Human-polar bear conflicts in East Greenland: lessons learned from the circum Arctic


© Sergei Kavry

Femke Koopmans, October 2011

WAGENINGEN UNIVERSITY
WAGENINGEN UR

WWF

Human-polar bear conflicts in East Greenland: lessons learned from the circum Arctic

Femke Koopmans
Oktober, 2011

Supervisors:
Arjen Buijs
Forest and Nature Policy Group
Wageningen University

Gert Polet
Advisor Protected Area Networks &
Species Conservation
WWF- Netherlands

WAGENINGEN UNIVERSITY
WAGENINGEN UR

Abstract

This study assesses the perceived increase in human-polar conflicts in East Greenland. Insight was gained in polar bear subpopulation size, factors which impact these subpopulations and trends in human-polar bear conflicts in East Greenland and three other Arctic regions. Lessons learned from conflict mitigation practices in Vankarem (Russia), Churchill (Canada), and Svalbard (Norway) were used to find suitable measures to mitigate conflict in East Greenland. Data was collected from scientific papers, supplemented with anecdotal information in reports and information gained from interviews with experts. The overall trend of the worldwide population, which is divided in 19 subpopulations, shows a decrease in number of polar bears. However, some subpopulations show an increase, as was also reported by local people who see more polar bear in vicinity of human settlements in recent years. The overall scientific explanation for this increase is the prolonged period of time polar bears spend on land when ice sheets diminish as a result of climate change. An increase in human activity in the Arctic further increases the potential for interaction between people and polar bears. In East Greenland, Vankarem and Churchill the number of human-polar bear conflicts has increased, and in Svalbard the potential for conflicts grew in recent years. Additional non-natural mortality as a result of human-polar bear conflicts can affect polar bear subpopulations which are already impacted by harvest, human disturbance, habitat loss and contaminants. Moreover, there are many social aspects related to human-polar bear conflicts which require attention. People's feeling of safety and even livelihoods can be at risk when no attention is paid to the mitigation of conflicts. Despite the fact that the collection of sufficient data proved to be challenging in this study, some advise can be given about measures to be taken to mitigate conflicts in East Greenland. More research is needed on polar bear population size and structure, trends in conflict numbers over time and the perception of local people on conflicts. If research shows a need of conflict mitigation, concrete measures should be taken such as improved waste management, food storage and fencing of waste dumps and dog facilities. In the case of significant conflicts and high involvement of local communities and the government, polar bear patrols can be established for long term polar bear deterrence and population monitoring. Even if conflicts are not perceived to be problematic, anticipation on future situations with expected increased interaction between people and polar bears is important. Education programmes should be used to raise awareness among local communities and visitors on how to increase conflict avoidance.

Main recommendations for East Greenland:

- More detailed research on polar bear sub-population size, local situation, and perception of local communities on human-polar bear conflicts;
- In cooperation with local people suitable interventions should be selected and implemented;
- Long term impacts such as climate change, and mitigation of conflicts need to be addressed simultaneously;
- At a minimum education programmes are needed to anticipate on expected increased human-polar bear interactions.

Contents **Page nr.**

List of abbreviations

ACIA	Arctic Climate Impact Assessment
COSEWIC	Committee On the Status of Endangered Wildlife In Canada
DEW	Distant Early Warning
DLP	Defence of Life and Property
HTO	Hunters and Trappers Organisation
IUCN	International Union for the Conservation of Nature
IUCN PBSG	IUCN Polar Bear Specialist Group
IUCN SSC	IUCN Species Survival Commission
KNAPK	Kalaallit Nunaanni Aalisartut Piniartullu Kattuffiat (Greenland hunters and fishermen association)
MMPA	Marine Mammal Protected Area
PBHIMS	Polar Bear-Human Information Management System
USFWS	United States Fish and Wildlife Service
WWF	World Wide Fund for nature

Section I Introduction and methods

1. Introduction

This study assesses human- polar bear conflict in eastern Greenland which some people believe to be increasing (pers com. Aksel Blytmann, May 13, 2011), and aims to give recommendations for mitigation measures to be tested and implemented based on experiences elsewhere in the Arctic.

Polar bears are completely adapted to-, and dependent on sea ice where they mainly hunt ringed and bearded seals. In areas were polar bears have access to sea ice year round, they are able to hunt for seals the entire year. However, subpopulations in areas where sea ice melts are forced to spend some months on land fasting on stored fat reserves until freeze-up. Use of land by polar bears during the ice-free season appears to be increasing in certain locations, such as in the Southern Beaufort Sea (Schliebe et al., 2008a), and the Western Hudson Bay (Derocher et al., 2004). When polar bears spend time on land, an increasing chance for conflicts between local people and these bears arises which can lead to the death of 'problem' bears and death or injuries to humans. Beside the increased number of polar bears on land, attractants such as waste dumps and the remains of kills (such as whale or seal carcasses) can attract polar bears and result in conflicts. Such conflicts include bears entering communities, waste dumps, hunting and research camps or industrial sites and can lead to destruction or damage of human life and property, raiding food caches, attacked dogs and endangering public safety (Stenhouse et al. 1988). According to Stirling & Calvert (1983), increasing human populations, economic development and an increasing interest in the Arctic as a tourist destination are expected to result in to more human- polar bear interactions. Another factor possibly increasing the number of conflicting situations is retreating sea ice, as a result of climate change, which affects access to prey (Schliebe et al., 2008a). When not able to hunt for seals on sea ice, bears are forced on shore for extended periods of time, which possibly increases the potential contact between local people and polar bears.

