**IUCN/Species Survival Commission**
**Polar Bear Specialist Group**

To
Parties to the 1973 Agreement on the Conservation of Polar Bears,
Heads of Delegations and Circumpolar Action Plan leads

Tromsø, Norway, September 15, 2012

## Circumpolar action plan for the conservation of polar bears and their habitats – input from IUCN/Polar Bear Specialist Group to polar bear Range States

At the Meeting of the Parties to the 1973 Agreement on the conservation of polar bears in Iqaluit in October 2011, the IUCN/Polar Bear Specialist Group (PBSG), as the independent scientific adviser to the Parties, was asked to give input to specific sections of the emerging circumpolar polar bear action plan (CAP). Contributors to the CAP were each assigned according to an annotated task list agreed upon at the meeting, and the PBSG was requested to give input on the following sections:

6.4.ii Impact of research methods
7b Ensure best practice standards for polar bear management and research
9 Monitoring
9 Research

The PBSG was originally asked to submit input on section 7b by July 1 (in an email-attached letter dated February 24 from the Canadian and US CAP leads), and input to other sections by the end of August. Upon request we were given a deadline for all input by September 15. We are grateful for this courtesy, and you will find our input to the respective sections in four appendixes to this letter.

The PBSG has, after discussions, chosen to give our input in the form of fully fleshed out text, as opposed to potentially ambiguous bullet points. The members are concerned about how this text will be handled by the various CAP section leads and the editors. We provide these materials as our scientific consensus, and we prefer that consensus to be reflected unchanged in the relevant sections of the CAP and with credit to the PBSG. If our text input is changed or edited, we expect the right to review the final edits to assure accuracy and consistency with our original intent. We are aware of that our format could somehow be challenging to merge into a policy document, as the action plan obviously will be, and we anticipate that the Parties will take steps to establish an arena where such issues can be discussed with us.

We have struggled a bit with how to understand what has been requested from us, especially with respect to section 7b. We have made our best effort at meeting that request and hope our input will be considered helpful.

The PBSG has at present 24 members spread out in all five polar bear nations, six including Denmark, and it is a considerable effort for the group to produce such extensive and important input. This requires a high degree of commitment and allocation of time and resources among scientists with a variety of agendas and other commitments. Members of the PBSG are committed to help ensuring that the emerging CAP becomes a document with leverage, and we sincerely hope that input from the PBSG is and will continue to be helpful for the range-wide conservation of polar bears and their habitat.

This input will be posted at the PBSG website (http://pbsg.npolar.no).

Sincerely yours,

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APPENDIX 1:
Input to Circumpolar Action Plan section 6.4.ii: Effects of handling on polar bears

# An assessment of possible effects on polar bears of being handled for research: a report prepared for the Polar Bear Range States

Prepared by the IUCN/Polar Bear Specialist Group
September 15, 2012

## Introduction

At the 2011 Meeting of the Polar Bear Range States in Iqaluit, Nunavut, the PBSG was asked to provide a review of the possible effects of immobilization and handling of polar bears for research. This brief report summarizes some of what is known from studies conducted to date and identifies ongoing analyses that have not yet been completed.

The possibility that immobilization and handling of polar bears for research might have negative effects on the animals has been a concern to both scientists and Inuit hunters since large-scale mark-recapture studies for population assessment began over 40 years ago. If handling of the bears were to significantly change any important aspect of their biology, then the value of the results of such studies to conservation and management might be in question.

Currently, immobilization and handling of polar bears occurs for three primary kinds of research or management purposes.

1. Population Assessment. Overall, physical mark-recapture has been the most widely used method for assessing the size and status of polar bear populations. It requires immobilization of large numbers of individual animals that are tagged, released, and subsequently recaptured. While animals are immobilized, biological specimens and measurements can be collected that facilitate detailed analyses of body condition, reproduction, age structure, survival rates, genetics, contaminants, and other aspects of polar bear biology that cannot be determined in any other way and which can provide important information on population health and status. It is also important to note that most jurisdictions and universities undertaking polar bear research undergo rigorous evaluations by Animal Care and Use Committees, as well as extensive permit review processes by federal agencies responsible for managing polar bears.

2. Movement Studies. Polar bears are immobilized and handled in a similar manner as for population assessment. Satellite collars are fitted around the neck of individuals to facilitate the study of movements and use of different habitat types. Collars may be worn for one or more years dependent on transmitter configuration and project objectives. Historically, collar retrieval required that the animal be immobilized. However, since 2008, collars have been deployed with release mechanisms that open on a pre-programmed date. The collar then drops off and is recovered without the need to recapture the animal

3. Polar bears are also handled for management purposes in several regions; most significantly, by the Polar Bear Alert Program, in Churchill, Manitoba. Each year, substantial numbers of polar bears enter or come close to the town of Churchill, MB, on the western

coast of Hudson Bay. Individual bears that are thought to be a threat to human life or property are immobilized and moved to a secure holding facility for periods of up to several weeks. Some animals are released with the use of a truck and trailer, which does not necessitate a second immobilization whereas others are drugged again to facilitate being moved safely in a cargo net beneath a helicopter prior to being released.

The primary concerns expressed by Inuit, scientists, and managers have been with respect to whether the bears captured for population studies and/or the deployment of radio collars are negatively affected in some way as a consequence of being immobilized by drugs injected remotely from a helicopter. There are two broad categories of possible effects to consider:

1) short-term effects on health or behavior (including movements) that have no detectable long-term influences on critical aspects such as survival or reproductive success;

2) measureable long-term negative effects on survival or reproductive success as a consequence of being immobilized and handled.

