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# RESEARCH AND MANAGEMENT OF POLAR BEARS *URSUS MARITIMUS*

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ABSTRACT. Through the 1950s and 1960s there was a marked increase in recorded numbers of polar bears being killed for their hides, giving rise to world-wide concern that the species might be endangered. At a meeting in Fairbanks, Alaska 1965, representatives of circumpolar arctic nations discussed conservation of polar bears and concluded that international coordination of research and management efforts was essential. Subsequent meetings of scientists engaged in polar bear research were organized every two years by the International Union for the Conservation of Nature and Natural Resources, facilitating exchanges of views and cooperation; as a result, in 1973 the International Agreement on the Conservation of Polar Bears and their Habitats was signed in Oslo, Norway. This paper describes some of the research and management undertaken in the years leading up to the agreement, and initiatives that are continuing because of it.

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## Introduction

On 15 November 1973, the International Agreement on the Conservation of Polar Bears and their Habitat was signed in Oslo, Norway. The most significant aspect of this remarkable agreement from a political standpoint is that for the first time it brought the five arctic nations (Canada, Denmark, Norway, USA and USSR) together to negotiate the framework for resolving a unique circumpolar concern: the conservation of polar bears *Ursus maritimus*. No less significant from a biological standpoint is that the agreement is remarkably sound scientifically; it is not simply a protectionist document contributing solely to the welfare of bears and little of substance to related environmental issues. Though the agreement allows polar bears to be hunted and captured, it sets out specific conditions under which these may take place, for example for bona fide scientific purposes, to prevent serious disturbance of the management of other resources by local people exercising traditional rights, and for protection of life and property. The contracting parties agreed to conduct national research programmes on polar bears, with particular emphasis on conservation and management, and exchanges of data from their studies.

From an ecological point of view, Article II may be the most profound part of the Agreement. It states 'Each Contracting Party shall take appropriate action *to protect the*

*ecosystems of which polar bears are a part* (my emphasis), with special attention to habitat components such as denning and feeding sites and migration patterns, and shall manage polar bear populations in accordance with sound conservation practices based on the best scientific data.' Clearly the intention is to protect polar bear populations from becoming endangered because of hunting or the detrimental effects of man on the environment. Polar bears are potentially dangerous carnivores, requiring flexible management that rejects simplistic solutions—for example that all problems would be solved if the bears were no longer killed. To underline the significance of the agreement, this paper reviews the events that heralded international cooperation, how cooperation came about, and the current status of polar bear research and management resulting from it.

## Events leading to the agreement

Through the 1950s, and particularly during the 1960s, the rapidly-growing value of polar bear hides in North America and Europe, combined with increasing use of oversnow machines, stimulated unprecedented increases in numbers of polar bears reported killed. In Alaska, trophy kills alone increased from 139 in 1961 to 399 in 1966 (Lentfer 1970). In Canada between 1953 and 1964 the recorded harvest fluctuated between 350 and 550, and in 1967 suddenly rose to 726 (Schweinsburg 1981). Records from most countries were incomplete, so we shall never know the actual numbers of polar bears killed. During that period there was little scientific knowledge of polar bears, particularly their population size and movements. One commonly-held view was that all polar bears formed part of a single circumpolar population that ranged widely and at will from country to country throughout the Arctic (Pedersen 1945). Preliminary estimates of total world population were as low as 5,000–10,000 (Uspenski and Chernyavski 1965; Harington 1964). Uspenski and Shilnikov (1969) later estimated a world population of 10,000 animals, a figure based on only 58 bears seen during aerial survey flights over the sea ice in 1962, 1967 and 1968. These hypotheses could be neither confirmed nor rejected, but if they were even partly true, the future of polar bears could have been in jeopardy. The situation was aggravated by the way in which some polar bears were legally hunted. The largest outcry was over the use of aircraft for hunting polar bears in Alaska. Similarly lacking in sportsmanship though less frequent in occurrence was the shooting of polar bears on pack ice, or even in the water, from ships including Norwegian tour ships near Svalbard. On Svalbard between 1945 and 1970 Norwegian trappers took on average 324 polar bears annually. Many were killed with set guns, which indiscriminately killed or wounded whatever bear set them off, regardless of age or sex (Lønø 1970).

