the Southern Beaufort Sea II: Demography and Population Growth in Relation to Sea Ice Conditions

This is a demographic analysis of the southern Beaufort (SB) polar bear population. The analysis uses a female-dominant stage-classified matrix population model in which individuals are classified by age and breeding status. Parameters were estimated from capture-recapture data collected between 2001 and 2006. We focused on measures of long-term population growth rate and on projections of population size over the next 100 years. We obtained these results from both deterministic and stochastic demographic models. Demographic results were related to a measure of sea ice condition, *ice*(*t*), defined as the number of ice-free days, in year *t*, in the region of preferred polar bear habitat. Larger values of *ice* correspond to lower availability of sea ice and longer ice-free periods. Uncertainty in results was quantified using a parametric bootstrap approach that includes both sampling uncertainty and model selection uncertainty.

Deterministic models yielded estimates of population growth rate λ, under low *ice* conditions in 2001–2003, ranging from 1.02 to 1.08. Under high *ice* conditions in 2004–2005, estimates of λ ranged from 0.77 to 0.90. The overall growth rate estimated from a time-invariant model was about 0.997; i.e., a 0.3% decline per year. Population growth rate was most elastic to changes in adult female survival, and an LTRE analysis showed that the decline in λ relative to 2001 conditions was primarily due to reduction in adult female survival, with secondary contributions from reduced breeding probability.

Based on demographic responses, we classified environmental conditions into good (2001–2003) and bad (2004–2005) years, and used this classification to construct stochastic models. In those models, good and bad years occur independently with specified probabilities. We found that the stochastic growth rate declines with an increase in the frequency of bad years. The observed frequency of bad years since 1979 would imply a stochastic growth rate of about -1% per year.

Deterministic population projections over the next century predict serious declines unless conditions typical of 2001–2003 were somehow to be maintained. Stochastic projections predict a high probability of serious declines unless the frequency of bad *ice* years is less than its recent average. To explore future trends in sea ice, we used the output of 10 selected general circulation models (GCMs), forced with "business as usual" greenhouse gas emissions, to predict values of *ice*(*t*) until the end of the century. We coupled these to the stochastic demographic model to project population trends under scenarios of future climate change. All GCM models predict a crash in the population within the next century, possibly preceded by a transient population increase.

The parameter estimates on which the demographic models are based have high levels of uncertainty associated with them, but the agreement of results from different statistical model sets, deterministic and stochastic models, and models with and without climate forcing, speaks for the robustness of the conclusions.

Hunter, C. M., H. Caswell, M. C. Runge, E. V. Regehr, S. C. Amstrup, and I. Stirling. 2007. Polar Bears in the Southern Beaufort Sea II: Demography and Population Growth in Relation to Sea Ice Conditions. USGS, Alaska Science Center, Anchorage, Alaska. Administrative Report. 46 pp.

Hunter, C.M., H. Caswell, M.C. Runger, E.V. Regehr, S. C. Amstrup and I. Stirling. *In press*. Climate Change threatens polar bear populations: a stochastic demographic analysis. Ecology.

Polar Bear Population Status in Southern Hudson Bay, Canada

The Southern Hudson Bay (SH) population of polar bears (*Ursus maritimus*) resides in a seasonal sea ice environment and is the most southerly population in the species' range. Therefore, SH polar bears may be among the first to show negative effects associated with climate warming and consequent loss of sea ice. Polar bears in the neighboring Western Hudson Bay (WH) population have declined significantly in body condition since the mid-1980s, and a recent study indicated that the size of the WH population declined by about 22% between 1987 and 2004. Similarly, SH bears have shown a significant decline in body condition since the mid-1980s, and an assessment of the current status of the SH population was therefore needed. We applied open population capture-recapture models to data collected from 1984-86 and 1999-2005 to estimate population size and survival. The size of the SH population appears to be unchanged from the mid-1980s (1984-1986: 641, 95% CI = 401, 881) vs. 2003-2005: 681 (95% CI = 401, 961). Point estimates of survival for subadults and adult females were 94% (95% CI = 68%, 100%) in 1984-1985 to 89% (95% CI = 79%, 99%) in 2003-2005, but imprecision exhibited by overlap of the confidence intervals prevented us from unequivocally concluding that this 5% decline in survival was not a chance occurrence. Similarly, a decline of 7% in survival was estimated for subadult and adult males over the same time period (male survival estimates = 88% (95% CI = 77%, 100%) in 1984-1985; 81% (95% CI = 66%, 96%), but again we could not unequivocally conclude that this decline was not chance. There was weak evidence of lower survival of cubs, yearlings, and senescent adults in the recent time period. This, combined with the evidence of significant declines in body condition for all age and sex classes, which were greatest for pregnant females and subadults, suggests this population may be under increased stress at this time. However, we did not find any clear association between survival and cub-of-the-year body condition, average body condition for the age class, or extent of ice cover in our data. This lack of association could be real or attributable to the coarse scale of our average body condition measure, or to limited sample size and few years of intensive sampling. That the WH population appears to be in decline, but the SH population does not, might be explained by changes to sea ice patterns which to date have been greater in the western half of Hudson Bay (breakup 10 days earlier per decade) than in the eastern and southern portions of Hudson Bay (breakup 5-8 days earlier per decade). However, if the trend in sea ice patterns (i.e., earlier melt and later freeze-up) continues in eastern and southern Hudson Bay, the SH population will likely respond similarly to the WH population and begin to decline.

Obbard, M. E., T. L. McDonald, E. J. Howe, E. V. Regehr, and E. S. Richardson. 2007. Polar Bear Population Status in Southern Hudson Bay, Canada. USGS, Alaska Science Center, Anchorage, Alaska. Administrative Report. 32 pp.