Hard evidence of increasing human-polar bear interactions and conflicts is however patchy and reported cases are incomplete in terms of numbers of people and animals involved. Furthermore, analysis is hampered by differences in record keeping between the different Arctic states and territories, and despite recent efforts to create one (Wilder, 2009) under the auspices of the IUCN Polar Bear Specialist Group (PBSG), there is yet no circumpolar database which records human-polar bear conflict incidents.

In this study three case studies were used to assess the successfulness of conflict mitigation methodologies applied in these different localities (i.e. Chukotka (Russia), Churchill (Canada) and Svalbard (Norway)). These sites have been selected on the basis of such mitigation measures being implemented and the relatively good availability of information for these sites. Lessons from these case studies could be tested and applied in eastern Greenland to mitigate human- polar bear conflict.

Objectives

The first goal of this research is to get insight in human polar bear conflicts in East Greenland and the case study areas. The second goal is to provide an overview of mitigation measures practised in human-polar bear conflicts in Chukotka (Russia), Churchill (Canada) and Svalbard (Norway), to assess the effectiveness of these measures. With a clear understanding of the contextual factors which contribute to the success or failure of any of the used methods, appropriate solutions can be sought for human- polar bear conflicts in East Greenland.

Research questions

What is the development of human- polar bear conflicts in East Greenland?

1. How many human-polar bear conflicts take place on a yearly base?
2. How many polar bears are lost each year in defence of life and property?
3. What is the number of human casualties each year?
4. What is the relative impact of human-polar bear conflicts to polar bear subpopulations compared to other threats and stressors?

What methods are used to successfully reduce human-polar bear conflict (from 4 case studies)?

5. What was the development of human-polar bear conflicts over time in these particular cases?
6. Which contextual factors explained these conflicts?
7. Which conflict mitigation methodologies are being practised in each of the case studies?
8. How effective are these methods since their application in terms of trends in:
   - number of recorded conflicting situations;
   - number of polar bears being scared off or relocated;
   - number of killed polar bears;
   - number of human casualties.
9. How are local communities being involved in the mitigation of human- polar bear conflicts?;
10. Which contextual factors contribute to the success or failure of each of the mitigation methods?

2. Methods

2.1. Study area

This study focussed on East Greenland. Besides, three areas where conflict mitigation measures were implemented were used as case study areas (Vankarem (Chukotka, Russia), Churchill (Manitoba, Canada) and Svalbard (Norway)) (Figure 1.). In the following chapters information is given on country level, with details about the villages of interest when available.

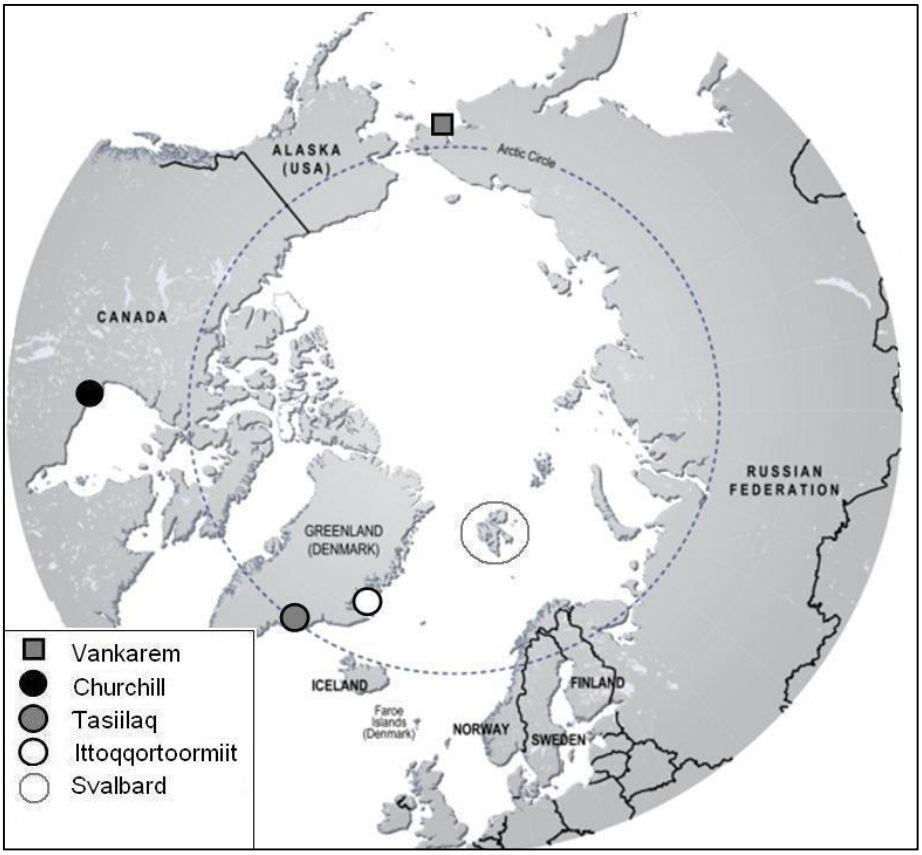


Figure 1. Location of study areas in Arctic circle (Hugo Ahlenius, UNEP/GRID-Arendal, 2006).