In response to growing concern about numbers killed each year, the first international meeting to discuss conservation of polar bears was held in Fairbanks, Alaska in 1965. Agreement was reached on the following points: the polar bear is an international circumpolar resource; each country should take whatever steps are necessary to conserve the polar bear until the results of more precise research findings can be applied; cubs, and females accompanied by cubs, should be protected throughout the year; each nation should, to the best of its ability, conduct a research programme on polar bears within its territory; each nation should exchange information freely, and the International Union for the Conservation of Nature and Natural Resources (IUCN) should facilitate such exchange; further international meetings should be called when urgent problems or new scientific information warrant international consideration. The results of this First International Scientific Meeting on the Polar Bear were published (Delegates 1966).

IUCN was asked by the five nations to act as an information centre and coordinate the exchange of research results on polar bears, but it was the Conservation Foundation in the United States that catalysed the next stages of development (Lentfer 1985). In 1967 it funded Dr Richard Cooley of the University of Washington to arrange a second gathering of polar bear scientists, and provided travel funds for them to meet at IUCN headquarters in Morges, Switzerland. At that meeting the scientists organized themselves into what is now the IUCN Polar Bear Specialists Group of the Survival Services Commission, a group which met every two years to discuss coordination of polar bear research and management. The group negotiated the objectives and text of the International Agreement on the Conservation of Polar Bears and their Habitat, which was signed in Oslo, Norway in 1973. Ratified by three countries (the minimum number required) on 26 February 1976, this came into effect three months later. The remaining two countries ratified shortly thereafter, making support for the agreement unanimous. After a trial period of five years the agreement was unanimously reaffirmed in 1981 for an indefinite period. Proceedings of all meetings of the Polar Bear Specialists Group are available from IUCN, 1196 Gland, Switzerland.

## Conservation responses

In the years following 1965 polar bears were still being killed in ever-increasing numbers. The countries involved could not afford to await results from long-term research or the negotiation of an international agreement; worldwide concern demanded immediate action. In 1968 the government of Northwest Territories (where most Canadian polar bears are killed) for the first time imposed quotas on all its villages (Schweinsburg 1981). In the absence of polar bear population data, the mean of the previous three years' harvest was calculated separately for each settlement, and a slightly lower value was set as the quota. Inuit hunters were told that this was an interim measure; quotas could be changed up or down when results from population studies were eventually made known. In 1971 Alaska ceased to allow residents an unlimited bag for their own use, establishing an annual limit of three bears per person. The number of sport hunting permits was limited in 1971 to 210 for the west area and 90 for the north area (Lentfer 1972). In 1972, when the Marine Mammal Protection Act was passed, all polar bear hunting ceased except by native people for subsistence purposes. Ironically, because the Act imposes no restrictions on subsistence hunters, there was no longer a closed season or protection for bears in dens or females with cubs. As a result, a significant proportion of the kill became concentrated on the most valuable section of the population, the reproductive females.

On Svalbard in 1970 the number of permits issued for killing polar bears was limited to 300 (Nordenhaug 1970), divided between residents, trappers, weather crews, sealers and tourist hunters. In 1973 the Norwegian government established a five-year moratorium on polar bear hunting, and to date this moratorium has not been lifted. In Greenland no changes in harvesting practices followed the 1965 meeting; Inuit hunters continue to harvest 100 to 150 polar bears per year. The USSR had already declared complete protection of polar bears in 1955 (Delegates 1966).

Stimulated by the 1965 Fairbanks meeting and subsequent biennial exchanges of information among the specialists group, an outburst of new polar bear studies began in the late 1960s and early 1970s. Research emphasized live-capture and tagging techniques, population dynamics, movements, methods of identifying sub-populations, evaluating maternity denning areas, and establishing baseline levels of toxic chemicals. In particular,

large numbers of polar bears were tagged in Alaska, Svalbard, and several areas of Canada (DeMaster and Stirling 1981). Surveys for and studies of maternity denning areas were made in all countries.