## Results and Discussion

<u>Safety of drugs used for immobilization</u>

For about 25 years, most polar bears have been immobilized with Telazol® (an equal mixture of tiletamine HCl and zolazepam HCl) (Stirling et al. 1989) which is available under the trade names Telazol® or Zoletil®. A small number of bears have also been immobilized with other drug combinations such as xylazine and Telazol (XZT) or medetomidine and Telazol (MZT) to test their effectiveness and safety (Cattet et al. 1997, Cattet et al. 2003, Cattet et al. 2010). Telazol is an extremely safe drug and has several advantages over alternative agents including: full immobilization with a single injection; a wide range of tolerance to over- and under-dosing; maintenance of high respiratory rates that allow bears to thermoregulate while immobilized; and a low mortality rate (< 1 per 1000 captures; Messier 2000). Drug combinations such as XZT and MZT may have additional advantages including the ability to immediately reverse the effect of the drug and to be delivered in lower volumes (Cattet et al., 1997).

Although a very small number of mortalities resulting from handling have been reported, these have usually involved secondary aspects such as drowning. The record of Telazol® or Zoletil® with respect to both the safety of the bears and the biologists is well established through thousands of successful and safe capture of all species of ursids.

*Safety of eating meat from previously immobilized polar bears*

Another concern raised by Inuit hunters was whether the meat of bears that had been immobilized was safe to eat. Based on the results of a detailed technical study (Semple et al. 2003), Health Canada initially recommended not eating meat for a year after handling but in 2009 revised the timeline for safe consumption down to 45 days. Health Canada also required that any bear that had been immobilized be identifiable with a numbered ear tag. A detailed study of retention time of Telazol in American black bears (Ryan et al. 2009) suggested that bears metabolize Telazol quickly and it is essentially undetectable in tissue within a few days, and provides supportive information for the Health Canada decision related to polar bears. In Alaska, guidance for consuming polar bears immobilized with

Telazol® is based on the recommendations of state wildlife veterinarians that the meat of brown and black bears immobilized with Telazol® is safe for consumption after 14 days.

## Short-term effects of capture

### *Injuries associated with darting*

The live capture of free-ranging animals invariably involves some risk of injury. The chemical immobilization of polar bears via remote injection of Telazol® in a dart fired from a helicopter will result in at least minor bruising at the site of injection, more markedly with fast-injecting darts (Cattet et al. 2006). One of the disadvantages of Telazol® is the relatively large volumes of drug that are required to achieve immobilization, with adult male polar bears receiving up to 10 ml in the initial dart. Large, heavy darts can cause more serious injuries including hematomas at the injection site, as well as potentially fatal trauma if the dart inadvertently strikes the head, spine or punctures the abdominal cavity. Nevertheless, the incidence of significant injury associated with the chemical immobilization of polar bears is very low (Messier 2000). One advantage of some other drug combinations (e.g., XZT, MZT) is that the volume of injected drug, and therefore the dart size and resultant hematoma, is much smaller. For example, adult male polar bears can be immobilized with 7 ml of XZT or 5 ml of MZT. In addition, slow-injection darts can be used more readily with smaller volumes.

### *Assessments of the effect of radio or satellite-tags*

In the early to mid-1980s, early prototypes of satellite radios were attached to bears using a harness (Schweinsburg and Lee, 1982). In a preliminary behavioral study conducted as part of the long-term study of undisturbed behavior of polar bears at Radstock Bay, Nunavut, Taylor (1986) compared the behavior of 5 adult females with harnesses and 8 non-harnessed individuals. The duration of observations of both groups was preliminary and limited but, importantly, it was noted that within a few hours of recovery from immobilization, the bears showed no sign of being aware of the harnesses. Most importantly, there was no indication that the harnesses had a negative effect on the ability of bears to continue hunting. Harnessed bears killed 0.08 seals/hour of hunting vs. 0.09 seals/hour of hunting for non-harnessed bears. Some, apparently limited, signs of wear from the harnesses were reported from bears captured a year later but available information is limited. However, harnesses were soon replaced by radio collars and have not been used since.

Deployment of both VHF and satellite-linked radio collars as single units on adult female polar bears has been a standard method used throughout the circumpolar Arctic (e.g., Messier et al. 1992; Amstrup et al. 2000).

Satellite and radio collars can cause cuts behind the ears and hair loss, especially when bears become obese while feeding at persistent dumps of bowhead whale carcasses left by hunters. In an effort to reduce the use of collars and to also track male polar bears, researchers have developed and deployed satellite ear tags and glue-on tags. Ear-tag radios have been used with mixed-success (Amstrup et al. 2001; E. Peacock, E. Regehr, E. Born, unpublished data). Recent use of a new satellite ear tag shows promise for tracking of movements < 3 months (Born et al. 2010; USGS, USFWS unpublished data), however some tags have torn ear pinnae. Glue-on tags show promise due to their non-invasive nature and for tracking longer durations of movement if deployed in autumn; however these tags fall off during molt, rendering spring-deployed tags less useful (USGS, unpublished data).

*Post-capture movement rates*

In a detailed analysis of the movement rates of collared females in three subpopulations, Thiemann et al. (unpublished) reported that 68.9% (51/74) ) resumed normal movement rates within 3 days of capture, 24.3% (18/74) within 3-12 d and 6.8% (5/74) within 17-21 days. Bears showed individual variability in their recovery patterns although all gradually increased their movement rate over time. There were also some differences in the amount of individual variability exhibited by bears in the different study populations. The authors concluded that immobilization and collaring of free-ranging polar bears had little effect on their subsequent behavior. A more detailed report is in the final stages of preparation.