East Greenland: Ittoqqortoormiit and Tasiilaq

Greenland, called Kalaallit Nunaat ("Country of the People") in Inuit, is the world's largest island. The total area of Greenland is 2,175,600km^2 and stretches from Nunap Isua in the South (59.46° N) to Odaap Qeqertaa (83.40° N), which is the northernmost territory in the world. Greenland is covered for 85% by the world's second largest ice cap; the Greenland Ice Cap which is approximately 3,500 meter thick at its thickest point. Because of the large cover of sea ice, some areas in the North and on the East coast can only be reached by boat for a few months in summer (Bugge Jensen & Diget Christensen, 2003). In 2009 89% of the total population of 56,194 was Inuit and the remaining 11% Danish or from other backgrounds (Greenland in figures, 2009).

Ittoqqortoormiit is located on the East coast of Greenland in the Kangersuttuaq fjord system. The Danish name for the municipality is Scoresbysund, named after the English Whaler, William Scoresby, who was the first to map the area in 1822. About 550 people live in the town of Ittoqqortoormiit.

Tasiilaq can be found South of Ittoqqortoormiit, on Ammassalik island, a little more than 100 km South of the Polar Circle. With around 2,000 inhabitants it is the largest town of East Greenland. The name, Tasiilaq, means “like a lake”, and refers to the fjord, which is only accessible from the sea by a narrow entrance.

The size of East Greenland polar bear subpopulation is unknown since no inventories have been conducted in recent years (IUCN, 2009).

Case study area 1: Vankarem-Chukotka- Russia

The Chukotka region of Russia, officially the Chukotsky Autonomous Okrug, covers an area of 700,000 square kilometres and stretches from the Arctic Ocean in the North to the Pacific Ocean in the East. It is located close to the US, separated by the narrow Bering Strait. The total human population is 54,000 of which 11,000 live in Anadyr (the capital) and 4,000 in Pevek. Beside these two large cities, there are six smaller settlements which serve as district centres and 28 percent of the indigenous population lives in “national villages” (www.SRAS.org, accessed July 5, 2011). Ecologically, Chukotka can be divided into three distinct areas: the northern arctic desert, the central tundra, and the taiga in the South. About half of its area is above the Arctic Circle. This area is very mountainous, containing the Chukotsky Mountains and the Anadyr Range. In 1960, Wrangel Island was established as a wildlife refuge and later upgraded to a state nature reserve (Zapovednik), the only one in Chukotka. Moreover, there are three special protected areas for wildlife: the Avtatkuul, Ust-Tanyurersky and Chaunskaya Guba Regional Wildlife Refuges (WWF, 2006).

The village Vankarem is located on the northern coast of Chukotka, Cape Schmidt to the west and Kolyuchinskaya Bay to the east. The town is largely inhabited by indigenous Chukchi and Siberian Yupik people and has a population recently recorded at 100-110 people (pers com. Viktor Nikiforov, August 8, 2011).

The Chukchi Sea polar bear subpopulation which uses this area is shared with western Alaska (US). Reliable estimates of subpopulation size or status based upon mark-recapture or other scientific techniques (e.g., aerial survey) are not available for the Chukchi Sea subpopulation (IUCN, 2009).

Case study area 2: Churchill-Manitoba - Canada

The most northern community of the province of Manitoba is Churchill, located on the south western shores of Hudson Bay at the mouth of the Churchill River, approximately 1,000 kilometres north of Winnipeg. The Churchill area has been inhabited since 1700 BC and the present total human population counts about 1,100. Internationally, Churchill is known as the ‘polar bear capital of the

world'. Since the area is located along the tree line or the northern edge of the Boreal Forest, Churchill attracts arctic and boreal species of wildlife, birds and plants (www.town of Churchill.ca, accessed July 7,2011).

In Churchill, the Western Hudson Bay polar bear subpopulation can be found (Towns et al., 2009). According to the report of Regher et al (2007), the Western Hudson subpopulation declined from 1,194 animals in 1987 to 935 in 2004.

Case study area 3: Svalbard - Norway

Svalbard is a archipelago located in the Norwegian Sea, about 565km North of Norway and contains three large and several more small islands between 71°-81° N & 10°-35° E. The archipelago, which covers an area of about 63,000km^2 , is covered for 60% by glaciers. Svalbard is the Norwegian term for 'cold coast' and is mainly used for the largest island of the archipelago. Another common name for Svalbard is 'Spitsbergen', given by the Dutch explorer Willem Barentsz in 1596. About 25,000 people inhabit Svalbard and Longyearbyen is the capital (www.spitsbergen-svalbard.info, accessed July 7, 2011).

Svalbard is covered by the Barents Sea polar bear subpopulation, which was estimated on approximately 2,650 individuals in August 2004 using aerial survey techniques (Aars et al. 2009).