Polar Bears in the Southern Beaufort Sea I: Survival and Breeding in Relation to Sea Ice Conditions, 2001-2006

Climatic warming and associated declines in Arctic sea ice have raised concerns about the long-term conservation of polar bears. We used multistate capture-recapture models that classified individuals by sex, age, and reproductive category to evaluate the effects of declines in the extent and duration of sea ice on survival and breeding probabilities for polar bears in the southern Beaufort Sea (SB), using data collected from 2001-2006. We estimated model-averaged vital rates for three sets of models: time-invariant models, models with vital rates that depended upon an environmental covariate, and models with vital rates that varied with time but did not depend on a covariate. Sampling and model selection uncertainty were quantified using parametric bootstrap procedures. The most supported models included dependence of survival on the duration of the ice-free period over the continental shelf in the SB region, and included time variation in breeding probabilities. In 2001 and 2002, the ice-free period was relatively short (mean 92 days) and survival of adult female polar bears was high (approximately 0.99, 90%CI = 0.10-1.0). In 2004 and 2005, the ice-free period was long (mean 135 days) and survival of adult female polar bears was lower (approximately 0.77, 90%CI = 0.53-0.94). Breeding and cub-of-the-year litter survival also declined from high rates in early years to lower rates in later years of the study. Although the precision of estimated vital rates was low, subsequent analyses (Hunter et al. 2007) indicated that the declines in vital rates associated with longer ice-free periods have ramifications for the probability of persistence of the SB population. Our results are relevant to over one-third of the world's polar bears, which inhabit regions of the polar basin with sea ice dynamics similar to the SB and have experienced more severe sea ice changes than the SB. This study was short in duration relative to the life history of polar bears. Therefore, continued monitoring will be necessary to increase our confidence in the relationships between declining sea ice and polar bear vital rates, to elucidate the ecological mechanisms underlying these relationships, and to understand how polar bears will respond to the continued declines in the sea ice that are projected for many parts of the Arctic.

Regehr, E. V., C. M. Hunter, H. Caswell, S. C. Amstrup, and I. Stirling. 2007. Polar Bears in the Southern Beaufort Sea I: Survival and Breeding in Relation to Sea Ice Conditions, 2001-2006. USGS, Alaska Science Center, Anchorage, Alaska. Administrative Report. 45 pp.

Regehr, E. V., Hunter, C. M., Caswell, H., Amstrup, S. C. & Stirling, I. 2010. Survival and breeding of polar bears in the southern Beaufort Sea in relation to sea ice. *Journal of Animal Ecology,* **79,** 117-127.

Polar Bears in the Southern Beaufort Sea III: Stature, Mass, and Cub Recruitment in Relationship to Time and Sea Ice Extent Between 1982 and 2006

Changes in individual stature and body mass can affect reproduction and survival and have been shown to be early indicators of changes in status and trends of polar bear populations. We recorded body length, skull size, and mass of polar bears

(*Ursus maritimus*) during capture/recapture studies conducted in the southern Beaufort Sea of Alaska (SB) between 1982 and 2006. We calculated a body condition index (BCI) which reflects trends in mass relative to length. We also recorded the number of dependent young accompanying females in the spring and fall as an indicator of cub recruitment. Previous work suggested stature of some sex and age classes of bears in the SB had changed between early and latter portions of this study but did not investigate trends in or causes of those changes. Here, we investigate whether these measurements changed over time or in relation to sea ice extent. Because our study required bears to be repeatedly immobilized and captured, we tested whether frequency of capture could have affected these measurements. Mass, length, skull size, and BCI of growing males (aged 3-10), mass and skull size of cubs-of-the year, and the number of yearlings per female in the spring and fall were all positively related to the percent of days in which sea ice covered the continental shelf. Skull sizes and/or lengths of adult and subadult males and females decreased over time during the study. Adult body mass was not related to sea ice cover and didn't show a trend with time. BCI of adult females exhibited a positive trend over time reflecting a decline in length without a parallel trend in mass. Though cub production increased over time, the number of cubs-of-the-year (COYs) per female in the fall and yearlings per female in the spring declined suggesting reduced cub survival. Bears with prior capture history were either larger or similar in stature and mass to bears captured for the first time, indicating that research activities did not influence trends in the data. Declines in mass and BCI of subadult males, declines in growth of males and females, and declines in cub recruitment suggest that polar bears of the Southern Beaufort Sea have experienced a declining trend in nutritional status. The significant relationship between several of these measurements and sea ice cover over the continental shelf suggests that nutritional limitations may be associated with changing sea-ice conditions.

Rode, K. D., S. C. Amstrup, and E. V. Regehr. 2007. Polar Bears in the Southern Beaufort Sea III: Stature, Mass, and Cub Recruitment in Relationship to Time and Sea Ice Extent Between 1982 and 2006. USGS, Alaska Science Center, Anchorage, Alaska. Administrative Report. 26 pp.

Rode, K. D., Amstrup, S. C. and Regehr, E. V. 2010. Reduced body size and cub recruitment in polar bears associated with sea ice decline. *Ecological Applications* 20:768-782.

Polar Bear Population Status in the Northern Beaufort Sea

The Northern Beaufort (NB) Sea polar bear (*Ursus maritimus*) population is situated on the perimeter of the polar basin in a region where sea ice converges on shorelines throughout most of the year. In this study, we present data on the status of this population, based on our research between 1971 and 2006. We applied open population capture-recapture models to data collected from 1971-2006 to assess the relationship between polar bear survival and sex, age, time period, and a number of environmental covariates. Model-averaged estimates of survival (which include harvest mortality) for senescent adults ranged from 0.33 (1980s, males) to 0.92 (1990s, females). Estimates of cub-of-the-year (COY) and yearling survival ranged between 0.10 (1980s, male yearlings) and 0.97 (1990s, female COY). Survival of 2–4 year olds and adults were nearly identical and ranged from 0.61 (1980s, males) to 0.97 (1990s, females). Relatively wide confidence intervals for survival of young age classes were largely due to small sample sizes. In addition, we modeled recapture probability as a function of three covariates (*effort*, *radio.vhf*, *radio.satellite*) and used a Horvtiz-Thompson (HT) estimator to estimate long term trends in the size of the NB population. Models that allowed associations between annual variation in survival, habitat, or relative seal abundance variables were not, in general, supported by the data. The model-averaged estimate of population size from 2004 to 2006 = 980 (± 155, 95% CI) and was not significantly different from estimates for the periods of 1972 to 1975 and 1985 to 1987 of 745 (± 246, 95% CI) and 867 (± 141, 95% CI), respectively. These abundance estimates apply primarily to that segment of the NB population residing west and south of Banks Island to the mainland coast, plus a relatively small but unknown fraction of the population residing further north around Prince Patrick Island. In 1992 to 1994, a capture effort focused in the area around Prince Patrick Island confirmed significant mixing between northern and southern segments of the population, that some bears residing in the extreme northern portions of the population may not have been equally available for capture during other sampling periods, and that the number of polar bears around Prince Patrick Island was not large relative to the rest of the population. Thus, we consider our estimates of total abundance during the other three sampling periods to be slightly low. Currently the NB polar bear population appears to be stable, probably because ice conditions remain suitable for feeding through much of the summer and fall in most years and the Inuvialuit harvest has not exceeded sustainable levels.