*Behavior of handled versus unhandled free-ranging polar bears*

Between 1974 and 1993, the behavior of undisturbed polar bears was quantified at Radstock Bay by observing them for extended periods from cliff-top camps using telescopes (Stirling 1974). During that study, several bears were immobilized and their fur marked with numbers or patterns to facilitate identification after recovery so their behavior could be compared with that of bears of the same sex and age classes that had not been handled. Some data on hunting behavior relevant to management issues have been analyzed and published (Stirling and Latour 1978; Stirling and Øritsland 1995) but analyses of other aspects have yet to be completed. However, the overall impression of experienced observers at the time was that the behavior and hunting success of bears was not negatively affected by immobilization and all bears returned to hunting shortly after recovery and continued to hunt successfully in the same area. Furthermore, from the longer-term studies of individually marked animals, it was clear that they continued to come back to the same areas year after year despite, in some cases, having been caught there several times. (In fact, the fidelity of individual polar bears to the same areas in the same seasons has been documented everywhere that polar bears have been studied.)

*Post-capture movements of pregnant female polar bears immobilized while in their dens in the autumn*

Lunn et al. (2004) deployed satellite radio collars on adult female polar bears in western Hudson Bay in August and September to evaluate whether human disturbance might cause pregnant female polar bears to move from den sites they had already chosen or possibly abandon them. To eliminate the possibility that being handled while pregnant and seeking a maternity den might influence their choice of a suitable site, the collars were attached to females accompanied by yearlings, a full year before the females were expected to select dens. The locations of the pregnant females after coming ashore were known from the radio collars so those areas were avoided by helicopters in order to not disturb the bears and possibly influence their behavior. The results indicated that undisturbed pregnant females moved inland and selected an area to den shortly after coming ashore in the summer and remained there if they were not subsequently disturbed by being immobilized. In contrast, bears that were disturbed at their dens moved to a different den site. In an earlier study, 10 of 13 pregnant females handled at dens in October or November abandoned them soon after being captured and moved a median distance of 24.5 km (Ramsay and Stirling 1986). Data from the cubs of undisturbed bears were compared to those captured at dens in autumn of the previous 24 years (1979–2002) to examine whether disturbance of pregnant females affected the litter size or mass of their cubs the following spring. There were no differences in the litter size of male or female cubs or in the mass of male cubs. However, females handled in the autumn had significantly lighter female cubs than females that were not handled. It is not known whether disturbance in late October or early November, closer to the time when cubs are born, might have a different effect. Regardless, in response to this study, females in their maternity dens in the fall on the western coast of Hudson Bay are no longer handled at that time of year.

*Evaluation of longer-term effects of capture on individual health, reproduction, and survival*
Ramsay and Stirling (1986) evaluated the long-term effects of immobilizing and handling free-ranging polar bears on body weight, reproductive effort, cub survival, and movements on land. Between 1967 and 1984, 2,246 bears (≥1 year old) were handled on 2,899 occasions, and 445 cubs-of-the-year were handled at least once. Bears were stratified for analyses by sex, age, reproductive status, and season. Comparisons of mean body weight were made between bears never before captured and those handled on during at least one previous year or season. Significant differences ($P < 0.05$) were found only for 2 categories of age, reproductive, or seasonal strata. One exception was 2-year-old males, which were heavier on recapture than they were on initial capture. A second exception was adult females with cubs captured in spring (February through May), which were heavier the first time they were caught than they were on later recaptures. Mean weights of 2-3-month-old cubs and mean litter sizes of 1-, 2-, and 3-year-old young did not differ between the first capture and recaptured mothers. However, recaptured adult females showed a consistent trend toward smaller litters and lighter cubs. Furthermore, 10 of 13 pregnant females handled at dens in October or November abandoned them soon after being captured and moved a median distance of 24.5 km. For most of the parameters that could be measured, for all age and sex classes of polar bears, the long-term effects associated with capture were small and seemingly negligible in a time frame measured in months or years.

Since the study by Ramsay and Stirling (1986) was completed, it has become apparent that the date of breakup of the sea ice in western Hudson Bay has advanced by over 3 weeks since the early 1980s. Furthermore, Stirling et al. (1999) documented a significant positive correlation between the condition of polar bears and date of breakup (i.e., the earlier the breakup of sea ice, the poorer the condition of the bears). Consequently, the differences in weights of adult female bears between handlings reported by Ramsay and Stirling, and the decline in weights of cubs reported by Lunn et al. (2004) were more likely related to factors associated with a changing environment and not to previous handling by researchers. Derocher and Stirling (1995) detected these declines in the body mass of polar bears in western Hudson Bay in the 1990s and found no difference in the rates of decline between bears with and without a history of capture.

Messier (2000) reviewed information from 3237 immobilizations of polar bears with Telazol, including many recaptures of the same individuals in subsequent years following their initial capture. He conducted 25 independent analyses of the long-term effects of tagging; 24 of these analyses showed no measurable effects. Similarly, he conducted 29 independent analyses to test for measurable effects of radio collaring; 27 showed no effects, one suggested a positive effect and one suggested a negative effect. He concluded that, overall, the long-term effects of tagging and radio-collaring polar bears were either not measurable or negligible.