2.2. Data collection

In principle the study limits itself to data which have been officially recorded and released by the different authorities, presented in IUCN-SSC Polar Bear Specialist Group reports. Where available, more detailed information has been used from a range of sources (anecdotal information in reports, interviews with experts and local people) which is however most often not substantiated with standardised data sets. An overview was made of important data available or missing for the selected Arctic countries and villages. Questionnaires were created for each of the selected case study sites, focussing on the local context and missing data. Two separate questionnaires were made, one targeting specialists, or key respondents, and one targeting local people. Both questionnaires addressed the same issues, with different use of language. In Appendix I the questionnaire send to key respondents can be found.

The first part of the questionnaires focussed on trends in polar bear numbers in and around the study sites. These questions were followed by a list of questions about human-polar bear conflicts and how people cope with them. A list of possible impacts to polar bear subpopulations was presented and respondents were asked to give an indication of the relative importance of each impact to polar bears near their village. They were also asked to put them in order of relative importance – starting with the most important.

The last part of the questionnaires focussed on the use of mitigation strategies and their effectiveness. Each of the selected Arctic countries uses different types of mitigation strategies, such as polar bear patrol groups. Information about these groups could be found in literature, but data on the organisational aspects were missing. Other questions focussed on their effectiveness in terms of trends in killed polar bears, human injuries, number of conflicts, etc. The questions on mitigation strategies were less applicable to the target villages in Greenland, since no mitigation strategies have been implemented here yet.

The questionnaires were send by electronic mail to respondents selected with help of Geoff York, head aquatic species conservation at WWF Canada. A total of four key respondents were selected; Mickael Stishov (WWF Russia), Mike Pederson (Department of Wildlife, North Slope Borough, Alaska), Daryll Hedman (Government Manitoba, Canada) and Aksel Blytmann (KNAPK, Greenland). They were asked to share contact details of more relevant respondents and were approached for further in-depth telephone interviews.

It turned out that some respondents were not available during the time of this study or had no time to fill in the time consuming questionnaires. It was decided to focus more on data presented in scientific papers, supplemented with anecdotal information in reports and information gained from interviews with experts. Many respondents were addressed by phone to get more detailed information about human-polar bear conflicts in their region and the type of mitigation strategies used, appendix II shows the list of respondents who shared information. Unfortunately this information is not as detailed as hoped for by using questionnaires. Moreover, since little detailed information on the polar bear work in Barrow, Alaska could be found, and none of the selected respondents replied to mail or phone calls, this case study was deleted from the study.

As a result of lacking quantitative and qualitative data only few of the stated research questions could be answered of which most answers were comprised of expectations and ideas rather that facts and figures.

Section II Status of- and impacts on polar bear populations

3. Population figures

Polar bears (*Ursus maritimus*) have a circumpolar distribution (Canada, Greenland, Norway, Russian Federation, the United States, and occasionally in Iceland). The species is listed as 'vulnerable' on the IUCN Red List with an estimated global number of 20,000 to 25,000 individuals, divided in 19 subpopulations. Considerable overlap of putative subpopulations occurs and genetic differences among them are small (Schliebe et al., 2008b). Studies carried out for all 19 subpopulations showed that seven are in decline, three are stable, one is increasing and for eight subpopulations data on status is inaccurate or deficient (Figure 2). The overall trend of the world wide population shows a decrease in number of polar bears (Schliebe et al, 2008b). This study focuses on subpopulations present in Greenland, Russia and Canada which are all in decline.