## Management-orientated research

*Techniques of capturing and marking*

Population studies of this large and potentially dangerous carnivore demanded the development of safe and efficient methods for immobilizing and individually marking substantial numbers. Techniques for handling free-ranging animals were at this time only just being developed. Flyger and others (1967) were the first to try drugging Alaskan polar bears, using dart guns from helicopters. Anectine (succinylcholine chloride) gave an unacceptably high rate of loss of animals, but further attempts using Sernylan (phencyclidine hydrochloride) were much more successful (Jonkel 1967; Larsen 1971; Lentfer 1971). Many large-scale mark-and-recapture studies were made in the late 1960s and 1970s. In 1980 Sernylan became unavailable; since then M99 and carphentanil citrate have been used with mixed success on bears (Miller and Will 1974; Haigh and others 1983), but in Canada at least their use has been restricted because of strict legal constraints, risks to humans in the event of spillage, and high cost.

Ketamine (ketamine hydrochloride) and Rompun (xylazine hydrochloride) were used satisfactorily for a time on polar bears (Lee and others 1981) but proved to have serious disadvantages. It was difficult to tell if a drugged bear was safe to approach when observed from a distance, and because breathing rate was lowered, bears that had run or were drugged on warm days sometimes suffered hyperthermia because they could not thermoregulate. Sometimes they got up without warning, which was dangerous for both biologists and bears. Recent tests of Yohimbine as an antagonist have facilitated a significant breakthrough in the use of Ketamine and Rompun. By injecting Yohimbine sublingually, the heart beat and respiratory rate can be increased markedly, and an immobilized bear can be capable of walking again and thermoregulating within a few minutes (Ramsay and others 1985). In recent tests Telazol (tiletamine hydrochloride and zolazepam hydrochloride) has been shown to act quickly (Haigh and others 1985; Stirling and others 1985); drugged bears are safer to approach, heart and breathing rates are not depressed, and the animals can thermoregulate while drugged. They do not have convulsions (a drawback to chemically-similar Sernylan), recover quickly, and are not aggressive when waking up. From results obtained to date, Telazol may be one of the best drugs so far available for use on bears. Its use, along with Rompun, Ketamine and Yohimbine, will ensure the continuation of large-scale mark-and-recapture studies or the immobilization of individual bears for physiological research and other special purposes.

## Discreteness of sub-populations

Large numbers of polar bears were tagged in population studies in Alaska, Svalbard, and several parts of Canada (DeMaster and Stirling 1981). When movements of these bears were analysed, it quickly became apparent that polar bears are distributed in many relatively discrete sub-populations, rather than in one continuous population that ranges throughout the Arctic as Pedersen (1945) suggested. Within Canada for example there are 10 or more sub-populations which are regarded as discrete enough to range independently. Similarly, Lentfer (1974, 1983) has shown that the populations of polar bears off western and northern coasts of Alaska appear to be relatively discrete. Taking the data available, it appears that the polar bears occupying the area from northeast

Greenland, to Svalbard and Zemlya Frantsa-Iosifa [Franz Josef Land] belong to a single population (Larsen 1985a). In comparative studies using parameters as different as skull morphology and pesticide levels, significant variation was found between polar bears from different areas, which also suggested separate genetic stocks with limited exchange (Manning 1971; Lentfer 1974; Eaton and Farant 1982).

Polar bears are difficult to see, and are distributed at fairly low densities over large, often relatively inaccessible areas. Even people experienced in arctic travel do not see many; consequently the idea has grown that the total population is small, especially in relation to the number of bears killed annually, and could be declining. From mark-and-recapture studies it has become apparent that numbers are higher than previously thought; estimated world total is now between 20,000 and 40,000. Although estimates of world population attract the attention of many people, it is more important to delineate the size and discreteness of sub-populations, because it is at their level that the species must be managed.

*Maternity denning areas*

In many areas where polar bears den, for example the vast area of the Canadian Arctic islands, they appear to live at low densities (Stirling and others 1978, 1984). Even where suitable polar bear habitat appears to be unlimited, there are particular areas such as the west coast of Banks Island, southeastern Baffin Island, Gateshead Island, and the Simpson Peninsula where dens are relatively more abundant (Harington 1968; Stirling and others 1975, 1978, 1980; Schweinsburg and others 1984). Harington (1968) called these 'core areas'. What makes the bears prefer these areas is in most cases not clear, though some, including the west coast of Banks Island and southeastern Baffin Island, are close to places where ringed seals *Phoca hispida* pup, and where female polar bears with newborn cubs may begin to hunt soon after leaving their maternity dens.