Stirling, I., T. L. McDonald, E. S. Richardson, and E. V. Regehr. 2007. Polar Bear Population Status in the Northern Beaufort Sea. USGS, Alaska Science Center, Anchorage, Alaska. Administrative Report. 31 pp.

Other USGS publications and reports, 2005-2009

Rebuttal of "Polar Bear Population Forecasts: A Public-Policy Forecasting Audit"

Observed declines in the Arctic sea ice have resulted in a variety of negative effects on polar bears. Projections for additional future declines in sea ice resulted in a proposal to list polar bears as a threatened species under the US ESA. To provide information for the DOI's listing-decision process, the USGS produced a series of nine research reports evaluating the present and future status of polar bears throughout their range. In response, Armstrong et al. (Armstrong, J. S., K. C. Green, W. Soon. 2008. Polar bear population forecasts: A public-policy forecasting audit. Interfaces 38(5) 382–405), which we will refer to as AGS, performed an audit of two of these nine reports. AGS claimed that the general circulation models upon which the USGS reports relied were not valid forecasting tools, that USGS researchers were not objective or lacked independence from policy decisions, that they did not utilize all available information in constructing their forecasts, and that they violated numerous principles of forecasting espoused by AGS. AGS (p. 382) concluded that the two USGS reports were "unscientific and inconsequential to decision makers." We evaluate the AGS audit and show how AGS are mistaken or misleading on every claim. We provide evidence that general circulation models are useful in forecasting future climate conditions and that corporate and government leaders are relying on these models to do so. We clarify the strict independence of the USGS from the listing decision. We show that the allegations of failure to follow the principles of forecasting espoused by AGS are either incorrect or are based on misconceptions about the Arctic environment, polar bear biology, or statistical and mathematical methods. We conclude by showing that the AGS principles of forecasting are too ambiguous and subjective to be used as a reliable basis for auditing scientific investigations. In summary, we show that the AGS audit offers no valid criticism of the USGS conclusion that global warming poses a serious threat to the future welfare of polar bears and that it only serves to distract from reasoned public-policy debate.

Amstrup. S. C., H. Caswell, E. DeWeaver, I. Stirling, D. C. Douglas, B. G. Marcot, and C. M. Hunter. 2009. Rebuttal of "Polar Bear Population Forecasts: A Public-Policy Forecasting Audit". Interfaces doi 10.1287/inte.1090.0444.

Estimating Potential Effects of Hypothetical Oil Spills on Polar Bears

Much is known about the transport and fate of oil spilled into the sea and its toxicity to exposed wildlife. Previously, however, there has been no way to quantify the probability that wildlife dispersed over the seascape would be exposed to spilled oil. Polar bears, the apical predator of the arctic, are widely dispersed near the continental shelves of the Arctic Ocean, an area also undergoing considerable hydrocarbon exploration and development. We used 15,308 satellite locations from 194 radiocollared polar bears to estimate the probability that polar bears could be exposed to hypothetical oil spills. We used a true 2-dimensional Gausian kernel density estimator, to estimate the number of bears likely to occur in each 1.00 km^2 cell of a grid superimposed over near shore areas surrounding 2 oil production facilities: the existing Northstar oil production facility, and the proposed offshore site for the Liberty production facility. We estimated the standard errors of bear numbers per cell with bootstrapping. Simulated oil spill footprints for September and October, the times during which we hypothesized effects of an oil-spill would be worst, were estimated using real wind and current data collected between 1980 and 1996. We used ARC/Info software to calculate overlap (numbers of bears oiled) between simulated oil-spill footprints and polar bear grid-cell values. Numbers of bears potentially oiled by a hypothetical 5912 barrel spill (the largest spill thought probable from a pipeline breach) ranged from 0 to 27 polar bears for September open water conditions, and from 0 to 74 polar bears in October mixed ice conditions. Median numbers oiled by the 5912 barrel hypothetical spill from the Liberty simulation in September and October were 1 and 3 bears, equivalent values for the Northstar simulation were 3 and 11 bears. In October, 75% of trajectories from the 5912 barrel simulated spill at Liberty oiled 9 or fewer bears while 75% of the trajectories affected 20 or fewer polar bears when we simulated an October spill at the Northstar site. Northstar Island is nearer the active ice flaw zone than Liberty. Simulations suggested that oil spilled at Northstar would spread more effectively and more consistently into surrounding areas. Also, polar bear densities are consistently higher near Northstar. Oil spills simulated for the Liberty site were more erratic in the areas they covered and the numbers of bears impacted, and numbers of bears hypothetically exposed were usually smaller. Methods described here are broadly applicable to other dispersed marine wildlife.

Amstrup, S. C., G. M. Durner, T..L. McDonald, and W. R. Johnson. 2006. Estimating Potential Effects of Hypothetical Oil Spills on Polar Bears. U.S. Department of the Interior, U.S. Geological Survey, Anchorage, Alaska. 56 pp.