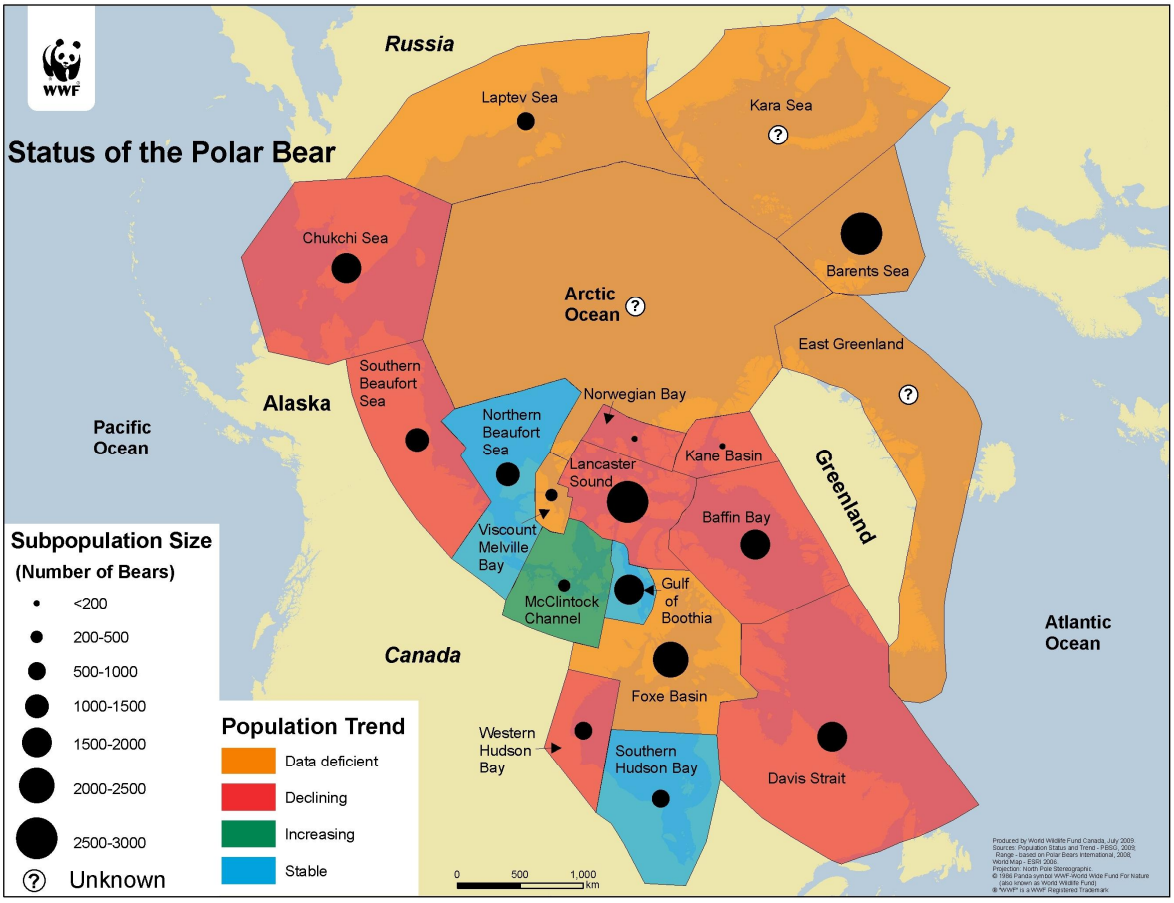


Figure 2. Map of location, size and trends of polar bear subpopulations in the Arctic (WWF, 2009)

East Greenland: Ittoqqortoormiit and Tasiilaq

Greenland is home to five subpopulations; the Davis Strait population; ± 2,142 animals, in decline (Peacock, 2009), Baffin Bay population; ± 2,047 animals, in decline (Taylor et al., 2005), Kane Basin population; ± 164 animals, in decline (Taylor et al., 2008), the East Greenland population; data deficient and the Polar basin population; data deficient (IUCN, 2009).

The eastern and southern side of Greenland, the study area of this research, is home to the East Greenland subpopulation where no inventories have been conducted in recent years to determine the size of the polar bear subpopulation. The opinion of hunters in East Greenland, who were interviewed by Sandell et al. (2001), was that polar bear abundance show natural fluctuations related to fluctuations in prey (mostly seals) abundance which depends in variation in the extension and seasonal distribution of sea ice. Although no recent census of the sub-population has been conducted, local people report an increasing number of polar bears in East Greenland, possibly related to a growing number of seals (prey species). This idea was shared by Aksel Blytmann (pers com. July 12, 2011), who stated that seal populations have increased up to 2 million individuals in recent years.

Case study area 1: Vankarem- Chukotka- Russia

The polar bears present in Russia (the Russian Arctic) include three subpopulations; the Kara-Barents population, the Laptev population and the Chukotka-Alaska population. This last subpopulation covers the eastern part of the East Siberian Sea, the Chukchi Sea, and the northern part of the Bering Sea. The Chukchi Sea subpopulation is shared by Russia and Alaska, and includes parts of the Chukchi and Bering Seas adjacent to the western and north-western coasts of Alaska. Reliable estimates of population size or status based upon mark-recapture or other scientific techniques (e.g., aerial survey) are not available but the subpopulation is believed to be declining (IUCN, 2009).

Case study area 2: Churchill- Canada

The town of Churchill, Manitoba on the western coast of Hudson Bay is located in the area inhabited by the Western Hudson Bay polar bear subpopulation (Towns et al., 2009). The distribution, abundance, and population boundaries of the Western Hudson Bay subpopulation have been intensively studied. At times, over 80% of the adult population has been marked, and there are extensive records from mark-recapture studies and the return of tags from bears killed by Inuit hunters. According to the report of Regher et al (2007), the Western Hudson population declined from 1,194 animals in 1987 to 935 in 2004. The survival of cubs, sub-adults, and old bears were negatively correlated with the date of breakup of sea ice. The earlier the breakup, the poorer the survival and conversely.

Case study area 3: Svalbard - Norway

Ecological data indicates that this subpopulation has grown steadily in the first decade, since the ban on hunting was implemented in 1973. In August 2004 the subpopulation was estimated on approximately 2,650 individuals (Aars et al., 2009).

Studies on the movement of individual polar bears have shown that bears associated to Svalbard are very restricted in their movements. However, on population level, bears from the Barents Sea subpopulation range widely between Svalbard and Franz Josef Land (Wiig 1995, Mauritzen et al. 2001). There may be some overlap and/or exchange between the Barents Sea and Eastern Greenland subpopulations (Paetkau et al. 1999).

4. Impacts on polar bear populations

Most polar bear subpopulations are in decline and face some major impacts. The flowchart in figure 3 shows the most important impacts to polar bears and how these are interlinked. The upper bar indicates whether the impact indirectly affects a population or whether this population is immediately affected. The most acute impact is non-natural mortality due to hunting and conflict. Human disturbance and especially contaminants put further pressure on polar bears, also in terms of declining reproduction success. The biggest long-term impact to the global polar bear population is however climate change. Scientists predict a decline of roughly 10-50% of the annual sea ice by 2100 (Schliebe et al., 2008b), resulting in the loss of habitat to a large part of the global population which has therefore a very bleak outlook to long-term survival. Climate change resulting in diminishing suitable habitat is the most important long-term threat to the survival of polar bears as a species. Non-natural mortality of polar bears (harvest and conflict) pose the most important short-term threats to polar bears.