Amstrup (1993, Table 1) compared the litter size and physical size of cubs from a substantial number of bears that had been handled (some several times), some with radio collars, in the southern Beaufort Sea to litters from females that had never been handled before. He found no evidence that being captured influenced either litter sizes or the physical size of cubs. Rode et al. (2007) also examined the potential effect of capture on the body condition of polar bears of all sex and age classes in the southern Beaufort Sea. Approximately 100 bears were captured each year between 1982 and 2006, including 23% that were captured at least twice during the study and 19% that were captured three times or more. There was no difference in the body mass or body condition index of bears captured more than once versus those captured once only. Similarly, the body mass and skull size of cubs-of-the-year and yearlings were the same for females captured once only and those captured twice or more. These results suggest that bears are able to compensate for any short-term loss in foraging opportunity and that the capture and immobilization process does not have an impact on bear health.

During a population study of polar bears in Davis Strait, where the largest number of polar bears ever captured for such a study occurred, Peacock (unpublished data) found no difference in the body condition of adult females captured once, twice, or three times and the number of times a mother was caught did not affect the size of her litter in the following year.

Most recently, Lunn (unpublished data) has analyzed long-term data from western Hudson Bay to examine trends in body condition, survival, and reproductive parameters. As part of that analysis, he also compared values for bears re-captured over a series of years with those for bears with no previous history of capture. There were no significant differences. Thus, it can be concluded that declines in the parameters measured are statistically related to the progressively earlier breakup dates in western Hudson Bay, and are not due to the handling of animals. In southern Hudson Bay, where polar bears were handled for population studies in the 1980s and then not again until 20 years later in the 2000s, there was a similar decline in the body condition of bears of all age and sex classes (Obbard et al. 2006), further indicating that environmental factors, not handling for research, is responsible for these changes.

**Conclusions**

Careful analyses that test hypotheses about possible negative impacts on polar bears of being immobilized, tagged, collared, and sampled by researchers is an important topic to undertake. Although this report is preliminary and will be augmented by further development and quantification of results to provide additional depth and detail on several different aspects, it is important to note there is no evidence to suggest any serious negative effects on polar bears resulting from research.

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APPENDIX 2:

Input to Circumpolar Action Plan section 7b: Ensure best practice standards for polar bear management and research

## Ensuring best practice standards for polar bear research and monitoring

Prepared by the IUCN/Polar Bear Specialist Group
September 15, 2012

Best practices are those that represent the most effective and efficient way of completing a task using repeatable and proven procedures. In the context of polar bear research and monitoring, this includes identifying cost-effective study plans that address identified information needs in a timely fashion, and produce reliable and accurate results. Research and monitoring are often interpreted in variable ways. For the purpose of this section, research is defined as investigations that further our understanding of how polar bears interact with their environment and the key mechanisms affecting individual and population ecology and trends. This information is used to inform management decisions and actions. Monitoring is defined as investigations that repeat the same observations or data collections in order to determine 1) the direction of long-term responses to environmental conditions, 2) whether the response of polar bears to key processes proceeds as projected, and 3) whether management actions undertaken (as a result of research) for polar bear conservation have achieved the intended goal or objective.

For polar bears, the activities undertaken to research and monitor a subpopulation often have been one and the same. For example, population studies often involve ecological aspects that address how environmental change might affect polar bear reproduction and survival, as well as estimates of population growth or size under various harvest regimes. The threat of climate change to polar bears, however, is likely to result in a need for nearly continuous long-term monitoring which may not be cost-effective or practical for most subpopulations. Thus the best practices for monitoring the success of management actions may be to consider alternative approaches to the traditional focus on estimating population size and growth rate. Several documents, including a proposed circumpolar monitoring plan (Vongraven et al. in press) provide some alternative biological indicators and metrics for assessing population status. In addition, advances in conservation science offer some alternatives, including guidance for adaptive management approaches and the use of threats-based assessment, for monitoring. Thus, future research and monitoring efforts might be more separate than the combined research and monitoring efforts that have occurred to date. Careful consideration of the different roles of research (to address information gaps and better understand causal links) and monitoring (to determine the effectiveness of management actions and accuracy of projections) will be needed. The following sections broadly outline some best practices for approaching research and monitoring activities.

### Communication between managers, researchers, and local communities

Best practice standards for polar bear research and monitoring rely upon effective communication networks between managers, researchers, and the people affected by their activities. In the case of polar bears, local communities that are largely inhabited by Native people can be affected both by research activities and the consequences of management actions and decisions. Not all research that is conducted is in response to a specified management need and therefore may not require close coordination, but responding to management needs is a high priority for most research organizations. Research and management priorities should be developed in consultation with the various user groups and organizations and communicated to local communities. This is especially relevant when activities of researchers have direct effects on resource users such as polar bear hunters, who, in turn, have a direct effect on polar bear conservation.

Many polar bear subpopulations or groups of subpopulations within the same jurisdiction are managed via decisions made by a management body with support from a separate science or technical group. For example, the Polar Bear Administrative Committee (PBAC) of Canada consists of polar bear managers who make management and policy decisions based on, and supported by, input from technical experts on the Polar Bear Technical Committee (PBTC). Similarly, the US-Russia Polar Bear Commission makes management decisions about the Chukchi Sea polar bear subpopulation with input from a scientific working group, similarly consisting of technical experts including federal, state, and local scientists and experts in traditional ecological knowledge. On an Arctic-wide scale, the technical input of the PBSG to the Range States make this model similar in all polar bear subpopulations, albeit with different intensities of management and research among subpopulations (Vongraven et al. in press).

However, communication between managers and researchers is most effective when: 1) managers articulate to researchers the information they need to support and move forward with management decisions, 2) researchers respond with study plans that have undergone peer-review and incorporate rigorous and well-developed methodologies, and 3) results from research studies and their implications for management are effectively communicated to management bodies, including those that represent local resource users. Because polar bears are long-lived species and are logistically challenging to study, managers need to anticipate, to the best of their ability, the information they may need in the future to address conservation issues.