Recent observations of intraspecific predation and cannibalism among polar bears in the southern Beaufort Sea

Intraspecific killing has been reported among polar bears (*Ursus maritimus*), brown bears (*U. arctos*), and black bears (*U. americanus*). Although cannibalism is one motivation for such killings, the ecological factors mediating such events are poorly understood. Between 24 January and 10 April 2004, we confirmed three instances of intraspecific predation and cannibalism in the Beaufort Sea. One of these, the first of this type ever reported for polar bears, was a parturient female killed at her maternal den. The predating bear was hunting in a known maternal denning area and apparently discovered the den by scent. A second predation event involved an adult female and cub recently emerged from their den, and the third involved a yearling male. During 24 years of research on polar bears in the southern Beaufort Sea region of northern Alaska and 34 years in northwestern Canada, we have not seen other incidents of polar bears stalking, killing, and eating other polar bears. We hypothesize that nutritional stresses related to the longer ice-free seasons that have occurred in the Beaufort Sea in recent years may have led to the cannibalism incidents we observed in 2004.

Amstrup, S. C., I. Stirling, T. S. Smith, C. Perham, and G. W. Thiemann. 2006. Recent observations of intraspecific predation and cannibalism among polar bears in the southern Beaufort Sea. Polar Biology DOI 10.1007/s00300-006-0142-5.

Variations in the Arctic's multiyear sea ice cover: A neural network analysis of SMMR-SSM/I data

A 26-year (1979–2004) observational record of January multiyear sea ice distributions, derived from neural network analysis of SMMR-SSM/I passive microwave satellite data, reveals dense and persistent cover in the central Arctic basin surrounded by expansive regions of highly fluctuating interannual cover. Following a decade of quasi equilibrium, precipitous declines in multiyear ice area commenced in 1989 when the Arctic Oscillation shifted to a pronounced positive phase. Although extensive survival of first-year ice during autumn 1996 fully replenished the area of multiyear ice, a subsequent and accelerated decline returned the depletion to record lows. The most dramatic multiyear sea ice declines occurred in the East Siberian, Chukchi, and Beaufort Seas.

Belchansky, G. I., D. C. Douglas, V. A. Eremeev, and N. G. Platonov. 2005. Variations in the Arctic's multiyear sea ice cover: A neural network analysis of SMMR-SSM/I data, 1979–2004. Geophysical Research Letters 32: L09605, doi:10.1029/2005GL022395.

Spatial and temporal variations in the age structure of Arctic sea ice

Spatial and temporal variations in the age structure of Arctic sea ice are investigated using a new reverse-chronology algorithm that tracks ice-covered pixels to their location and date of origin based on ice motion and concentration data. The Beaufort Gyre tends to harbor the oldest (>10 years old) sea ice in the western Arctic while direct ice advection pathways toward the Transpolar Drift Stream maintain relatively young (≤5 years) ice in the eastern Arctic. Persistent net losses (-4.2% yr^{-1}) in extent of ice >10 years old (10+ year age class) were observed during 1989–2003. Since the mid-1990s, losses to the 10+ year age class lacked compensation by recruitment due to a prior depletion of all mature (6–10 year) age classes. Survival of the 1994 and 1996–1998 sea ice generations reestablished most mature age classes, and thereby the potential to increase extent of the 10+ year age class during the mid-2000s.

Belchansky, G. I., D. C. Douglas, and N. G. Platonov. 2005. Spatial and temporal variations in the age structure of Arctic sea ice. Geophysical Research Letters 32:L18504, doi:10.1029/2005GL023976.

Fluctuating arctic sea ice thickness changes estimated by an in situ learned and empirically forced neural network model

Sea ice thickness (SIT) is a key parameter of scientific interest because understanding the natural spatiotemporal variability of ice thickness is critical for improving global climate models. In this paper, changes in Arctic SIT during 1982–2003 are examined using a neural network (NN) algorithm trained with in situ submarine ice draft and surface drilling data. For each month of the study period, the NN individually estimated SIT of each ice-covered pixel (25-km resolution) based on seven geophysical parameters (four shortwave and longwave radiative fluxes, surface air temperature, ice drift velocity, and ice divergence/convergence) that were cumulatively summed at each monthly position along the pixel's previous 3-yr drift track (or less if the ice was <3 yr old). Average January SIT increased during 1982–88 in most regions of the Arctic ($+7.6 \pm 0.9$ cm yr^{-1}), decreased through 1996 Arctic-wide (-6.1 ± 1.2 cm yr^{-1}), then modestly increased through 2003 mostly in the central Arctic ($+2.1 \pm 0.6$ cm yr^{-1}). Net ice volume change in the Arctic Ocean from 1982 to 2003 was negligible, indicating that cumulative ice growth had largely replaced the estimated 45 000 km^3 of ice lost by cumulative export. Above 65°N, total annual ice volume and interannual volume changes were correlated with the Arctic Oscillation (AO) at decadal and annual time scales, respectively. Late-summer ice thickness and total volume varied proportionally until the mid-1990s, but volume did not increase commensurate with the thickening during 1996–2002. The authors speculate that decoupling of the ice thickness–volume relationship resulted from two opposing mechanisms with different latitudinal expressions: a recent quasi-decadal shift in atmospheric circulation patterns associated with the AO's neutral state facilitated ice thickening at high latitudes while anomalously warm thermal forcing thinned and melted the ice cap at its periphery.

Belchansky, G. I., D. C. Douglas, and N. G. Platonov. 2008. Fluctuating arctic sea ice thickness changes estimated by an in situ learned and empirically forced neural network model. Journal of Climate. 21:716-729.

