Aquatic Mammals 1994, **20.3**, 113–124

The International Polar Bear Agreement and the current status of polar bear conservation

Pål Prestrud[1] and Ian Stirling[2]

[1]*Ministry of Environment, Myntgt. 2, P.O. Box 8013 Dep., 0030 Oslo 1, Norway*
[2]*Canadian Wildlife Service, 5320 122 St., Edmonton, Alberta, Canada, T6H 3S5*

Abstract

In 1973, after much negotiation, the International Agreement for the Conservation of Polar Bears and Their Habitat was signed by Canada, Denmark, Norway, the United States of America, and the former Union of Soviet Socialist Republics. This was in response to concern that the rapidly increasing levels of recorded harvest might result in the polar bear becoming endangered. The influence of the Polar Bear Agreement on the circumpolar development of polar bear conservation is judged to have been significant and, on a worldwide basis, polar bear populations are now reasonably secure. Most hunting is done by aboriginal people. Nevertheless, shortcomings still exist. For example, the population boundaries and size of several populations, some of which are currently being harvested, are inadequately known. The Agreement has been seen limited use to conserve habitat. Nevertheless, strong coordinated national and international research and management programs continue throughout much of the Arctic. Although the major conservation issue is still controlling and monitoring the harvest, additional potential concerns include long range transportation of hydrocarbons, offshore exploration for and production of hydrocarbons, radioactivity from nuclear dumping, climatic warming, and increased disturbance and harassment resulting from increased development of the Arctic in general. It is unclear whether the Polar Bear Agreement can play a significant role in dealing with these wider issues.

Introduction

Through the 1950s, and particularly during the 1960s, there was a rapid increase in the recorded number of polar bears (*Ursus maritimus*) killed. This was believed to be a consequence of a rapid increase in the price paid for polar bear hides, and the use of oversnow machines, aircraft, and boats for hunting (Stirling, 1988). In Alaska, trophy kills alone increased, albeit with fluctuations between years, from 139 in 1961 to 399 bears in 1966 (Lentfer, 1970). In Canada, the recorded harvest between 1953 and 1964 fluctuated between 350 and 550 while in 1967, it suddenly rose to 726 (Schweinsburg, 1981). The size of the unrecorded harvest throughout the circumpolar Arctic will probably never be known but it must have been substantial.

In response, and after considerable negotiation, the five nations with jurisdiction over areas where polar bears are distributed (Canada, Denmark, Norway, USA and USSR), signed the International Agreement on the Conservation of Polar Bears and their Habitat (henceforth referred to as the Agreement) in Oslo Norway in 1973. The Agreement, which came into effect on 26 May, 1976, was unanimously reaffirmed in 1981. This Agreement was one of the first treaties in international wildlife law to specify that decisions should be based on '. . . sound conservation practices based on the best available scientific data' (Article II). The Agreement also represented a significant political achievement because it was the first time the five arctic rim nations collaborated in a signed commitment to solve a common regional problem. In his review of international wildlife law, Lyster (1985) described the Polar Bear Agreement as '. . . very successful as a legal conservation instrument'.

More specifically, the contracting parties agreed on three important issues: all taking (killing, hunting etc.) of polar bears is prohibited except for some specific exceptions (Articles I and III); the ecosystems of which polar bears are a part are to be protected (Article II); and, national research programs on polar bears are to be conducted (Article VII). The Agreement allows bears to be hunted and captured 'by local people using traditional methods in the exercise of their traditional rights and according to the law of that Party; or wherever polar bears have or might have been subject to taking by

traditional means by its nationals' (Article IIId & e). In Article IV, the use of aircraft and large motorized vessels for the purpose of taking polar bears was prohibited. With its Instrument of Ratification, Canada also submitted a formal Declaration of how the Government interpreted Articles III and IV as they affected traditional hunting by Inuit and Indian people within its jurisdiction. Because implementation and enforcement of the Agreement were left to each contracting party, different interpretations of these paragraphs have resulted in a diversity of practices in managing polar bear populations.

During the last decade, concern has developed that factors other than hunting might also threaten polar bear populations. For example long range transportation of pollutants (Norstrom *et al.*, 1988; Muir *et al.*, 1992), local industrial/economic development (Stirling & Calvert, 1983; Stirling, 1990), increased tourism, the renewable resource demands of rapidly increasing native populations (Fuller & Hubert, 1981), and climatic change (Alexander, 1992; Stirling & Derocher, 1993). In this paper we review the importance of the Agreement in protecting the polar bear from the original threat of overharvest and discuss the utility of the Agreement to address newer problems, either directly or because of the influence of its existence.

Sources of Information

We reviewed management practices and harvest records before and after the period during which the Agreement was signed and ratified (1973–1976) to evaluate its effect. In particular, we assessed the establishment of quotas, protection of females with cubs, setting of hunting seasons, hunting methods, and the sealing of hides for legal trade. Data were compiled from the Proceedings of the First International Scientific Meeting on the Polar Bear at Fairbanks, Alaska in 1965, and the Proceedings of subsequent meetings of the Polar Bear Specialist Group (PBSG, 1970–1994). Updated harvest records from Alaska and Greenland, through the periods considered in this paper, were provided by S.L. Schliebe and E.W. Born respectively.

Results and Discussion

Management practices before and after signing of the Agreement in 1973

When the first international meeting to discuss protection and research on polar bears was convened in Fairbanks, Alaska in 1965 (Anon., 1966), there was little management except by the USSR where polar bear hunting had been illegal since 1956. However, direct effects of signing the Agreement are not easily identified because, after the Fairbanks meeting in 1965, and the formation of the PBSG to advise the International Union for the Conservation of Nature (IUCN) and Governments in 1968, it was clear that polar bear populations were at risk from overhunting and that negotiating an international agreement to conserve them was a primary objective. Consequently, in the eight years between the first meeting (1965), and the signing of the Agreement (1973), several changes in management practices were made and research was intensified. The following national summaries are much abbreviated from PBSG (1970–1994).

United States (Alaska)

The harvest of polar bears doubled from the early 1960s to 1965, largely because of increased interest in guided hunting (Fig. 1). After implementation of the Marine Mammal Protection Act (MMPA) in 1972, the subsistence harvest by indigenous people stabilized at 100–150 animals. Ironically however, because there were no restrictions on subsistence harvesting by native people under the MMPA, it would be legal to overharvest the population. Until the population was declared depleted, the Federal Government could not take on the responsibility of management, which seems a little counterproductive.

Between 1950 and 1972, trophy hunters took 85–90% of the kill. Trophy hunters were required to hire a licensed guide, were limited to one bear per year, and the season during which they could hunt was short. Beginning in 1961, females with cubs were protected and the hide of a killed bear had to be sealed by a representative from the state, which provided an opportunity to obtain information on sex and age composition of the harvest. For residents, an unlimited bag applied until 1971, when it was restricted to three bears. Research on population dynamics and movements has continued from the late 1960s to the present.