**Research proposal development**

The best research proposals are those that are thoroughly peer-reviewed by several internal and external (outside the agency or organization conducting the work) technical experts and, at least conceptually, vetted with stakeholders prior to initiation. Proposals should include a statement of the information need, how the research will satisfy the information need, what data are required to address the questions, methods of how the data will be collected (i.e. field methods), how the data will be analyzed (i.e. statistical methods), and the expected outlet of the research results and conclusions. Involvement of stakeholders at the stage of proposal development ensures local input into study needs and design, and encourages understanding and support of research activities and the management actions that might result from research conclusions, especially if community concerns or traditional knowledge can be incorporated. Consulting with local communities early in the process of proposal development also promotes mutual respect between scientists and northern residents. Communication prior to initiation of field work is necessary to avoid conflicts with subsistence or other community activities and to re-iterate research objectives and purpose.

**Development of range-wide approaches to polar bear research and monitoring**
Several documents have been developed recently that summarize and provide recommendations on improving methodologies for researching and monitoring polar bears, including how to incorporate traditional ecological knowledge (TEK) (Peacock et al. 2011) at the proposal stage. Peacock et al. (2011) also provides specific recommendations on what type of information can be used, in addition to subpopulation inventories, to inform management decisions.

Vongraven et al. (in press) proposes a circumpolar monitoring framework for polar bears with recommendations on methodological approaches to monitoring subpopulation abundance and trend, reproduction, survival, ecosystem change, human-caused mortality, human-bear conflict, prey availability, health, stature, distribution, behavioral change, and the effects that monitoring itself may have on polar bears. The PBSG also drafted a section on key research elements as a separate section of this Range-wide conservation strategy and action plan. These documents are comprehensive sources of the potentially best practices for studying polar bears and can be used by researchers for consideration in the proposal development stage.

**Inter-jurisdictional exchange of research-based management and monitoring practices**
Although communication networks that allow information exchange are established between managers and researchers within most polar bear jurisdictions, they do not necessarily facilitate the exchange of information among jurisdictions. There are some exceptions to this, for example, US Department of Interior managers and researchers participate in the annual Canadian Polar Bear Technical Committee meeting. Exchange of information on subpopulation status and polar bear research efforts also occurs among the Range States through the PBSG which meets every 3-5 years. To promote exchange of information on the application of research to management decisions and subsequent monitoring efforts between jurisdictions; each jurisdiction should ensure that documents are created that outline management decisions and the information used to inform those decisions, and that these documents are made available to other jurisdictions and the public. A single public outlet may best serve this function where documents outlining management decisions, the research and other information used to inform decisions, and proposed monitoring can be made available. This could take the form of a website shared by the Range States or within the existing PBSG website structure (see: http://pbsg.npolar.no/en/methods/index.html). At a minimum, websites or other outlets where information is available for each jurisdiction should be used to promote exchange regarding practices for incorporating research into management decisions and subpopulation monitoring. For example, the US-Russia Commission is developing a website that will include postings of all proceedings from Commission and Scientific working group meetings. This approach ensures transparency, helps communicate decisions to the public, and clearly demonstrates how the available science was integrated with other considerations (e.g., cultural, economic, etc.) in making the management decisions.

**Information exchange and cooperation on range-wide polar bear research and monitoring**

The PBSG is the primary means by which range-wide information is exchanged on research and population monitoring of the 19 polar bear subpopulations (see: http://pbsg.npolar.no/en/index.html). Cooperation on research and monitoring is also facilitated by existing agreements between Range States that share subpopulations. However, with the exception of genetic and contaminant studies, most polar bear studies focus on a single subpopulation and are not circumpolar in nature. Studies of subpopulations that are shared between Range States and studies that take a regional approach to understanding polar bear ecology and population dynamics will be most successful if they involve collaboration of all relevant jurisdictions. Researchers should focus on the biological population or ecological region that best addresses the study questions. Agencies and organizations can facilitate polar bear cross-boundary and multi-population polar bear studies by prioritizing funding (and cost-sharing where applicable) for projects that incorporate this approach.

**Compiling and communicating study results**

The best outlet for information to support management decisions will be of a quality that facilitates publication in peer-reviewed journals. Ensuring that research results are published guarantees the highest level of scrutiny of data analysis and interpretation. However, delivery of published research to the management community might require a different format for effective communication. Researchers should be encouraged to not only publish research but also to provide study results in a less technical format, such as an oral presentation, fact sheet, or reports on a web site. These outreach materials should provide details about study results and approaches that are relevant to the intended audience, such as managers, the general public and key stakeholders.

Although publication is the gold standard for research that should be used to support management, the pathway to publication in scientific journals often can be long. In contrast, management needs are often immediate. When information needs are immediate, non-published peer-reviewed reports can be created in a more timely fashion than the publication process. For example, this approach was used by the USGS to provide new analyses on the current and projected status of polar bear populations in response to climate change to inform the Secretary of the Interior in his decision on whether to list polar bears as Threatened under the US Endangered Species Act (see: http://www.usgs.gov/newsroom/special/polar_bears/). Other management agencies, such as the Government of Nunavut, puts unpublished research reports on line after internal review and editing. Regardless of how information reaches managers, stakeholders and the public, peer-review is essential before release of research findings. It is important that researchers acknowledge the degree to which their work has been peer-reviewed and therefore, the degree to which it may be appropriate to consider the results in management decisions. For example, study results that are presented at conferences and professional meetings do not have the same level of peer-review as publications or peer-reviewed reports; the results can be preliminary and subject to change.