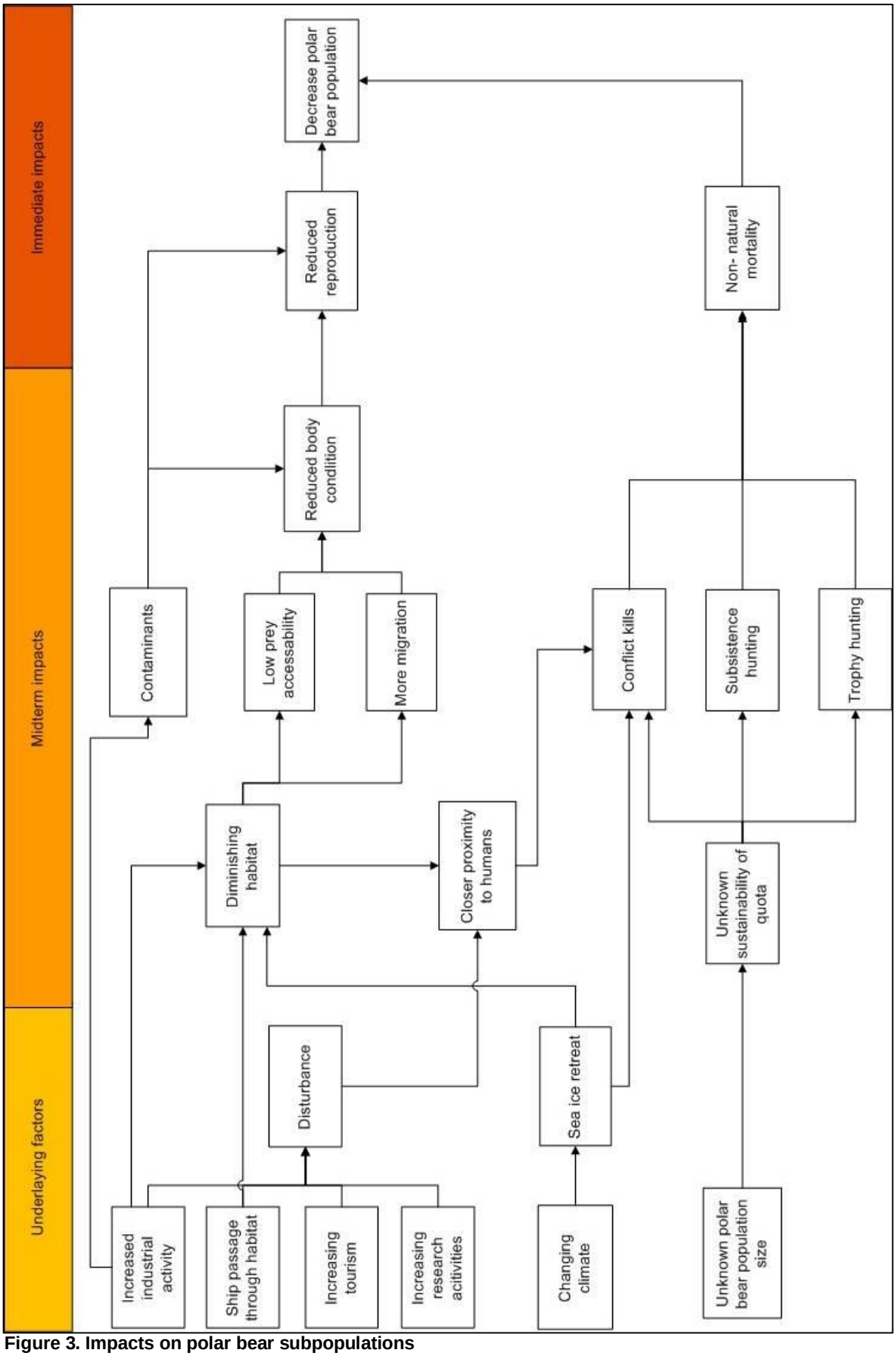


Figure 3. Impacts on polar bear subpopulations

4.1. Immediate impacts

Immediate impacts may have significant effect on polar bear subpopulations on a small time scale. They mainly have a local source and will be discussed her for each of the case study areas.

4.1.1. Harvest

In the 1960's polar bears have been hunted indiscriminately throughout their range. Steeply falling polar bear numbers due to unregulated harvest prompted governments to regulate hunting and improve polar bear protection for which they signed the International Agreement on the Conservation of Polar Bears in 1973 (IUCN PBSG, 2011).

Annually a substantial number of polar bears are harvested. Throughout the range, polar bears harvests are regulated, table 1 gives an overview of the hunting status per country. Harvest regulations usually take sustainability at sub-population level into account. Uncertainty regarding sub-population size is however complicating the ability to set sustainable quota levels. This is the case in East Greenland which sub-population has not been assessed in recent years.

Table 1. Overview of hunting status per country (IUCN, 2009).