Canada

In Canada, the Provinces and Territories control management of polar bears although, in several areas, the decision-making process is shared with aboriginal groups as part of the settlement of land claims. Apart from complying with the Convention on International Trade in Endangered Species (CITES), the Federal Government has no mandate for management of polar bears. The situation is complex because there are at least 12 subpopulations, each of which is managed separately and several of which are shared between two or more jurisdictions (PBSG, 1994). Most of the important regulations came into effect before the Agreement was signed, but modifications have continued to the present. In the Northwest Territories (NWT), the

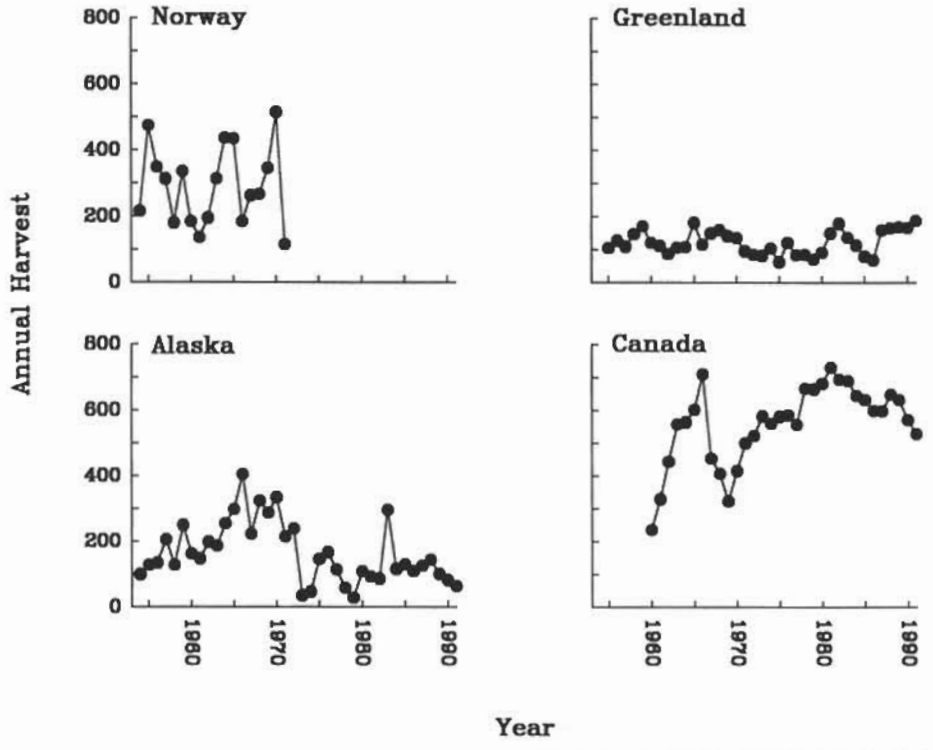

Figure 1. Recorded harvest of polar bears in Norway, Greenland, Alaska and Canada for selected intervals between 1955 and 1991.

Inuvialuit, and Nunavut land claims have now been settled so that the Inuit are now legally co-managers of wildlife, including polar bears. Legal quotas, or closed seasons, are established everywhere but in Québec and Ontario where recommended guidelines are in place but where enforcement and the maintenance of records are variable.

Hunting of polar bears in Canada is principally conducted by Inuit and Indians although, in the NWT, a non-native or Metis person who holds a Special General Hunting Licence may hunt polar bears if he or she is issued with a tag by their local Hunters and Trappers Committee. Similarly, in Labrador, access to wildlife is equal for all residents independent of race, although in practice, all hunting of polar bears is currently done by Inuit. In the Canadian Letter of Interpretation, filed when Canada signed the Agreement, provision was made for '. . . a token sports hunt based on scientifically sound settlement quotas as an exercise of the traditional rights of local people.' Inuk-guided sport hunting continues in the NWT and hunters are required to travel by dog team. All tags (the quota) allocated to each community are distributed by the local Hunters and Trappers Committee. Regulations regarding sealing of hides were implemented in most of the Provinces and Territories after the Agreement was signed. This improved the collection of data on the harvest and reduced illegal hunting. Females accompanied by cubs less than one year of age and bears in dens are protected everywhere except in Québec and Ontario (Calvert *et al.*, 1991, 1994).

The recorded annual kill in Canada tripled during the 1960s (Fig. 1). Unfortunately, the size of the unrecorded harvest will never be known. In the NWT in the 1960s, there were no data on the size of any polar bear populations on which to base sustainable annual quotas. Thus, in 1968, arbitrary quotas, based on the previous harvest record for each community, were introduced on an interim basis (Schweinsburg, 1981) (Fig. 1). Government agencies explained to Inuit hunters that the quotas would be revised as new data became available. Consequently, the harvest dropped markedly in 1968, but increased again through the 1970s, mainly in response to local political pressure. After about the late 1970s, increases in quotas were granted only if they were recommended on the basis of new scientific information on an individual population. By the mid-1980s, the total annual harvest was similar to annual harvest levels in the late 1960s but

has since declined because population research on some subpopulations which had not previously been studied indicated quota reductions were necessary (Fig. 1).

In the NWT, Management Agreements are being negotiated between the communities that harvest each population to ensure that the total of all bears removed from the population (hunting, problem-bears, bears for zoos, etc) is within the sustainable quota to ensure an overharvest does not occur. These agreements are witnessed by the Minister of the Department of Renewable Resources. In the case of shared populations, the respective user groups and government agencies from neighbouring jurisdictions are also invited to participate. In the negotiations, both scientific and traditional knowledge are drawn upon and aspects for which there are inadequate data are identified for further study. Management for a two-thirds male harvest, or greater, in order to conserve females, is a keystone of the Agreements.

Greenland—Denmark

All Greenland residents for whom hunting is the principal occupation are allowed to hunt polar bears and they must hold a valid hunting licence issued by the Greenland Home Rule Authorities (Born 1994). There are no quotas and, until recently, there has been only limited research on the size or distribution of subpopulations. Reporting on the harvest began in the early 1800s (Vibe, 1967), but is mainly conducted on a voluntary basis (Rosing-Asvid & Born, 1990). In 1975, use of motorized vehicles, planes, and helicopters for hunting bears became illegal, traps and set guns were prohibited, and female bears with cubs aged less than one year were protected. In 1988, females with cubs and cubs less than 2 years of age were protected except for three settlements in north-western Greenland where cubs older than one year of age may be harvested. Males may be hunted throughout the year. It is illegal to disturb bears in dens. Helicopters, fixed-wing aircraft, snowmobiles, and ships exceeding 40 GRT cannot be used for hunting polar bears or for transportation to or from hunting areas (Born, 1991). The latest revision of the hunting regulations was in 1992 (Born, 1994).