Ostrov Vrangelya [Wrangel Island] in the USSR and Svalbard are isolated island groups situated in vast areas of excellent polar bear sea ice habitat. It is perhaps not surprising that dens are abundant there. However, even in these areas they tend to concentrate in a small number of favoured areas rather than being widespread (Uspenski and Kistchinski 1972; Larsen 1976, 1985a). Similarly, along the Manitoba coast of Hudson Bay, maternity denning is concentrated in two areas, south of Churchill and east of York Factory (Jonkel and others 1972; Stirling and others 1977; Ramsay and Stirling 1982). About 100–150 cubs leave the Churchill denning area per year, while the largely unstudied latter area appears to have fewer denning females. In contrast to the way maternity dens are concentrated in Manitoba, dens along the same coastline in Ontario, only a few hundred miles away, appear to be widely spread out at low density (Kolenosky and Prevett 1983).

*Legal protection of polar bear habitat*

Over the years, as data from population ecology studies have accumulated, several areas which include critical habitat for polar bears have been given some degree of legal protection. Approximately 40% of the land area on Svalbard was protected by Royal Decree in June 1973. This included three National Parks, two nature reserves and 15 bird sanctuaries. In 1976 the northeast Svalbard nature reserve was made into a biosphere reserve under UNESCO's Man and the Biosphere Programme. Because of this, most of the denning areas and important summer sanctuaries are now protected (Larsen 1980); even entry by scientists to study polar bears is allowed only by permit.

The Northeast Greenland National Park, established in 1973, includes a lot of good polar bear habitat, but even people from neighbouring settlements are allowed to hunt

only as far as a sledge can travel in one day. Part of Melville Bugt in northwest Greenland is proposed as a reserve where hunting and all movement would be totally prohibited. All identified denning areas in Greenland now receive protection up to 12 miles [19.3 km] out to sea (Vibe 1980).

In 1976, Ostrov Vrangelya and Ostrov Geral'd [Wrangel and Herald Islands], important polar bear denning areas in the USSR, were designated State Reserves. Managers of such reserves can stop or restrict all human activity, including research, and visitors are not allowed (Uspenski and others 1980).

Canada's Polar Bear Provincial Park was established along the Hudson Bay coast of northeastern Ontario. A wilderness area where motorized transport is prohibited, it is important both for denning females and for bears of all age and sex classes in the summer. In Manitoba the Cape Tatnam and Cape Churchill Wildlife Management Areas were established in 1968 to allow managers to regulate activities, including research, along the coast. These are large, and include most of the important denning areas and summer sanctuaries along the western coast of Hudson Bay. In southeastern Baffin Island, Auyuittuq National Park, which was mainly set aside because of its spectacular scenery, contains a small amount of polar bear denning and summer habitat in northern fiord areas.

## Fundamental research

Because initial concern about polar bears was related to their conservation, early studies were orientated towards population size, discreteness, and reproductive parameters. However it quickly became apparent that much pure research was needed in several areas to promote understanding of much of the data collected, and patterns in the observations made during the mark-and-recapture studies. The following aspects are currently under investigation.

*Physiology*

Considerable research has been conducted on aspects of hibernation and energetics of thermoregulation, particularly at Barrow, Alaska and Churchill, Canada. Cardiac physiology of resting and active bears has been studied, especially to evaluate the energy required by individuals and populations of polar bears to survive through the year (Folk and others 1972; Øritsland and others 1974; Øritsland and Lavigne 1976; Best and others 1981; Hurst and others 1982). Polar bears use their fat both for insulation and to meet their energy requirements; their oxygen consumption rate while walking is about double the rate of most mammals, and heat is lost by conduction through the foot pads, face and shoulders, and through the mouth by panting.