**Monitoring of management actions to ensure goals are achieved**

The primary way the efficacy of management actions are currently monitored, to ensure that actions achieve their goals, is through population monitoring. This takes the form of either repeated population estimates that give an indication of the trend of the subpopulation (e.g., from aerial survey), or via estimation of survival and reproduction which allows estimation of population growth rate (Vongraven et al. in press). This type of monitoring is typical and appropriate in response to the primary management action that has occurred for polar bear subpopulations to date: harvest management. However, many polar bear subpopulations are so difficult to study and access that estimation of population trend is highly problematic. Additionally, future management actions for all polar bear subpopulations will need to integrate an objective that maximizes long-term population persistence in the face of chronic loss in sea ice habitat resulting from climate warming (Peacock et al. 2010, 2011). Because long-term, continuous population monitoring is an expensive endeavor even for the most easily studied populations, alternative approaches to assessing the success of management actions may need to be considered.

Regardless of method, monitoring management success needs to include indicators that are measurable, precise, consistently used, and sensitive to the metric being tracked. At the same time, monitoring methods must also be feasible and cost-effective (Margoluis and Salafsky 1998). Unfortunately, the traditional indicators used to monitor the success of management actions for polar bears (e.g., mark-recapture population estimates) rarely fit this description. However, recent developments within the field of conservation science provide important new and relevant ideas for monitoring the success of management actions. For example, one proposed alternative approach is to focus on assessing changes in threats, rather than changes in a population or species, over time (Salafsky and Margoluis 1999). It can be helpful to define management goals as not only maintaining or attaining a certain biological state that becomes the objective of monitoring (information which can be difficult data to obtain), but also as reducing both current and future threats. For example, if the management objectives are to alter harvest regimes, reduce human-bear conflicts on land, or to further consider the effects of sea ice loss on other management strategies, then harvest monitoring, quantification and collection of data on human-bear interactions, and monitoring of changes in sea ice habitat through satellite data can provide measurements for assessing these threat factors to populations.

Monitoring of threats should not replace traditional population monitoring, but rather be used in situations where population monitoring is not possible, or in addition to longer-term population monitoring when feedback on the success of management actions requires a faster turnaround than can be achieved through population monitoring. Using an adaptive-management approach wherein managers help monitoring threats may benefit by inclusion of management personnel who are trained as applied researchers (Salafsky et al. 2002). To be effective, an adaptive management approach does require subsequent monitoring to assess the effects of the management change.

One key aspect of monitoring is to balance effectiveness in obtaining the required data with efficient use of available resources (Reynolds et al. 2010). This is an iterative process that involves identifying what data can be feasibly and accurately collected, the likely precision and costs to obtain those data, and the degree to which the resulting information will address management needs. Dialogue, between researchers and managers, helps in determining whether alternative response metrics may need to be considered (Reynolds et al. 2010).

Long-term monitoring should be an objective of polar bear management for all polar bear subpopulations, in light of current and projected loss of sea ice habitat. In cases where long-term monitoring of the status of a subpopulation is needed, other considerations need to be made, including repeatability, standardization of protocols, and reducing inter-observer bias (Oakley et al. 2003; Beever and Woodward 2011). It is especially important that if monitoring strategies change over time, they are calibrated against each other to assure long-term comparability of data. Inconsistent protocols and inter-observer bias have the potential to affect analysis of long-term data sets collected on polar bears. For example, condition scores and other morphometric measures are subject to inter-observer bias if an effort is not made to standardize these procedures. Identifying the need for a long-term monitoring plan and developing standardized, repeatable, methodologies that are feasible in the face of variable funding levels is critical to effective world-wide polar bear conservation (Beever and Woodland 2011).

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APPENDIX 3:
Input to Circumpolar Action Plan section 9: Monitoring

## Polar bear monitoring

Prepared by the IUCN/Polar Bear Specialist Group
September 15, 2012

***The input to the circumpolar action plan is the entire framework as given in Vongraven et al. (in press). We submit an introductory outline, in large part taken from the monograph, that could be included in the CAP for brevity.***

The lack of comparable monitoring data across the range of the polar bear has long been recognized. Conservation risks resulting from this lack of data were low when the habitat for polar bears appeared to be relatively stable. When managers felt able to assume adequate habitat to support healthy polar bear subpopulations, each jurisdiction could prioritize its local concerns (e.g., harvest quotas or oil and gas permitting) over regional or global concerns. For example, if allowed harvest levels in one subpopulation were found to be excessive, managers could re-adjust their strategies to bring their local areas back into balance with what they thought the habitat could sustain. Status descriptions of individual polar bear subpopulations over the last decade illustrate this management paradigm (Lunn et al. 2002, Aars et al. 2006, Obbard et al. 2010).

Vongraven et al. (in press) describe a framework for an integrated circumpolar monitoring plan to detect ongoing patterns, predict future trends, and identify the most vulnerable polar bear subpopulations. They recommend strategies for monitoring subpopulation abundance and trend, reproduction, survival, ecosystem change, human-caused mortality, human-bear conflict, prey availability, health, stature, distribution, behavioral change, and the effects that monitoring itself may have on polar bears. They assigned monitoring intensity for each subpopulation through adaptive assessment of the quality of existing baseline data and research accessibility. A global perspective is achieved by recommending high intensity monitoring for at least one subpopulation in each of four major polar bear ecoregions. Collection of data on harvest, where it occurs, and remote sensing of habitat, should occur with the same intensity for all subpopulations. They outlined how local traditional knowledge may most effectively be combined with the best scientific methods to provide comparable and complementary lines of evidence. They also outline how previously collected intensive monitoring data may be sub-sampled to guide future sampling frequencies and develop indirect estimates or indices of subpopulation status. Adoption of this framework will inform management and policy responses to changing worldwide polar bear status and trends.