Although there were no quotas, the recorded annual harvest in Greenland was fairly stable from 1960 through 1985 at 100–200 animals (Fig. 1). However, these figures are probably not complete because of the voluntary system of reporting (Born, 1991). Similarly, details of the sex and age composition of the harvest are not known except for a recent study by Rosing-Asvid & Born (1990; 1994).

Norway—Svalbard area

The annual harvest, taken by trappers before 1973, was about 300–350 animals (Lønø, 1970; PBSG, 1976). In 1969, 520 bears were harvested and the population at that time was estimated *a posteriori* to have been 1500–2500 animals (Larsen, 1986). In 1970, females with cubs were protected and it became illegal to use traps, set-guns, or poison. Research on population dynamics was undertaken from 1968 to 1983, and resumed from 1987 to the present. Hunting stopped altogether in 1973 when the polar bear was completely protected. Since then three to five problem-bears have been killed annually (Gjertz & Persen, 1987).

Russia (USSR)

Uspenski (1977) estimated a total harvest of polar bears in Russia, from the 1800s through to the early 1950s, of more than 150,000. The polar bear was completely protected in 1956 because Soviet populations were thought to be severely depleted because of overhunting (USSR Delegates, 1966). Subsequent research has focused on studies of denning bears at Wrangel Island and attempts to count bears from fixed-wing aircraft assigned to ice surveys in the polar basin. In 1988, after more than 30 years of protection, numbers of problem bears were increasing in coastal communities, and Russian authorities were considering allowing a limited hunt on polar bears (Uspenski & Belikov, 1991). To date, however, no changes have been made and hunting is still illegal. In 1992, unsanctioned brochures circulated from hunting companies in Scandinavia advertised sports hunting on polar bears in Russia. The Russian Academy of Science was erroneously reported to be sponsoring the hunting program.

Total harvest figures

Worldwide, the recorded annual harvest of polar bears dropped substantially from over 1400 in some years prior to 1972 to fewer than 800 in the early 1970s (Fig. 2). The sudden decline in the late 1960s resulted mainly from the introduction of quotas in the NWT in Canada in 1986 (Schweinsburg, 1981). The reduction in the recorded kill in the early 1970s was largely a consequence of the implementation of the MMPA in the United States and the total ban on hunting polar bears in Svalbard.

The status of polar bear populations today

There is often a preoccupation with the total number of animals of any species the public has a particular interest in. For a species like the polar bear, we suggest this is not a meaningful approach. Firstly, there are vast areas of the circumpolar Arctic for which no reliable population estimates are available because of lack of research. Secondly,

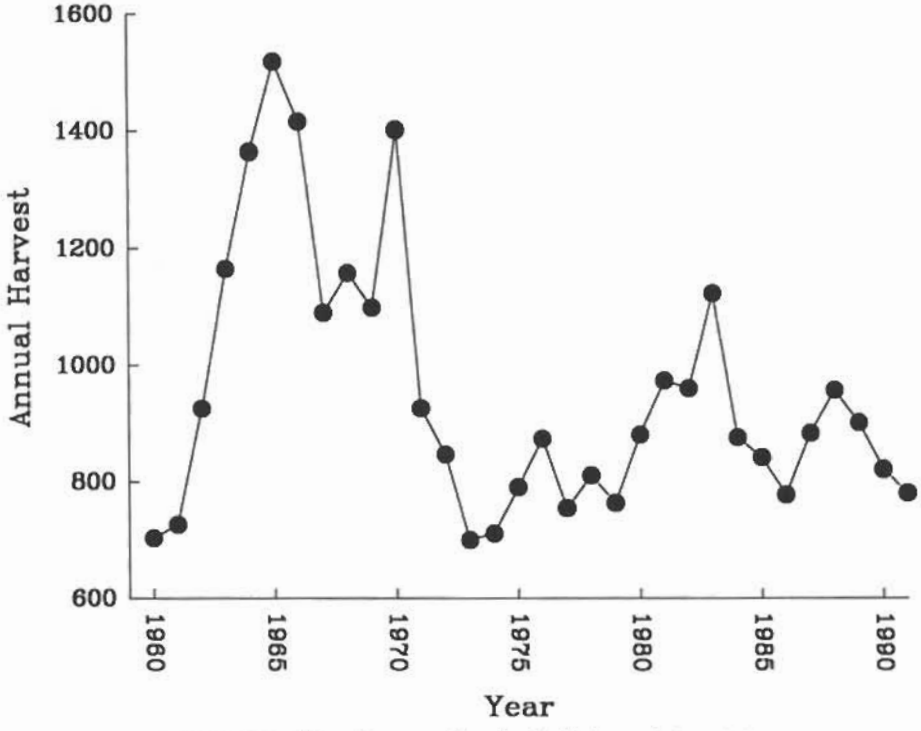

Figure 2. Total recorded harvest from Norway, Greenland, Alaska and Canada from 1960 to 1991.

and more important, polar bears are distributed in relatively discrete subpopulations and managed as such so that considering the total harvest in relation to the total estimated number of bears is meaningless. For example, at least 11 subpopulations are shared or completely contained within Canada. However, recognizing that many people want to know how many polar bears there are world-wide, the PBSG (1994) reviewed the available data and conservatively estimated the total population to be between 21,370 and 28,270.

In Canada, populations for which there are estimates of size are being managed within the estimated sustainable yield of females greater than two years of age (Taylor *et al.*, 1987). In Viscount Melville Sound and Foxe Basin, quotas have been reduced in response to research that indicated the populations had been overharvested (M. K. Taylor, in Calvert *et al.*, 1994). Research is also continuing in Canada on subpopulations where the numerical status is still uncertain (M. K. Taylor, in Calvert *et al.*, 1994). Similarly, population studies are also being conducted in West Greenland, Alaska, and to some degree in Russia, depending on financial and logistic constraints. When completed, the results of all these studies will be used to estimate sustainable harvests.

Most of the current annual harvest of polar bears is taken from subpopulations distributed between western Alaska and eastern Greenland. Knowledge of the status of these populations is variable. For example, on the basis of the data available, it appears that harvest levels in the Beaufort Sea and in western and southern Hudson Bay are sustainable but close to their Maximum Sustained Yield (MSY) (DeMaster *et al.*, 1980; Amstrup *et al.*, 1986; Derocher, 1991). In the 1980s, the polar bear population on the eastern coast of Baffin Island was thought to have been overharvested so the local Inuit Hunters undertook to reduce their quotas by 2/3 for seven years to assist the recovery of the population (Lloyd, 1986). More recent studies, including the use of satellite telemetry, indicate a possibility that the population may be larger than was formerly thought (PBSG, 1994). In response, a cooperative research program between Greenland and Canada is being conducted to determine the size of the polar bear population in the area of the eastern Canadian High Arctic and Baffin Bay (M. K. Taylor, in Calvert *et al.*, 1994). In the area of Foxe Basin, northern Hudson Bay, and Hudson Strait, where there has been concern about an overharvest of polar bears, the quotas in the NWT have been reduced significantly in response to the

mutual concern about overharvest on the part of biologists and Inuk hunters from NWT. However, although this population is also hunted by Inuit from northern Québec, neither Inuit nor government agencies are yet involved with its comanagement (Stirling, 1991). There is limited information on polar bear populations from west Greenland and little from east Greenland.