Country	Hunting status
Greenland	Regulated hunting (quota), no trophy hunting
Russia	Ban on hunting, but illigal hunting takes place
Canada	Regulated hunting (quota), and trophy hunting
Norway (Svalbard)	Ban on hunting

Hunting and fishing are still important traditions in indigenous Arctic communities. These activities do not only provide food, they are also socially, economically and culturally meaningful and important to the Inuit daily life (Kishigami, 2008). Beside whales, seals and small terrestrial mammals, also polar bears are hunted. They provide Inuit hunters with meat, fat which is used to make oil that keeps sealskin straps and whips soft and elastic and hides which are used for local clothing and the rims of gloves and boots (Bugge Jensen & Christensen, 2003). Moreover, trophy hunting is being practiced in Canada. The average annual harvest across the Arctic amounted 772 animals over harvest years 2003-2004 till 2007-2008 (Table 2). Illegal hunting in Russia is believed to amount to about 100 animals per year (pers com. Thor Larsen, July 17, 2011).

Table 2. Harvest figures per polar bear subpopulation for harvest years 2003-2004 till 2007-2008 (IUCN, 2009).

	Harvest year				
Population per country	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008
Baffin Bay					
Greenland	164	155	134	75	66
Canada	72	97	98	99	99
Davis Strait					
Greenland	1	3	4	0	1
Canada	68	58	49	55	64
Foxe Basin					
Canada	96	100	102	102	105
Gulf of Boothia					
Canada	41	66	65	72	56
Kane Basin					
Greenland	12	9	25	5	5
Canada	0	1	0	0	0
Lancaster Sound					
Canada	79	87	81	94	74
M'Clintock Channel					
Canada	0	2	3	3	3
Northern Beaufort Sea					
Canada	36	36	27	31	17
Norwegian Bay					
Canada	3	4	3	4	4
Southern Beaufort Sea					
Canada	28	19	10	16	14
USA (Alaska)	?	44	44	31	28
Southern Hudson Bay					
Canada	44	27	35	37	34
Viscount Melville Sound					
Canada	5	5	4	6	3
East Greenland					
Greenland	59	54	51	55	59
Chukchi Sea					
USA (Alaska)	?	17	45	40	6
Russia	0	0	0	0	0
Western Hudson Bay					
Canada	52	43	37	58	33
Arctic Basin					
Greenland	0	0	0	0	0
Canada	0	0	0	0	0
Laptev Sea					
Russia	0	0	0	0	0
Kara Sea					
Russia	0	0	0	0	0
Barents Sea					
Norway	0	0	0	0	0
Total	760	827	817	783	671

East Greenland: Ittoqqortoormiit and Tasiilaq

Harvest in Greenland has been regulated by the governmental authority through hunting quota since 2006, allowing the harvest of approximately 150 animals per year for subsistence or trophy (Table 3). The actual annual harvest is around 140 animals per year and has diminished slightly. In East Greenland the annual take is about 60 animals and stable. Each year the quota is distributed among the local management authorities, which issue and distribute permits to ensure that the allocated quota is not exceeded. After hunting, the hunter must make sure that the permit is stamped by the local authority or settlement office. Polar bear parts can not be sold unless a copy of the stamped permit furnished with the permit holder's signature accompanies the sale (IUCN, 2009). This counteracts the sale of illegally killed polar bears and increases control of the harvest. All catches must be reported and necessary information of each catch must be available to management authorities for setting quota for the following year (Winter Hansen, 2009).

It should also be noted that the East Greenland polar bear subpopulation size is unknown, which could result in non-sustainable quota setting. Local people report a growing number of polar bears encountered which is believed to be a spill-over from the North-Eastern Greenland National Park to the North and the Svalbard subpopulation further afield (pers. comm. Ko de Korte, July 19, 2011). But it may also be due to more polar bears forced on land due to diminishing extend of sea ice and earlier break-up of sea ice in the area (Paetkau et al. 1999).

The harvest season is between September 1st till June 30th. In the management areas of Ittoqqortoormiit and Ammassalik, however, polar bears can be hunted from October 1st to July 31st. Cubs and females with cubs irrespective of there age are fully protected. Moreover, it is prohibited to disturb polar bears in their winter dens (Piniarneq, 2011). According to Born et al. (2011) only those who practice hunting as their main occupation, reside permanently in Greenland, and have strong ties to the Greenlandic community can apply for a hunters licence. Hence in Greenland there is no trophy hunting of polar bears practised by visiting hunters. Greenland has about 2,000 full-time hunters who are entitled to hunt polar bears against the regionally set quota's repeat sentence. The use of aeroplanes, helicopters, motorized vehicles, large boats, poison, traps, snares and semi- or full automatic rifles is prohibited when hunting for polar bears or when travelling from and to hunting grounds.

Table 3. Annual harvest quota for the five management areas in Greenland between 2006 and 2011 (www.Nanoq.gl, accessed May 23, 2011).

	Harvest quota per year					
Management area	2006	2007	2008	2009	2010	2011
Kane Basin	–	10	8	6	6	6
Baffin Bay	92	73	71	68	68	68
Davis Strait	3	2	2	2	2	2
East Greenland	55	54	64	54	54	64
Arctic Basin	–	–	–	–	–	–
Total	150	139	145	130	130	140

The destruction of conflict animals is well regulated, permission must be sought from the central governmental authority in Nuuk to destroy threatening conflict animals. In general hunters are not keen to shoot such animals as they will be deducted from next-year's quota. Moreover, hunters need to hand in all animal parts to the government and are not able to trade these. Hence there seems to be no economic incentive to hunt polar bears under the pretext of conflict mitigation (pers com. Aksel Blytmann, July 12, 2011).