Organohalogen concentrations in blood and adipose tissue of southern Beaufort Sea polar bears

We analyzed 151 organohalogen chemicals (OHCs) in whole blood and subcutaneous fat of 57 polar bears sampled along the Alaskan Beaufort Sea coast in spring, 2003. All major organochlorine pesticides, PCBs, PBDEs and their congeners were assessed. Concentrations of most OHCs continue to be lower among Southern Beaufort Sea polar bears than reported for other populations. Additionally, toxaphenes and related compounds were assessed in adipose tissue, and 8 perflourinated compounds (PFCs) were examined in blood. Perfluorooctane sulfonate (PFOS) concentrations exceeded those of any other contaminant measured in blood. ΣChlordane concentrations were higher in females, and both ΣPCBs and ΣChlordane concentrations in adipose tissue decreased significantly with age. The rank order of OHC mean concentrations was similar for compounds above detection limits in both fat and blood. Although correlation between OHC concentrations in blood and adipose tissue was examined, the predictability of concentrations in one matrix for the other was limited.

Bentzen, T. W., D.C.G. Muir, S.C. Amstrup, and T.M. O'Hara. 2008. Organohalogen concentrations in blood and adipose tissue of southern Beaufort Sea polar bears. The Science of the Total Environment. 2008. 406:352-67.

Dietary biomagnification of organochlorine contaminants in Alaskan polar bears

Concentrations of organochlorine contaminants in the adipose tissue of polar bears vary throughout the Arctic. The range in concentrations has not been explained fully by bear age, sex, condition, location, or reproductive status. Dietary pathways expose polar bears to a variety of contaminant profiles and concentrations. Prey range from lower trophic level bowhead whales (*Balaena mysticetus* L., 1758), one of the least contaminated marine mammals, to highly contaminated upper trophic level ringed seals (*Phoca hispida* (Schreber, 1775)). We used $\delta^{15}N$ and $\delta^{13}C$ signatures to estimate the trophic status of 42 polar bears sampled along Alaska's Beaufort Sea coast to determine the relationship between organochlorine concentration and trophic level. The $\delta^{15}N$ values in the cellular portions of blood ranged from 18.2‰ to 20.7‰. We found strong positive relationships between concentrations of the most recalcitrant polychlorinated biphenyls (PCBs) and $\delta^{15}N$ values in models incorporating age, lipid content, and $\delta^{13}C$ value. Specifically these models accounted for 67% and 76% of the variation in PCB153 and oxychlordane concentration in male polar bears and 85% and 93% in females, respectively. These results are strong indicators of variation in diet and biomagnification of organochlorines among polar bears related to their sex, age, and trophic position.

Bentzen, T. W., E. H. Follman, S. C. Amstrup, G. S. York, M. J. Wooller, D. C. G. Muir, and T. M. O'Hara. 2008. Dietary biomagnification of organochlorine contaminants in Alaskan polar bears. Canadian Journal of Zoology 86:177-191.

Variation in winter diet of southern Beaufort Sea polar bears inferred from stable isotope analysis

Ringed seals and bearded seals (*Erignathus barbatus*) represent the majority of the polar bear's annual diet. However, remains of lower trophic level bowhead whales (*Balaena mysticetus* L., 1758) are available in the southern Beaufort Sea and their dietary contribution to polar bears has been unknown. We used stable isotope ($^{13}C/^{12}C$, $\delta^{13}C$, $^{15}N/^{14}N$, and $\delta^{15}N$) analysis to determine the diet composition of polar bears sampled along Alaska's Beaufort Sea coast in March and April 2003 and 2004. The mean $\delta^{15}N$ values of polar bear blood cells were 19.5‰ (SD = 0.7‰) in 2003 and 19.9‰ (SD = 0.7‰) in 2004. Mixing models indicated bowhead whales composed 11%–26% (95% CI) of the diets of sampled polar bears in 2003, ans 0%–14% (95% CI) in 2004. This suggests significant variability in the proportion of lower trophic level prey in polar bear diets among individuals and between years. Polar bears depend on sea ice for hunting seals, and the temporal and spatial availabilities of sea ice are projected to decline. Consumption of low trophies level foods documented here suggests bears may increasingly scavenge such foods in the future.

Bentzen, T. W., E. H. Follmann, S. C. Amstrup, G. S. York, M. J. Wooller, and T. M. O'Hara. 2007. Variation in winter diet of southern Beaufort Sea polar bears inferred from stable isotope analysis. Canadian Journal of Zoology 85:596-608.

Microsatellite DNA and mitochondrial DNA variation in polar bears (*Ursus maritimus*) from the Beaufort and Chukchi seas, Alaska

Radiotelemetry data have shown that polar bears occur in separate subpopulations in the Chukchi Sea and the southern Beaufort Sea. However, segregation is not absolute, and there is overlap of ranges of animals in each subpopulation. We used genetic variation at eight microsatellite DNA loci and mitochondrial DNA (mtDNA) to further assess the degree of spatial structure of polar bears from the Chukchi and southern Beaufort seas. Microsatellite allele frequencies and mtDNA haplotype frequencies of bears from the southern Beaufort and Chukchi seas did not differ significantly. Lack of differentiation at both maternally inherited mtDNA and bi-parentally inherited microsatellite loci suggests that gene flow between the two areas is mediated by both sexes. The genetic data indicate that polar bears in the southern Beaufort and Chukchi seas compose one interbreeding population. However, there is considerable fidelity to ranges in each area, particularly by adult females. The combined genetic and movement data suggest that polar bears could be managed as Beaufort Sea and Chukchi Sea subpopulations of a combined Beaufort Sea and Chukchi Sea population.

M.A.Cronin, S.C. Amstrup, and K.T. Scribner. 2006. Microsatellite DNA and mitochondrial DNA variation in polar bears (*Ursus maritimus*) from the Beaufort and Chukchi seas, Alaska. Canadian Journal of Zoology 84:655-660.