Trends in the populations

Polar bears are patchily distributed at low densities over vast areas, which makes it difficult and extremely expensive to determine population trends over time. Population growth rates are low because polar bears have a low reproductive rate, late sexual maturation, long interbirth intervals, and a long life-span (Øritsland & Schweinsburg, 1983; Taylor *et al.*, 1987a,b). Usually a minumum of 3–5 years of research is required to obtain a reliable population estimate. As a consequence, population studies need to continue for periods of 10–20 years if significant changes are to be detected. Unfortunately, such studies are extremely expensive so that data on long-term changes are available from only a few populations. For example, using aerial counts of polar bears along the Ontario coast between 1963 and 1980, Prevett & Kolenosky (1982) concluded that the subpopulation in southern Hudson Bay increased steadily after 1975. Larsen (1986) concluded that the polar bear population at Svalbard had been overharvested prior to 1970, and that it has increased from 1500–2500 bears around 1970 to 3000 to 5000 in the early 1980s. In the southern Beaufort Sea, ongoing population analyses and data on the age structure of the population suggest that the population was depressed prior to the establishment of quotas in Canada and the implementation of the MMPA but has since increased (Amstrup *et al.*, 1986). In western Hudson Bay Derocher & Stirling (in press), found that the population was stable between 1978 and 1990. Although the data are equivocal, they suggested that, following a period of overharvesting in the 1960s, the population increased up to about 1978 after which it has been relatively stable.

Protected areas

Article II of the Agreement states, 'Each Contracting Party shall take appropriate action to protect the ecosystem of which polar bears are a part, with special attention to habitat components such as denning and feeding sites and migration patterns, ...' The three largest known denning areas for polar bears, Wrangel Island (Russia), Kong Karl's Land (Svalbard), and western Hudson Bay are all protected to varying degrees. Denning habitat is also protected in the Northeast Greenland National Park, Melville Bugt Game Reserve (Greenland), Herald Island (Russia), other islands in Svalbard, and in some National and Provincial Parks in Canada. Although indigenous people are allowed to hunt in the Canadian Arctic National Parks, females with cubs and bears in dens are still protected. In Alaska, the most important terrestrial denning habitat lies within the Arctic National Wildlife Refugee close to the Canadian border (Stirling & Andriashek, 1992; Amstrup, 1993). Although approval has yet to be given, hydrocarbon exploration and production is still proposed there.

Feeding sites and migration routes occur on the sea ice, a habitat that exhibits marked seasonal and annual changes in distribution. Polynyas and areas where currents create unstable sea ice and stimulate marine primary production create critical feeding habitat for polar bears (Stirling, 1980). However, this dynamic habitat, which is also limited in distribution, does not fit into conventional thinking about protected areas. To date, none of this critical offshore habitat for polar bears is protected.

International waters

A considerable amount of polar bear habitat is distributed in international waters outside the jurisdiction of the national states, mainly in the polar basin where densities of bears are likely low, and near the southern edges of the seasonal pack ice in winter where they are high. However, passage of ships from which polar bears might be hunted in these regions are few. Thus, for the foreseeable future, it is unlikely that the number of bears killed in international waters will be significant.

New threats not addressed by the Polar Bear Agreement

Pollution

Polar bears are at the top of the arctic marine food chain. They store large depots of fat to survive periods of food shortage (Watts & Hansen, 1987; Ramsay & Stirling, 1988). Several organochlorines are lipophilic, biomagnify along food chains, and have been found in polar bears, sometimes at high levels (Norstrom *et al.*, 1988; Norheim *et al.*, 1992). For example, concentrations of some chemicals in polar bear fat collected from Baffin Bay and Hudson Bay were twice as high in 1984 than they were in 1969 (Norstrom *et al.*, 1988). A concentration of 30–70 ppm PCB in fat has been suggested to be the threshold for causing pathological effects on the uteri of ringed seals (*Phoca hispida*) (Helle *et al.*, 1976; Reijnders, 1980; Bergman & Olsson, 1985). In polar bears from Svalbard, the mean value

was 31 ppm in fat, but some bears had values up to 90 ppm (Norheim *et al.*, 1992). Although the possibility of negative effects on the reproduction of polar bears has been suggested, none has yet been demonstrated. However, PCBs continue to be transported to the arctic, by air and via ocean currents, where they are incorporated into the marine food chain (Oehme, 1991).

Cadmium, mercury and lead also occur at varying levels in polar bears from Canada, Greenland and Svalbard (Dietz, 1987; Lentfer & Galster, 1987; Norstrom *et al.*, 1988; Renzoni & Norstrom, 1990; Born *et al.*, 1991; Norheim *et al.*, 1992). The long-term ecological consequences of such contamination in polar bears are unknown.

Recently, it has become apparent that radioactive pollution constitutes a threat to the Arctic marine ecosystem (Canadian Arctic Resources Committee, 1990). In 1988, a nuclear submarine from the USSR sank in the Barents Sea and is still on the ocean bottom; Soviet specialists have stated that leakage of radioactivity is likely in a few years. Of more immediate concern is the recent disclosure that significant amounts of atomic waste from the USSR have been dumped in the Kara Sea. The possible effects of this are unknown but likely to be of long-term duration.

Industrial and tourism development

An extensive continental shelf surrounds the Polar Basin and is assumed to contain signficant reserves of hydrocarbons. It is significant that much of the best habitat for polar bears and other marine mammals also overlies the continental shelf (e.g. Uspenski, 1977; Stirling, 1990). To date, offshore drilling in ice-covered waters has only been conducted in the Beaufort Sea (Stirling, 1988). Norway is presently conducting an Environmental Impact Assessment in the northern Barents Sea to provide Parliament with the information it needs to decide whether to open the area for petroleum activity.

An oil spill in the Arctic has the potential to be particularly harmful because oil in this environment decomposes slowly, it may become frozen into the ice, and animals congregate in huge numbers locally (Stirling & Calvert, 1983; Hanson *et al.*, 1990). If oil is spilled under the ice, it may have harmful effects on the environment for several months and be transported over large areas. From an experimental study, Øritsland *et al.* (1981) found oil was highly toxic to polar bears because they ingested it when grooming and concluded that free-ranging bears exposed to oil would probably die. Although St. Aubin (1990) criticised the experimental protocol of Øritsland *et al.* (1981), his conclusions appear to be the same. Stirling (1988; 1990) has pointed out that behavioral characteristics and habitat preferences of polar bears are likely to increase their chances of coming into contact with spilled oil. Similarly, anecdotal evidence also suggests that wild polar bears will not avoid petroleum products (Stirling, 1988; Derocher & Stirling, 1991), even though St. Aubin (1990) suggested that they might do so. Polar bears have also been recorded ingesting other harmful toxic material (Lunn & Stirling, 1985; Amstrup, 1989).