There is great variation in accessibility, existing available information, and probability of gathering future information among subpopulations. Ideally, a monitoring plan should identify basic and easily-collected metrics for each monitoring element that can be reasonably, realistically, and comparatively measured in all or most subpopulations. Such metrics must provide sufficient power and resolution to reveal changes in polar bear status at the ecoregion or circumpolar level. For subpopulations that are more accessible or for which substantial data already exist, monitored metrics can provide more statistically robust assessments of status and trend than others. In subpopulations where research access is good and resources are available it is important to continue research on ecological relationships and causal mechanisms that determine trends.

Vongraven et al. (in press) recommends high-, medium-, and low-intensity levels of population-level research and monitoring for polar bear subpopulations. The high intensity subpopulations are the Barents Sea and the Southern Beaufort Sea subpopulations in the Divergent ecoregion, the Norwegian Bay Convergent (former Queen Elizabeth) suggested subpopulation in the Convergent ecoregion, the Lancaster Sound and the Norwegian Bay subpopulations in the Archipelago ecoregion, and the Western Hudson Bay subpopulation in the Seasonal Ice ecoregion. These assignments are based on the level of existing knowledge (e.g., quality of baseline data sets, availability of TEK), accessibility for science-based methods, and CBM for each subpopulation of polar bears.

Although several assessments have provided evidence for the threat of climate warming to polar bears, we also summarize direct effects of harvest, poaching, industrial activity (including marine and terrestrial exploration and development, and ice-breaking), and pollution. We also recommend annual harvest monitoring, CBM, and the collection of TEK to occur at intensities commensurate with community access (these levels of intensity may not be the same as intensities recommended for population-level scientific research).

Metrics in the medium- and low-intensity sampling areas must be measured in a way that maximizes their comparability with the more intensively monitored subpopulations within each ecoregion. Trends at the global level can be estimated by amalgamation of information from each ecoregion. A high-intensity program should also be developed in parts of the Convergent Sea Ice Ecoregion, which is predicted to be a future refugium for polar bears under current scenarios of climate warming (Durner et al. 2009).

It is recommended that estimates of subpopulation size and assessments of trend for subpopulations monitored at high-intensity be developed at intervals no longer than five years. However, power analyses of data from subpopulations with long time series of population estimates may help further clarify the optimal length of intervals between study efforts. It is also suggested that subpopulations designated as medium-intensity be monitored in an adaptive framework based on threats and information needs. Low-intensity monitoring is primarily for those subpopulations where research access is difficult. However, this designation does not imply that these subpopulations do not have high levels of threats or that monitoring of them might not be valuable should funding be available.

The future changes in ecosystems and habitats are likely to be so rapid and severe that existing monitoring schemes will not adequately reveal trends. Therefore, an adaptive framework should be applied to the subpopulations designated for medium-intensity monitoring. Adaptive monitoring "provides a framework for incorporating new questions into a monitoring approach for long-term research while maintaining the integrity of the core measures" (Lindenmayer and Likens 2009:483). This implies that subpopulation monitoring frequency and intensity will be modified as needed, based on the assessed threat level, or other factors influencing the well-being of subpopulations. Assessment of threat levels and means to monitor those threats must be undertaken regularly.

For this monitoring framework to have long-term utility, we must measure its success. We call for a periodic examination, made available to the public and the Parties to the Agreement, of what monitoring has been conducted relative to the overall framework recommended in this plan. As new results become available, the plan should be refined and revised, including reassessment of ecoregional and monitoring-intensity designations. Further details on the monitoring framework is given by Vongraven et al. (in press).

The peer-reviewed monograph will be distributed to the Parties once it has been printed, probably by the end of September 2012.

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APPENDIX 4:
Input to Circumpolar Action Plan section 9: Research

## Circumpolar priorities for research on polar bears

Prepared by the IUCN/Polar Bear Specialist Group
September 15, 2012

At the Meeting of the Polar Bear Range States in Iqaluit, Nunavut, in October 2011, the PBSG was asked to identify priorities for research on polar bears. This has been interpreted by the PBSG to mean priority research for polar bears throughout their range. Thus, issues of immediate management concern to a particular jurisdiction, such as a status assessment of a particular subpopulation for harvest or environmental impact assessment are being considered as national, not circumpolar priorities and therefore, not included in this list.

Members of the PBSG recently took part in the completion of a large scale review of the monitoring priorities for polar bears, by ecoregion, for the entire Arctic (Vongraven et al. in press). To a fairly substantial degree, there is overlap between "monitoring" and "research" (see Appendix 2). In many cases, the results from analyses of the same systematically collected data set can be used for both objectives. A fairly common example of this overlap is the systematic collection of data from a specific population on status, demographics, reproduction, and body condition. Analyses of such data are used to monitor population status, recruitment, or survival rates for the purpose of ensuring sustainable harvest. The same data set might be used in a research context to test hypotheses on changes in reproduction or recruitment in relation to changes in environmental conditions.

Thus, for this report, the PBSG is broadly recommending priority areas of research. The methodological approaches that would likely be used to address these research topics are described in detail in the monitoring framework monograph (Vongraven et al. in press). Consistent with Vongraven et al. (in press), we recommend strategies for monitoring subpopulation abundance and trend, reproduction, survival, ecosystem change, human-caused mortality, human-bear conflict, prey availability, health, stature, distribution, behavioral change, and the effects that monitoring itself may have on polar bears.