Polar Bear Maternal Den Habitat in the Arctic National Wildlife Refuge, Alaska

Polar bears give birth during mid-winter in dens of ice and snow. Denning polar bears subjected to human disturbances may abandon dens before their altricial young can survive the rigors of the Arctic winter. Because the Arctic coastal plain of Alaska is an area of high petroleum potential and contains existing and planned oil field developments, the distribution of polar bear dens on the plain is of interest to land managers. Therefore, as part of a study of denning habitats along the entire Arctic coast of Alaska, we examined high-resolution aerial photographs (n = 1655) of the 7994 km2 coastal plain included in the Arctic National Wildlife Refuge (ANWR) and mapped 3621 km of bank habitat suitable for denning by polar bears. Such habitats were distributed uniformly and comprised 0.29% (23.2 km2) of the coastal plain between the Canning River and the Canadian border. Ground-truth sampling suggested that we had correctly identified 91.5% of bank denning habitats on the ANWR coastal plain. Knowledge of the distribution of these habitats will help facilitate informed management of human activities and minimize disruption of polar bears in maternal dens.

Durner, G. M., S. C. Amstrup, and K. J. Ambrosius. 2006. Polar bear maternal den habitat in the Arctic National Wildlife Refuge. Arctic 59:31-36

A Model for Autumn Pelagic Distribution of Adult Female Polar Bears in the Chukchi Sea, 1987-1994

We made predictions of polar bear autumn distribution in the Chukchi Sea with a Resource Selection Function (RSF) developed from 1198 satellite radio-collar locations on 124 adult female polar bears, 1987 – 1994. The RSF was created to assist in an aerial survey design for polar bears proposed by the USFWS. The RSF was based on bathymetry and daily sea ice covariates extracted from passive microwave satellite imagery within the pelagic region > 25 km from shore. The RSF indicated that polar bears selected habitats with intermediate amounts (~50%) of ice cover in close proximity to higher ice concentrations, and over relatively shallow waters. The RSF showed good predictive abilities for the years of its construct, worked best in October, and was robust to inter-annual variability. When evaluated with recent (1997 – 2005) data, the RSF performed well for October and November but poorly in September. This loss of predictive abilities appeared to be related to recent changes in habitat due to longer melt seasons and younger sea ice, and testing the retrospective model with a small sample of recent polar bears locations from a limited region of the Chukchi Sea. Contemporary applications of this RSF must consider three factors that could limit its utility: 1) different sea ice phenology; 2) distributions of males and sub-adults; and 3) occupancy in nearshore habitats.

Durner, G.M., D.C. Douglas, R. M. Nielson, and S. C. Amstrup, S.C. 2006. A Model for Autumn Pelagic Distribution of Adult Female Polar Bears in the Chukchi Sea, 1987-1994: Anchorage, USGS Alaska Science Center, Contract Completion Report 70181-5-N240, 67 pp.

Landward and eastward shift of Alaskan polar bear denning associated with recent sea ice changes

Polar bears in the northern Alaska region den in coastal areas and on offshore drifting ice. We evaluated changes in the distribution of polar bear maternal dens between 1985 and 2005, using satellite telemetry. We determined the distribution of maternal dens occupied by 89 satellite collared female polar bears between 137°W and 167°W longitude. The proportion of dens on pack ice declined from 62% in 1985–1994 to 37% in 1998–2004 (P = 0.044) and among pack ice dens fewer occurred in the western Beaufort Sea after 1998. We evaluated whether hunting, attraction to bowhead whale remains, or changes in sea ice could explain changes in den distribution. We concluded that denning distribution changed in response to reductions in stable old ice, increases in unconsolidated ice, and lengthening of the melt season. In consort, these changes have likely reduced the availability and quality of pack ice denning habitat. Further declines in sea ice availability are predicted. Therefore, we expect the proportion of polar bears denning in coastal areas will continue to increase, until such time as the autumn ice retreats far enough from shore that it precludes offshore pregnant females from reaching the Alaska coast in advance of denning.

Fischbach, A. S., S. C. Amstrup, and D. C. Douglas. 2007. Landward and eastward shift of Alaskan polar bear denning associated with recent sea ice changes. Polar Biology 30:1395-1405.

Polar Bear Population Status in the Southern Beaufort Sea

Polar bears depend entirely on sea ice for survival. In recent years, a warming climate has caused major changes in the Arctic sea ice environment, leading to concerns regarding the status of polar bear populations. Here we present findings from long-term studies of polar bears in the southern Beaufort Sea region of the U.S. and Canada, which are relevant to these concerns. We applied open population capture-recapture models to data collected from 2001 to 2006, and estimated there were 1,526 (95% CI = 1,211; 1,841) polar bears in the southern Beaufort Sea region in 2006. The number of polar bears in this region was previously estimated to be approximately 1,800. Because precision of earlier estimates was low, our current estimate of population size and the earlier ones cannot be statistically differentiated. For the 2001–06 period, the best fitting capture-recapture model provided estimates of total apparent survival of 0.43 for cubs of the year (COYs), and 0.92 for all polar bears older than COYs. Because the survival rates for older polar bears included multiple sex and age strata, they could not be compared to previous estimates. Survival rates for COYs, however, were significantly lower than estimates derived in earlier studies (P = 0.03). The lower survival of COYs was corroborated by a comparison of the number of COYs per adult female for periods before (1967–89) and after (1990–2006) the winter of 1989–90, when warming temperatures and altered atmospheric circulation caused an abrupt change in sea ice conditions in the Arctic basin. In the latter period, there were significantly more COYs per adult female in the spring (P = 0.02), and significantly fewer COYs per adult female in the autumn (P < 0.001). Apparently, cub production was higher in the latter period, but fewer cubs survived beyond the first 6 months of life. Parallel with declining survival, skull measurements suggested that COYs captured from 1990 to 2006 were smaller than those captured before 1990. Similarly, both skull measurements and body weights suggested that adult males captured from 1990 to 2006 were smaller than those captured before 1990. The smaller stature of males was especially notable because it corresponded with a higher mean age of adult males. Male polar bears continue to grow into their teens, and if adequately nourished, the older males captured in the latter period should have been larger than those captured earlier. In western Hudson Bay, Canada, a significant decline in population size was preceded by observed declines in cub survival and physical stature. The evidence of declining recruitment and body size reported here, therefore, suggests vigilance regarding the future of polar bears in the southern Beaufort Sea region.