With the overall increase in industrial development, tourism, scientific research, and recreational activity by residents in the Arctic in recent years (Stirling & Calvert, 1983; Hanson *et al.*, 1990) there has also been more extensive use of all-terrain vehicles, aircraft, and boats. The cumulative effect of these activities may have a negative impact on polar bears and the habitat they depend upon, particularly in denning areas (e.g. Blix & Lentfer, 1992; Amstrup, 1993). Another consequence of an increase in human activity is an increase in deaths caused directly by humans (Derocher & Stirling, 1991; Lunn & Stirling, 1985; Amstrup, 1989; Stenhouse *et al.*, 1988).

There has been extensive damming of rivers draining into Hudson and James bays in Canada for hydroelectric projects and more dams are planned. These projects have the potential to cause significant change to the hydrological regime of these water bodies and possibly influence the food chain that polar bears depend upon. Little study of possible ecological consequences has been undertaken.

In Hudson Bay, open water prevails for about four months in late summer and fall because the annual ice melts completely. Near Churchill, Manitoba, large numbers of polar bears fast on their fat reserves along the coast while they wait for the ice to refreeze so they can return to hunting seals (Stirling *et al.*, 1977). During that period, organized tours in specially built vehicles carry tourists over the tundra to view the bears. The tourists put significant pressure on the operators to get close to bears in order to facilitate better photographs and some individuals feed bears to encourage them to remain close to the vehicles (Watts & Ratson, 1989). It is unknown whether the cumulative effect of disturbances from tourists has a significant detrimental effect but, so far, at least two bears have died because of incidents that were triggered by feeding bears to attract them. Unregulated tourism for viewing polar bears has the potential to have detrimental effects on polar bears in other areas as well.

Climatic change

If climatic warming occurs, the first effects on polar bears will likely be felt at the southern limits of their distribution, such as in James and Hudson bays, where the whole population is already forced to fast

for approximately four months when the sea ice melts during the summer (Stirling & Derocher, 1993). There are a significant number of bear–human encounters at Churchill, Manitoba each autumn (Kearney, 1989), at least partly as a consequence of fasting bears becoming food-stressed toward the end of the period of fasting (Lunn & Stirling, 1985). Prolonging the ice-free period will increase nutritional stress on these bears until they are no longer able to store enough fat to survive the ice-free period. Early signs of impact will include declining body condition, lowered reproductive rates, reduced survival of cubs, and an increase in polar bear–human interactions.

In the High Arctic, a decrease in ice cover may stimulate an initial increase in biological productivity. Eventually, however, it is likely that seal populations will decline wherever the quality and availability of breeding habitat is reduced. Warm weather or rain during the late winter may cause polar bear maternity dens to collapse, causing the death of occupants (Clarkson & Irish, 1991). If populations of polar bears decline, harvest quotas for native people will be reduced and eventually be eliminated. Tourism based on viewing polar bears in western Hudson Bay might disappear. Should the Arctic Ocean become seasonally ice free for a long enough period, it is likely polar bears would be extirpated from at least the southern part of their range. However, should climatic warming occur, the polar bear is an ideal species through which to monitor the cumulative effects in arctic marine ecosystems because of its position at the top of the arctic marine food chain.

Discussion

Consequences of the Agreement

Because so many management changes were enacted during the period when the Agreement was negotiated, there was little detectable impact immediately after it was signed and ratified. However, there is no doubt that the knowledge that the Agreement was being negotiated, and was likely to be successful, was a significant stimulus to countries to act to conserve polar bears (Fikkan *et al.*, 1993).

The primary goal of the Agreement was to limit the hunting of polar bears to sustainable levels. From Figure 1, there were major reductions in the size of the reported kill in each country where harvesting of polar bears was allowed, most of which were implemented before the Agreement was signed in 1973 and all before it was ratified in 1976. However, the size of the total recorded harvest grew again through the 1970s, mainly because of increases in quotas in NWT (some recommended following research studies and some not), and one year of unusually high take in the subsistence hunt in Alaska (Fig. 2). As a consequence of population studies in the 1980s, quotas on some populations were found to be too high and were subsequently reduced, with a consequent decline in the total circumpolar harvest. Although monitoring of the harvest has improved greatly, so that the unrecorded harvest is probably small, there is still room for a significant amount of improvement. At present, documentation of subsistence use is not complete in either Greenland or Russia and, in Canada, there is variability in completeness of reporting of the harvest from Québec and Ontario.

In the complex jurisdictional situation that prevails in Canada, the Agreement facilitated the formation of the Federal-Provincial Technical and Administrative Committees to coordinate research and management throughout the country. Although the research and management practices in Canada today have evolved over several years, their development would probably not have been as extensive, without the influence of the Agreement.

One of the most interesting influences of the Polar Bear Agreement is a consequence of the anomaly in the MMPA which removes any restrictions from the harvest of polar bears by native people for subsistence in Alaska. The Inupiat of Alaska and the Inuvialuit of Canada both hunt polar bears from the shared population in the southern Beaufort Sea. Although there were strict quotas in place and enforced in Canada there were none in Alaska, leaving open the possibility of an overharvest. To rectify the situation, the two aboriginal groups negotiated a management agreement between themselves, using the International Polar Bear Agreement as one of the motivations for doing so (Nageak *et al.*, 1991). Although the Inuvialuit-Inupiat Agreement is not legally binding, it is signed by both groups, self-regulated, and continues to be successful overall.

Hunting of polar bears

According to Article IIId, hunting of polar bears is restricted to 'local people using traditional means'. Although not written as such, this is sometimes interpreted to refer to indigenous people. The Norwegian Ministry of Environment's interpretation of the Agreement is that only aboriginal people are permitted to hunt. Applications from trappers in Svalbard (where there are no aboriginal people) to hunt polar bears have been refused for this reason.

Canada and Denmark (Greenland) have interpreted these articles in a way that permits some non-native residents to hunt polar bears in specific circumstances. Canada also allows non-residents to hunt polar bears if they are guided by Inuit hunters

travelling by dog team. In Alaska, the State constitution prohibits limitation of access to wildlife resources on the basis of race but can do so on the basis of whether or not a person lives a 'subsistence' lifestyle. However, because Federal Law supersedes Alaskan State Law in this case, the exemption for native subsistence hunters can still be made. In Alaska, Canada, and Greenland, maintaining polar bear hunting as part of the subsistence lifestyle is widely viewed as being of significant cultural importance. Although hunting polar bears is still illegal in Russia, there is now significant interest in reopening a season. It remains to be seen how that will be done .