The following is a brief overview of priority research needs:

### *Research on the effects of climate change*

- *Quantification of the effects of climate warming on polar bears and their habitats throughout their range*

Climate warming is causing unidirectional changes to annual patterns of sea ice distribution, structure, and freeze-up. Viable polar bear populations can only be maintained if sea ice is available as a platform from which to hunt seals for long enough each year to accumulate sufficient energy (fat) to survive periods when seals are unavailable. Less time to access prey, because of progressively earlier breakup in spring, when newly weaned ringed seal (*Pusa hispida*) young are available, has been observed to result in longer periods of fasting, lower body condition, decreased access to denning areas, fewer and smaller cubs, lower survival of cubs as well as bears of other age classes and, finally, subpopulation decline toward eventual extirpation (see recent review by Stirling and Derocher 2012). However, for many populations, there is uncertainty concerning short- and mid-term responses to sea ice loss. Because populations with similar sea ice dynamics and life histories are likely to exhibit similar responses to sea ice loss, it is critical that monitoring occur in representative portions of the polar bear's circumpolar range. This need has been emphasized in the circumpolar monitoring framework for polar bears (Vongraven et al. In Press). Information on the effects of sea ice loss on survival and reproduction are particularly critical in populations where harvest or other predictable on the ground human effects may occur. Additionally, effects of habitat loss on polar bear distribution are important to managing bear-human interactions. Because the manner in which climate change affects polar bears throughout their range, and the time lines for projected changes, will differ., understanding this variability will aid in focusing management efforts and improving the accuracy of population projections.

- *Identification of the mechanisms by which climate change is affecting polar bear populations and potential variation across their range.*

In addition to determining the effects of climate change on polar bears, there is a need to identify the proximate mechanisms by which populations are affected. Mechanisms may be subpopulation-specific because of differences in life histories, prey bases, and because levels of additional stressors, such as harvest, industrial development and contaminants, also vary among subpopulations. Studies to date suggest that climate change is primarily affecting polar bears via reduced access to prey. However, a number of studies suggest additional mechanisms are currently or may become involved in affecting polar bears including reduced access to den sites, increased tissue contaminant levels associated with poorer body condition, and risks associated with increased frequency of long-distance swims. Identifying these mechanisms will be important in improving population projections that are needed for sound management.

***Analysis of sampling frequencies needed for population assessment***

Assessing population size of polar bears for ongoing management purposes is very expensive and time-consuming. For this study, we recommend that long-term data sets from continuously conducted, high intensity studies (e.g., Western Hudson Bay) could be sub-sampled and analyzed by select clusters of years from the overall database. This analysis should determine sampling efforts needed to achieve different confidence levels for estimates of abundance, trend, and status. This would provide co-management authorities, affected communities, and researchers with the needed information to scale sampling effort accordingly. Although maintaining a large number of marked individuals is considered desirable for long-term population monitoring, a cost-benefit analysis could provide guidance on sample size requirements for a particular desired confidence level. Such research would include power analyses of existing data to clarify how differing sampling frequencies may affect variance, accuracy, and precision in estimates of population parameters.

***Comparative analyses of strengths and weaknesses of different methods of population assessment***

As noted above, assessing population size of polar bears for ongoing management purposes is very expensive and time-consuming. Although physical mark-recapture is widely recognized as the best method for assessment of population size and related parameters, in recent years aerial surveys and genetic mark-recapture are being applied, partly in response to user groups that object to the immobilization and handling of polar bears for population studies. There is a need to quantitatively compare the kinds of data each method produces with respect to the quantitative reliability of aspects such as population size, reproductive rates, survival, and recruitment. This information is essential for determining the extent to which the precautionary principle will be needed when applying the results of studies that use different methodologies for assessing things like sustainable harvest or possible effects of environmental impacts.

***Assessment of polar bear ecology from samples of harvested bears***

Very large collections of specimens and data have been made from polar bear harvests in Canada, Alaska, and Greenland. Although the overall potential benefit of these collections remain largely unknown, some use has been made of these data for specific studies such as contributing to the estimates of population size and survival (Taylor et al. 2005), distribution (Taylor and Lee 1995), population structure (Paetkau et al. 1999), and foraging ecology (Thiemann et al. 2008). Extensive quantitative assessment of these databases and specimen collections is needed. Potential topics for harvest data analyses fall into three main categories: temporal patterns of harvest age and sex; spatial patterns of harvest over time relative to potential polar bear distributional changes; and temporal and spatial variation in body condition diet and contaminants. All of these, of course, depend on collection of the relevant covariates (e.g. sex, age, body metrics and necessary tissue samples) associated with harvest.

***An assessment of possible effects of research activities on polar bears***

The possibility that immobilization and handling of polar bears for research might have negative effects on the animals has been a concern to both scientists and Inuit hunters since large-scale mark-recapture studies for population assessment began over 40 years ago (see Appendix 1). If handling of the bears were to significantly change any important aspect of their biology, then the value of the results of such studies to conservation and management might be in question. A preliminary summary of this topic has been prepared for the Range States Committee and at least two important quantitative studies are underway and nearing completion. A quantitative, comprehensive evaluation of the potential effects of various research activities, including capture and handling and aerial survey is currently needed.

***Evaluation of potential multiple stressors on polar bear population***

There is currently a need to consider the potential for multiple stressors to affect polar bear populations in some areas of their range. Most studies examine effects of climate change, contaminants, disease, prey variability, industrial development, and other possible stressors independently. Amstrup et al (2008) made an attempt to qualitatively consider a wide variety of stressors in addition to a quantitative evaluation of the effects of sea ice loss. Updates and improvements to this initial effort are needed that more quantitatively provide links between multiple stressors.

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