Regehr, E. V., S. C. Amstrup, and I. Stirling. 2006. Polar Bear Population Status in the Southern Beaufort Sea. U.S. Department of the Interior, U.S. Geological Survey. Open-File Report 2006-1337. Available at: http://www.usgs.gov/pubprod.

Effects of Earlier Sea Ice Breakup on Survival and Population Size of Polar Bears in Western Hudson Bay

Some of the most pronounced ecological responses to climatic warming are expected to occur in polar marine regions, where temperature increases have been the greatest and sea ice provides a sensitive mechanism by which climatic conditions affect sympagic (i.e., with ice) species. Population-level effects of climatic change, however, remain difficult to quantify. We used a flexible extension of Cormack–Jolly–Seber capture–recapture models to estimate population size and survival for polar bears (Ursus maritimus), one of the most ice-dependent of Arctic marine mammals. We analyzed data for polar bears captured from 1984 to 2004 along the western coast of Hudson Bay and in the community of Churchill, Manitoba, Canada. The Western Hudson Bay polar bear population declined from 1,194 (95% CI=1,020–1,368) in 1987 to 935 (95% CI=794–1,076) in 2004. Total apparent survival of prime-adult polar bears (5–19 yr) was stable for females (0.93; 95% CI=0.91–0.94) and males (0.90; 95% CI=0.88–0.91). Survival of juvenile, subadult, and senescent-adult polar bears was correlated with spring sea ice breakup date, which was variable among years and occurred approximately 3 weeks earlier in 2004 than in 1984. We propose that this correlation provides evidence for a causal association between earlier sea ice breakup (due to climatic warming) and decreased polar bear survival. It may also explain why Churchill, like other communities along the western coast of Hudson Bay, has experienced an increase in human–polar bear interactions in recent years. Earlier sea ice breakup may have resulted in a larger number of nutritionally stressed polar bears, which are encroaching on human habitations in search of supplemental food. Because western Hudson Bay is near the southern limit of the species' range, our findings may foreshadow the demographic responses and management challenges that more northerly polar bear populations will experience if climatic warming in the Arctic continues as projected.

Regehr, E. V., N. J. Lunn, S. C. Amstrup, and I. Stirling. 2007. Effects of Earlier Sea Ice Breakup on Survival and Population Size of Polar Bears in Western Hudson Bay. Journal of Wildlife Management DOI: 10.2193/2006-180.

Post-den emergence behavior of polar bears (*Ursus maritimus*) in northern Alaska

We observed polar bear (*Ursus maritimus*) maternity den sites on Alaska's North Slope in March 2002 and 2003 in an effort to describe bears' post-den emergence behavior. During 40 sessions spanning 459 h, we observed 8 adults and 14 dependent cubs outside dens for 37.5 h (8.2% of total observation time). There was no significant difference between den emergence dates in 2002 (mean = 15 Mar ± 4.1 d) and 2003 (mean = 21 Mar ± 2.1 d). Following initial den breakout, polar bears remained at their den sites for 1.5 to 14 days (mean = 8.1 ± 5.1 d). The average length of stay in dens between emergent periods was significantly shorter in 2002 (1.79 h) than in 2003 (4.82 h). While outside, adult bears were inactive 49.5% of the time, whereas cubs were inactive 13.4% of the time. We found no significant relationships between den emergence activity and weather. Adult polar bears at den sites subjected to industrial activity exhibited significantly fewer bouts of vigilance than denned bears in undisturbed areas ($t = -5.5164$, $df = 4$, $p = 0.00$). However, the duration of vigilance behaviors at sites near industrial activity was not significantly shorter than at the other sites studied ($t = -1.8902$, df = 4, p = 0.07). Results for these bears were within the range of findings in other studies of denned polar bears.

Smith, T. S., S. T. Partridge, S. C. Amstrup, and S. S. Schliebe. 2007. Post-den emergence behavior of polar bears (*Ursus maritimus*) in northern Alaska. Arctic 60:187-194

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Appendix 1

Agreement on the Conservation of Polar Bears and Their Habitat

Oslo, 15 November 1973

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 co-ordinated national measures taken by the States of the Arctic Region;

Desiring to take immediate action to bring further conservation and management measures into effect;

Having agreed as follows:

ARTICLE I

1. The taking of polar bears shall be prohibited except as provided in Article III.

2. For the purposes 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-paragraph (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 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.

ARTICLE VIII

Each Contracting Party shall take action 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 I of this Article. Instruments of accession shall be deposited with the Depositary 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 Depositary Government by any of the Governments referred to in paragraph I 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 Depositary 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 Depositary Government has received the notification.

8. The Depositary Government shall notify the Governments referred to in paragraph 1 of this Article of the deposit of instruments of ratification, approval or accession, of the entry into force of this Agreement and of the receipt of notifications of denunciation and any other communications from a Contracting Part specifically 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 I of this Article.

10. The Depositary 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.

In Witness Whereof the undersigned, being duly authorized by their Governments, have signed this Agreement.

Done at Oslo, in the English and Russian languages, each text being equally authentic, this fifteenth day of November, 1973.

[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 emphasises that harvest management practices that select for males and young animals may aid in offering protection for adult females.

Appendix 3

Recent publications and reports 2005–2009

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Appendix 4

Numbers allocated to each country for eartags and tattoos used in polar bear management and research

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 series

37. *Best Practice Guidelines for the Prevention and Mitigation of conflict Between Humans and Great Apes* K. Hockings & T. Humle 2009 48pp
38. *Best Practice Guidelines for Wild Great Ape Tourism.* Elizabeth J. Macfie with contributions by Christina Ellis, Chloe Hodgkinson, and Marc Ancrenaz. Xxpp (not yet published, probably 2010)
39. *Guidelines for the in situ Re-introduction and Translocation of African and Asian Rhino.* Edited by Richard H Emslie, Rajan Amin & Richard Kock 125pp
40. *Indo pacific Bottlenose Dolphins (Tursiops Aduncus) Assessment Workshop Report.* Edited by R.R. Reeves and R.L Brownell Jr 61pp
41. *Guidelines for the Reintroduction of Galliformes for Conservation Purposes.* Edited by the World Pheasant Association and IUCN/SSC Re-introduction Specialist Group. 2009. 86pp
42. Invasive Species Conference Proceedings (working title) due to publish 2010
43. *Polar Bears: Proceedings of the 15th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 29 June–3 July 2009, Copenhagen, Denmark.* Compiled and edited by Martyn E. Obbard, Gregory W. Thiemann, Elizabeth Peacock and Terry D. DeBruyn. 2010. vii + 235 pp.