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

Protection of habitat

A shortcoming in applying the provisions of the Agreement has been the lack of its clear use to help protect critical areas of habitat, with a few exceptions in some denning areas. No migration routes or feeding areas have been protected. Furthermore, the protected denning areas are relatively small in relation to the total available polar bear habitat. However, with the exception of the three large and relatively concentrated polar bear denning areas at Wrangell Island (Russia), Kong Karls Land (Svalbard), and the Manitoba coast of Hudson Bay (Canada), most polar bear denning in the arctic occurs at low densities over large areas (Harington, 1968; Stirling *et al.*, 1984; Stirling & Andriashek, 1992; Amstrup, 1993). It is unclear how polar bear denning habitat in the Alaska National Wildlife Refuge will be conserved if development of hydrocarbons takes place there.

Overall, there is limited evidence that the Agreement has specifically resulted in an increase in the protection of polar bear habitat beyond that which has been ongoing for several years in the circumpolar countries. Nevertheless, in some areas the existence of the Agreement appears to have been helpful in the establishment of protected areas such as Northeast Greenland National Park and Melville Bugt Game Preserve in Greenland (Vibe, 1985).

Research

Article II stated that signatory parties were to '. . . manage polar bear populations in accordance with sound conservation practices based on the best scientific data.' Article VII states that '. . . Contracting Parties shall conduct national research programmes on polar bears . . .' and '. . . consult with other Parties on the management of migrating polar bear populations . . .'. There is no doubt that the existence of these articles in the Agreement, even during the negotiation period, stimulated governments to support the population and harvest studies needed to put the management of polar bears on a scientific basis. That influence continues today.

Conclusions

There is no immediate danger of polar bears becoming endangered or extinct and, overall, populations appear to be healthy. Because most of the original habitat of the polar bear is still intact and uninhabited, it is one of few large carnivores left that still occurs throughout most of its range.

In our opinion, the International Agreement on the Conservation of Polar Bears has been the most important single influence on the development of internationally coordinated management and research programs which have ensured the survival of polar bears to date. Despite the fact that the Agreement is not enforceable by law in any of the signatory countries, it has been successfully used to encourage the application of population studies to bring the harvest of polar bears within sustainable limits while still facilitating harvest by native people. Nevertheless, it will be critical to continue to monitor harvests from each population and monitor the status of populations in order to be able to detect changes in trends and to ensure overharvesting does not occur.

It is now 20 years since the Agreement was signed and it appears that several of the polar bear populations have recovered to former natural levels. However, some concerns remain because of uncertainty about the size of a few populations within, or shared by, Canada and consequently the possibility of an overharvest. Moving toward ensuring sustainable quotas is currently being addressed through a combination of cooperative research studies and management agreements. Unfortunately, less progress has been made on the protection of habitat under the Agreement, with the exception of protection for a number of denning areas.

Although controlling harvest is clearly still the major issue in the conservation of polar bears, some of the additional potential threats now facing polar bears are of a more global nature and less specific to individual species. Issues of concern include long-range transportation of pollutants, offshore

exploration for and production of hydrocarbons, radioactivity from nuclear dumping, climatic warming, and increased disturbance and harassment resulting from increased development of the Arctic in general. It is unclear whether or not the Polar Bear Agreement can play a significant role in dealing with these wider issues.

In the meantime, we suggest that protection of habitat, which is possibly the most visionary provision of the Agreement, should now be emphasized for the protection of polar bears. This can, in turn, serve an invaluable function in protecting biodiversity of Arctic marine ecosystems since, as noted by Eisenberg (1980), the health of large carnivore populations are likely to be indicators of the health of the ecosystems they live in.

Acknowledgements

We would like to thank the following for constructive criticism of the manuscript: S. C. Amstrup, E. W. Born, Wendy Calvert, D. Cluff, G. W. Garner, M. A. Ramsay, M. K. Taylor, S. L. Schliebe, and Ø. Wiig.

References

Anon. (1966). Proceedings of the 1st. International Meeting on the Polar bear. US Department of the Interior, Bureau of Sport Fisheries and Wildlife, and the University of Alaska, Fairbanks, 71 pp.

Alexander, V. (1992). Arctic Marine Ecosystems. In (ed.) Yale University Press, pp. 221–232.

Amstrup, S. C. (1989). Ethylene glycol (anti-freeze) poisoning in a free ranging polar bear. *Vet. and Human Toxicol.* **31,** 317–319.

Amstrup, S. C. (1993). Human disturbances of denning polar bears in Alaska. *Arctic* **48,** 246–250.

Amstrup, S. C., Stirling, I. & Lentfer, J. W. (1986). Past and present status of polar bears in Alaska. *Wildl. Soc. Bull.* **14,** 241–254.

Bergman, A. & Olsson, M. (1985). Pathology of Baltic grey seal and ringed seal females. *Finnish Game Res.* **44,** 44–62.

Blix, A. S. and Lentfer, J. W. (1992). Noise and vibration levels in artificial polar bear dens as related to selected petroleum exploration and development activities. *Arctic* **45,** 20–24.

Born, E. W. (1991). Polar Bear Research and Management in Greenland 1985–1988. Proceedings from the 10th Working Meeting of the IUCN/SSC Polar Bear Specialist Group. (eds S. C. Amstrup & Ø. Wiig). *Occ. Pap. IUCN Spec. Surv. Comm. (SSC)* **7,** 25–33.

Born, E. W. (1994). Status of the Polar Bear in Greenland 1993. Proceedings from the 11th Working Meeting of the IUCN/SSC Polar Bear Specialist Group. *Occ. Pap. IUCN Spec. Surv. Comm. (SSC)* (in press).

Born, E. W., Renzoni, A. & Dietz, R. (1991). Total mercury in hair of polar bears (*Ursus maritimus*) from Greenland and Svalbard. *Polar Research,* **9,** 113–120.

Calvert, W., Stirling, I., Taylor, M., Lee, L. J., Kolenosky, G. B., Kearny, S., Crête, M., Smith, B. & Luttich, S. (1991). Polar Bear Management in Canada 1985–87. Proceedings of the 10th Working Meeting of the IUCN/SSC Polar Bear Specialist Group. (eds S. C. Amstrup & Ø. Wiig) *Occ. Pap. Spec. Surv. Comm. (SSC)* **7,** 1–10.

Calvert, W., Taylor, M., Stirling, I., Kolenosky, G. B., Kearney, S., Crête, M. & Luttich, S. (1994). Polar Bear Management in Canada 1988–92. In Proceedings of the 11th Working Meeting of the IUCN Polar Bear Specialist Group (eds Ø. Wiig, E. Born & G. Garner) *Occ. Pap. Spec. Surv. Comm. (SSC)* (in press).