In most parts of the range of the polar bear, the annual sea ice melts for at least part of the summer, forcing the bears either to migrate northward to where there is still some ice cover, or to go ashore and fast until the ice freezes again. In lower Hudson Bay, the open water season is about four months long; there is nowhere to migrate, so the polar bears must come ashore (Stirling and others 1977). On landing about early August they are at or close to maximum weight. Though they may browse vegetation and scavenge opportunistically (Russell 1975), they feed little and spend most of their time resting and conserving stored energy (Knudsen 1978; Latour 1981; Lunn 1984). Recent research on serum urea and creatinine levels suggests that all polar bears on land in summer, and adult females in maternity dens in winter, spend a significant amount of their time in a physiological state similar to that of a black bear during normal winter hibernation (Nelson and others 1983, 1984). This finding is particularly significant because it suggests

that the polar bear may be able to change its physiological state facultatively to suit changes in environmental conditions or food availability.

*Behaviour*

The behaviour of free-ranging polar bears has been studied long-term at several locations to discover how sea ice habitat is used by different age and sex classes, to determine hunting efficiency, to evaluate whether or not the trauma of capturing and tagging polar bears influences behaviour (it does not), and to quantify activity budgets of bears in summer on land away from their normal food sources. The behaviour of females with newborn cubs in maternal denning areas, before they return to the sea ice to hunt seals, has also been observed (Stirling 1974; Stirling and Latour 1978; Knudsen 1978; Latour 1981; Hansson and Thomassen 1983). These and similar studies are developing because they are critical to our understanding distributional and seasonal movements observed during mark-and-recapture studies. At a more fundamental level these studies will also help develop our understanding of how polar bears adapted to their present habitat, which in turn should eventually help us to conserve the species more effectively.

*Population modelling*

Population models of brown bears *Ursus arctos* developed by Bunnell (1974) were later applied to polar bears (Stirling and others 1975). Since then the approach has become considerably more complex, and the field is developing rapidly using models as research tools (Taylor and others 1984). None of the models developed can yet be relied upon as management tools, but the IUCN Polar Bear Specialists Group gives this the highest priority in future research. An extension of this approach is to model the polar bear in its ecosystem using data on population dynamics, behaviour, physiology and environmental variables in such a way that they can interact dynamically. One important application of this approach is to predict what the consequences of perturbations of one part of the ecosystem will be on other components. This would have enormous value in environmental assessment when evaluating the possible effect of offshore exploration for hydrocarbons on the distribution and abundance of seals and polar bears.

*Detection and deterrence of problem bears*

As the number of human visitors to the Arctic increases, so does the number of interactions between people and bears; in Canada alone 20 to 40 polar bears are shot annually to protect life and property. There is concern both for human safety and for this addition to the annual kill of polar bears. In areas where the size of the polar bear population has been estimated, quotas are set at levels close to what is thought to be the maximum sustained yield. If the harvest is close to the maximum for a particular population, any additional killing may result in over-harvesting. This is a further area in which simulation modelling of the population can be extremely helpful.

Research is concentrated in two areas. Firstly, early detection of bears when they first arrive on the scene allows them to be chased away before people or bears are injured (Wooldridge 1983; Stenhouse 1983). Methods under test include electric fences, tripwires, and laser beams that set off alarms when crossed. Secondly, once a bear is detected, it may be deterred without killing by loud noises, electrified fences, and projectiles. Rubber bullets fired from 38 mm riot control guns were very effective (Stenhouse 1983) but their use is restricted in most countries; research continues on smaller projectiles fired from 12–gauge shotguns, that inflict a sharp but harmless stimulus (Gray 1984).

## Conclusion

Since the first international meeting on the conservation of polar bears in 1965, progress in research and management has been impressive. Though large gaps in our knowledge remain, an enormous amount of research has been completed; results are already incorporated into changes in regulations, and are influencing the protection of critical areas of polar bear habitat throughout the Arctic. Through cooperation between the circumpolar nations there now exist effective mechanisms—the International Agreement on the Conservation of Polar Bears and their Habitat, and the IUCN Polar Bear Specialists Group—through which continued research and management of polar bears is coordinated nationally and internationally. In an age when species are becoming progressively endangered, and environmental degradation continues on a global scale, the history of research and management of polar bears represents an international success story in conservation.

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