Many of these publications are available online on the Species pages of the IUCN website. See http://www.iucn.org/about/work/programmes/species/

Occasional Papers of the IUCN Species Survival Commission

1. *Species Conservation Priorities in the Tropical Forests of Southeast Asia.* Edited by R.A. Mittermeier and W.R. Konstant, 1985, 58pp. (Out of print)
2. *Priorités en matière de conservation des espèces à Madagascar.* Edited by R.A. Mittermeier, L.H. Rakotovao, V. Randrianasolo, E.J. Sterling and D. Devitre, 1987, 167pp. (Out of print)
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.
8. *Conservation Biology of Lycaenidae (Butterflies).* Edited by T.R. New, 1993, 173pp. (Out of print)
9. *The Conservation Biology of Molluscs: Proceedings of a Symposium held at the 9th International Malacological Congress, Edinburgh, Scotland, 1986.* Edited by Alison Kay. Including a Status Report on Molluscan Diversity, written by Alison Kay, 1995, 81pp.
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.
12. *Assessing the Sustainability of Uses of Wild Species: Case Studies and Initial Assessment Procedure.* Edited by Robert and Christine Prescott-Allen, 1996, 135pp.
13. *Tecnicas para el Manejo del Guanaco [Techniques for the Management of the Guanaco].* Edited by Sylvia Puig, Chair of the South American Camelid Specialist Group, 1995, 231pp.
14. *Tourist Hunting in Tanzania.* Edited by N. Leader-Williams, J. A. Kayera and G. L. Overton, 1996, 138pp.
15. *Community-based Conservation in Tanzania.* Edited by N. Leader-Williams, J. A. Kayera and G.L. Overton, 1996, 226pp.
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.* Richard Bodmer, Rolando Aquino, Pablo Puertas, Cesar Reyes, Tula Fang and Nicole Gottdenker, 1997, iv + 102pp.
19. *Proceedings of the Twelfth Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 3 – 7 February 1997, Oslo, Norway.* Compiled and edited by Andrew E. Derocher, Gerald W. Garner, Nicholas J. Lunn and Øystein Wiig, 1998, v + 159pp.
20. *Sharks and their Relatives - Ecology and Conservation.* Written and compiled by Merry Camhi, Sarah Fowler, John Musick, Amie Bräutigam and Sonja Fordham, 1998, iv + 39pp. (Also available in French)
21. *African Antelope Database 1998.* Compiled by Rod East and the IUCN/SSC Antelope Specialist Group, 1999, x + 434pp.
22. *African Elephant Database 1998.* R.F.W. Barnes, G.C. Craig, H.T. Dublin, G. Overton, W. Simons and C.R. Thouless, 1999, vi + 249pp.
23. *Biology and Conservation of Freshwater Cetaceans in Asia.* Edited by Randall R. Reeves, Brian D. Smith and Toshio Kasuya, 2000, viii + 152pp.
24. *Links between Biodiversity Conservation, Livelihoods and Food Security: The sustainable use of wild species for meat.* Edited by S.A. Mainka and M. Trivedi, 2002, ix + 137pp. (Also available in French)
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26. *Polar Bears: Proceedings of the Thirteenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 23 – 28 June 2001, Nuuk, Greenland.* Compiled and edited by N. J. Lunn, S. Schliebe and E. W. Born, 2002, viii + 153pp.
27. *Guidance for CITES Scientific Authorities: Checklist to assist in making non-detriment findings for Appendix II exports.* Compiled by A.R. Rosser and M.J. Haywood, 2002, xi + 146pp.
28. *Turning the Tide: The Eradication of Invasive Species. Proceedings of the International Conference on Eradication of Island Invasives.* Edited by C.R. Veitch and M.N. Clout, 2002, viii + 414pp.
29. *African Elephant Status Report 2002 : an update from the African Elephant Database.* J.J. Blanc, C.R. Thouless, J.A. Hart, H.T. Dublin, I. Douglas-Hamilton, C.G. Craig and R.F.W. Barnes, 2003, vi + 302pp.
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31. *The Status and Distribution of Freshwater Biodiversity in Eastern Africa.* Compiled by W. Darwall, K. Smith, T. Lower and J.-C. Vié, 2005, viii + 36pp.
32. *Polar Bears: Proceedings of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group,20–24 June 2005, Seattle, Washington, USA.* Compiled and edited by Jon Aars, Nicholas J. Lunn and Andrew E. Derocher. 2006. v + 189pp.
33. *African Elephant Status Report 2007: An update from the African Elephant Database.* Compiled and edited by J.J. Blanc, R.F.W. Barnes, C.G. Craig, H.T. Dublin, C.R. Thouless, I. Douglas-Hamilton and J.A. Hart. 2007. vi + 275pp.
34. *Best Practice Guidelines for Reducing the Impact of Commercial Logging on Great Apes in Western Equatorial Africa.* D. Morgan and C. Sanz. 2007. 32pp.
35. *Guidelines for Great Ape Re-introduction.* Edited by Benjamin Beck, Kristina Walkup, Michelle Rodrigues, Steve Unwin, Dominic Travis, and Tara Stoinski, 2007. 48pp.
36. *Best Practice Guidelines for Surveys and Monitoring of Great Ape Populations* H. Kühl, F. Maisels, M. Ancrenaz & E.A. Williamson 2008 36pp.