Canadian Arctic Resources Committee. (1990). Arctic pollution: how much is too much? *Northern Perspectives* **18(3),** 1–10.

Clarkson, P. L. & Irish, D. (1991). Den collapse kills female polar bear and two newborn cubs. *Arctic* **44,** 83–84.

Demaster, D. P., Kingsley, M. C. S. & Stirling, I. (1980). A multiple mark and recapture estimate applied to polar bears. *Can. J. Zool.* **58,** 633–638.

Derocher, A. (1991). Population dynamics and ecology of polar bears in western Hudson Bay. Ph.D thesis, University of Alberta, Edmonton, Canada, 188 pp.

Derocher, A. E. & Stirling, I. (1991). Oil contamination of polar bears. *Polar Rec.* **27,** 56–57.

Derocher, A. E. & Stirling, I. Mark and recapture estimation of population size and survival rates for polar bears in western Hudson Bay. *J. Wildl. Manage.* (in press).

Dietz, R. (1987). Tungmetaller i isbjørn og andre arktiske dyr. *Tusaat* **2,** 2–6.

Eisenberg, J. F. (1980). The density and biomass of tropical mammals. In: *Conservation Biology: an evolutionary-ecological perspective.* (eds M. E. Soule & B. A. Wilcox). Sinauer Associates, Sunderland, Mass. pp. 35–56.

Fikkan, A., Osherenko, G. & Arikainen, A. (1993). Polar bears: the importance of simplicity. *Polar Politics: Creating International Environmental Regimes.* (eds O. R. Young & G. Osherenko). Cornell University Press, New York. pp. 96–149.

Fuller, W. A. & Hubert, B. A. (1981). Fish, fur and game in the Northwest Territories: some problems of, and prospects for, increased harvests. In *Proceedings of the first international symposium on renewable resources and the economy of the north.* (Ed M. M. R. Freeman) Association of Canadian Universities for Northern Studies, Ottawa, Ont. pp. 12–29.

Gjertz, I. & Persen, E. (1987). Confrontations between humans and polar bears in Svalbard. *Polar Res.* **5,** 153–256.

Hanson, R., Prestrud, P. & Øritsland, N. A. (1990). Assessment system for the environment and industrial activities in Svalbard. Norwegian Polar Research Institute, Oslo 267 pp.

Harington, C. R. (1968). Denning habits of the polar bear (*Ursus maritimus* Phipps). Canadian Wildlife Service Report Series, No. 5. 30 pp.

Helle, E., Olsson, M. & Jensen, S. (1976). DDT and PCB levels and reproduction in ringed seal in Bothnian Bay. *Ambio* **5,** 188–189.

Kearney, S. R. (1989). The Polar Bear Alert program at Churchill, Manitoba. *Bear–People Conflicts: Proceedings of a Symposium on Management Strategies*. (eds P. A. Gray & P. L. Clarkson). Government of the Northwest Territories, Yellowknife, pp. 83–92

Larsen, T. (1986). Population biology of the polar bear (*Ursus maritimus*) in the Svalbard area. *Norsk Polar. Skrift.* **184,** 1–55.

Lentfer, J. W. (1970). Polar bear research and conservation in Alaska, 1968–69. *IUCN New Series*, **29,** 43–67.

Lentfer, J. W. & Galster, A. (1967). Mercury in polar bears from Alaska. *J. Wildl. Dis.* **23,** 338–341.

Lloyd, K. A. (1986). Cooperative management of polar bears on Northeast Baffin Island. *Native People and Renewable Resource Management*. 1986 Symposium of the Alberta Society of Professional Biologists. pp. 108–116.

Lønø, O. (1970). The Polar Bear in the Svalbard Area. *Norsk Polarinstitutt Skrifter*, **149,** 1–103.

Lunn, N. J. & Stirling, I. (1985). The significance of supplemental food to polar bears during the ice-free period of Hudson Bay. *Can. J. Zool.* **63,** 2291–2297.

Lyster, S. (1985). *International wildlife law*. Grotius Publications, Cambridge, England 470 pp.

Muir, D. C. G., Wagemann, R., Hargrave, B. T., Thomas, D. J., Peakall, D. B. & Norstrom, R. J. (1992). Arctic marine ecosystem contaminants. *Science Tot. Environ.* **122,** 75–134.

Nageak, B. P., Brower, C. D. & Schliebe, S. L. (1991). Polar bear management in the southern Beaufort Sea: an agreement between the Inuvialuit Game Council and the North Slope Borough Fish and Game Committee. *Trans. 56th N. Amer. Wildl. Nat. Res. Conf.* **56,** 337–343.

Norheim, G., Skaare, J. U. & Wiig, Ø. (1992). Some heavy metals, essential elements, and chlorinated hydrocarbons in polar bear (*Ursus maritimus*) at Svalbard. *Envir. Poll.* **77,** 51–57.

Norstrom, R. J., Simon, M., Muir, D. C. G. & Schweinsburg, R. E. (1988). Heavy metals and essential elements in livers of polar bears (*Ursus maritimus*) in the Canadian Arctic. *Sci. Tot. Environ.* **48,** 195–212.

Oehme, M. (1991). Dispersion and transport paths of toxic persistent organochlorines to the Arctic—levels and consequences. *Sci. Tot. Environ.* **106,** 43–53.

Øritsland, N. A. & Schweinsburg, R. E. (1983). Polar bear hunting strategies evaluated by a leslie matrix population model. *Pol. Res.* **3,** 241–247.

Øritsland, N. A., Engelhardt, F. A., Juck, F. A., Hurst, R. J. & Watts, P. D. (1981). Effect of crude oil on polar bears. Environmental Studies, No. 24, Department of Indian and Northern Affairs, Ottawa, Canada, 268 pp.

PBSG. (1970). Polar bears. Proceedings of the 2nd Working Meeting of Polar Bear Specialists, Morges, Switzerland. 2–4 February, 1970. IUCN Publications New Series, Morges, Switzerland, Supplementary Paper No. 29, 88 pp.

PBSG. (1972). Polar bears. Proceedings of the 3rd Working Meeting of the Polar Bear Specialist Group. 7–10 February, 1972. IUCN Publications New Series, Morges, Switzerland, Supplementary Paper No. 35, 97 pp.

PBSG. (1976). Polar bears. Proceedings of the 5th Working Meeting of the Polar Bear Specialist Group 1974. IUCN Publications New Series, Morges, Switzerland, Supplementary Paper No. 42, 105 pp.

PBSG. (1980). Polar bears. Proceedings from the 6th and 7th Working Meeting of the IUCN Polar Bear Specialist Group 1976 and 1979. IUCN Gland, Switzerland, 204 pp.

PBSG. (1984). Proceedings of the Technical Workshop of the IUCN Polar Bear Specialist Group 1983. IUCN Gland, Switzerland. 16 pp. plus 5 Appendices.

PBSG. (1985). Polar bears. Proceedings of the 8th Working Meeting of the IUCN/SSC Polar Bear Specialist Group 1981. IUCN Gland, Switzerland, 151 pp.

PBSG. (1986). Polar bears. Proceedings of the 9th Working Meeting of the IUCN/SSC Polar Bear Specialist Group 1985. IUCN Gland, Switzerland, 152 pp.

PBSG. (1991). Polar bears. Proceedings of the 10th Working Meeting of the IUCN/SSC Polar Bear Specialist Group 1988. (eds S. C. Amstrup & Ø. Wiig). Occasional Papers of the IUCN Species Survival Commission (SSC) No. 7, 107 pp.

PBSG. (1994). Polar bears. Proceedings of the 11th Working Meeting of the IUCN/SSC Polar Bear Specialist Group 1993, (eds Ø. Wiig, E. Born & G. W. Garner) Occasional Papers of the IUCN Species Survival Commission (SSC) (in press).

Prevett, J. P. & Kolenosky, G. B. (1982). The status of polar bears in Ontario. *Nat. canadien* (review of ecological systems), **109,** 933–939.

Ramsay, M. A. & Stirling, I. (1988). Reproductive biology and ecology of female polar bears (*Ursus maritimus*). *J. Zool.*, **214,** 601–634.

Reijnders, P. J. H. (1980). Organochlorine and heavy metal residues in harbour seals from the Wadden Sea and their possible effects on reproduction. *Netherlands J. Sea Res.* **14,** 30–65.

Renzoni, A. & Norstrom, R. J. (1990). Mercury in the hairs of polar bears *Ursus maritimus*. *Polar Rec.* **26,** 326–328.

Rosing-Asvid, A. & Born, E. W. (1990). Fangst af isbjørn (*Ursus maritimus*) i Avanersuaq og Upernavik kommuner: en interviewundersøgelse. Technisk rapport—Grønlands Hjemmestyre. Miljø-og Naturforvaltning. Rapport Nr. 23—December 1990: Copenhagen, Denmark. 63 pp. (In Danish with English summary).

Schweinsburg, R. E. (1981). A brief history of polar bear management in the NWT. *Northwest Territories Wildlife Notes*, **2,** 1–5.

St. Aubin, D. J. (1990). Physiologic and toxic effects on polar bears. In *Sea Mammals and Oil: Confronting the Risks*. (eds J. R. Geraci & D. J. St. Aubin). Academic Press, San Diego, California. pp. 235–239.

Stenhouse, G. B., Lee, L. J. & Poole, K. G. (1988). Some characteristics of polar bears killed during conflicts with humans in the Northwest Territories, 1976–86. *Arctic* **41,** 275–278.

Stirling, I. (1980). The biological importance of polynyas in the Canadian Arctic. *Arctic* **33,** 303–315.

Stirling, I. (1988). Attraction of polar bears to offshore drilling sites in the eastern Beaufort Sea. *Polar Rec.* **24,** 1–8.

Stirling, I. (1990). Polar Bears and Oil: Ecologic Perspectives. In *Sea Mammals and Oil: Confronting the Risk* (eds J. R. Geraci & D. J. St. Aubin). Academic Press, San Diego, California. pp. 223–234.

Stirling, I. (1991). Management of shared populations of polar bears. *Trans. 56th N.A. Wildl. & Nat. Res. Conf.*, **56,** 488–493.

Stirling, I. & Andriashek, D. (1992). Terrestrial maternity denning of polar bears in the eastern Beaufort Sea Area. *Arctic* **45,** 363–366.

Stirling, I. & Calvert, W. (1983). Environmental threats to marine mammals in the Canadian Arctic. *Polar Rec.* **21,** 433–449.

Stirling, I. & Derocher, A. E. (1993). Possible impacts of climatic warming on polar bears. *Arctic* **46,** 240–245.

Stirling, I., Calvert, W. & Andriashek, D. (1984). Polar bear (*Ursus maritimus*) ecology and environmental considerations in the Canadian High Arctic. *Northern Ecology and Resource Management*. (eds R. Olsen, R. Hastings & F. Geddes). Edmonton: University of Alberta Press. pp. 201–222.

Stirling, I., Jonkel, C., Smith, P., Robertson, R. & Cross, D. (1977). The ecology of the polar bear (*Ursus maritimus*) along the western coast of Hudson Bay. Ottawa: Canadian Wildlife Service Occasional Paper. No. 33. 62 pp.

Taylor, M. K., DeMaster, D. P., Bunnell, F. L. & Schweinsburg, R. E. (1987a). Modelling the sustainable harvest of female polar bears. *J. Wildl. Manage.* **51,** 811–820.

Taylor, M. K., Bunnell, F. L., DeMaster, D. P., Schweinsburg, R. E. & Smith, J. (1987b). ANURSUS: A population analysis system for polar bears (*Ursus maritimus*). *Int. Conf. on Bear Res. and Manage.*, **7,** 117–125

Uspenski, S. M. (1977). *Belyi Medved* (The Polar Bear). Moscow, Nakva. (Unedited translation by Government of Canada Translation Bureau, Ottawa. No. 1541321, June 1978).

Uspenski, S. M. & Belikov, S. E. (1991). Polar bear population in the Soviet Arctic: current state, studies, and management. In Proc. 10th Working Meeting of the IUCN/SSC Polar Bear Specialist Group. Occasional Paper of the IUCN Species Survival Commission (SSC) **7,** 93–95.

USSR Delegates (1966). The polar bear: distribution and status of stocks; problems of conservation and research, USSR. In Proceedings of the 1st. International Scientific Meeting on the Polar Bear. U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, and the University of Alaska, Fairbanks. pp. 39–43.

Vibe, C. (1967). *Arctic Animals In Relation to Climatic Fluctuations*. Copenhagen: Meddelelser om Gronland Bind. No. 5. 227 pp.

Vibe, C. (1985). Miscellaneous information relating to polar bears in Greenland. Proceedings of the Eighth Working Meeting of the IUCN/SSC Polar Bear Specialist Group 1981, *Occasional Papers of the IUCN Species Survival Commission (SSC)*. pp. 44–57.

Watts, P. D. & Hansen, S. E. (1987). Cyclic starvation as a reproductive strategy in the polar bear. *Symp. Zool. Soc. Lond.* **57,** 305–318.

Watts, P. D. & Ratson, P. S. (1989). Tour operator avoidance of deterrent use and harassment of polar bears. *Bear–People Conflicts: Proceedings of a Symposium on Management Strategies*. (eds P. A. Gray & P. L. Clarkson). Government of the Northwest Territories, Yellowknife. pp. 189–193.