Case study area 1: Vankarem- Chukotka- Russia

Russia has maintained a moratorium on harvest of polar bears since 1956. However, starting in the late 1990s, illegal killing began to increase and is currently believed to be 150-200 polar bears per year (Belikov et al., 2009). The take of polar bear cubs for public entertainment and education (zoos and circuses) is allowed. In 2005–2009, no permits for catching cubs were issued. In 2006, the Moscow Zoo adopted 1 orphan cub from Chukotka (Belikov et al., 2009). In the absence of accurate information on population size and trend, it is currently not possible to identify a sustainable level of harvest for the Chukchi subpopulation (IUCN, 2009). The harvest levels in the Chukchi Sea subpopulation for the past 10-15 years (100-150 illegally hunted bears by Russia and legal take by Alaska) are probably unsustainable (USFWS, 2010).

In June 2010 the U.S.-Russia Polar Bear Commission implemented a Bilateral Treaty for the shared Alaska-Chukotka polar bear population. This treaty includes a quota of 58 polar bears per year which will be shared between the two countries. The quota has not been implemented yet but is expected to be within the coming years. WWF stresses the need of population figures before setting harvest quota. The quota will be used to protect the ability of the Native peoples of Alaska and Chukotka to take polar bears for traditional subsistence purposes, and ensures that polar bear harvest is sustainable (pers com. Geoff York, August 3, 2011) .

The Zdor report (2011), created in a collaboration between the Russian WWF and the Chukotka Association of Traditional Hunting, shows that about 20-30 polar bears were shot last year without an appropriate permission. This figure does not exceed the quota as proposed by the U.S.-Russia Polar Bear Commission (between 25 and 30 bears for both the Russian and Alaskan side of the Chukchi subpopulation).

Case study area 2: Churchill- Canada

In some of the jurisdictional areas of Canada the hunting quota and regulations concerning harvest differ per area. Table 4 gives an overview of the annual quota and hunting figures of entire Canada. In each of the years presented here, the number of bears harvested was lower than the set quota. According to Thor Larsen (pers com. July 17, 2011) this can have several reasons, such as too small populations for a high hunting success, which is dependent upon population size and abundance.

Table 4. Quota and harvest figures of entire Canada between 2004 and 2009 (IUCN, 2009)

Hunting year	Quota	Hunted
2004- 2005	716	524
2005- 2006	679	545
2006- 2007	721	514
2007- 2008	695	577
2008- 2009	665	506

In Manitoba (where Churchill is located) there is a total ban on the harvest of polar bears, including harvest by indigenous communities (Manitoba hunting guide, 2011). Since no polar bears are harvested no quota are issued, however, for management purposes, eight animals are reserved for defence/accidental human-caused mortalities (IUCN, 2009). In Nunavut a quota system was implemented based on Inuit "*Qaujimajatuqangit*", a broad concept on traditional knowledge and "healthy, sustainable communities" regaining their rights to a say in the governance of their lives using principles and values they regard as integral to who and what they are. This system was adopted as guiding philosophy by the government for the Inuit-majority territory in Nunavut (Wenzel, 2004). This territory is shared by the Western Hudson Bay- and the Baffin Bay subpopulations. Table 5 shows the quota and harvest figures of Nunavut and Manitoba between 2004 and 2009.

Table 5. Harvest quotas and known numbers of polar bears killed in Manitoba and Nunavut, 2004- 2005 through 2008- 2009 (IUCN, 2009).

Management year		Territory	
		Manitoba	Nunavut
2004-2005	quota	8	507
	killed	2	466
2005- 2006	quota	8	474
	killed	4	452
2006- 2007	quota	8	512
	killed	3	498
2007- 2008	quota	8	486
	killed	2	446
2008- 2009	quota	8	456
	killed	-	-

Case study area 3: Svalbard- Norway

No polar bears are harvested from the Barents Sea subpopulation, but non-natural mortality does occur sporadically when polar bears get killed in defence of life and property (Gjertz and Scheie 1998). In the past the population was overharvested, but after the total ban on polar bear hunting in Norway in 1793 and in Russia in 1998, the population managed to increase again (Larsen 1986, Prestrud and Stirling 1994).

4.1.2. Human-polar bear conflicts

Another potentially important impact to polar bear populations is the increase in human-polar bear conflicts. More and more scientists from throughout the Arctic region express their concern about an

increased potential for human-polar bear conflicts (Dyk, 2006; Derocher et al., 2004; Stirling and Parkinson, 2006). Although the importance, severity and significance of this problem is under debate, scientists agree that the potential for conflicts is increasing due to increasing human activities, and increasing numbers of polar bears spending time on land.

Overall, a growing number of polar bears are destroyed due to conflict. Increasing human activity in the Arctic region and a tendency of polar bears spending more time on land (due to diminishing sea ice cover) results in increasing chance of encounters with polar bears.

Conflicts between polar bears and people generally occur in three types of situations: when polar bears approach human settlements, when polar bears come across people working in the tundra or on pack ice, and when people deliberately approach polar bears or their dens (Ovsyanikov, 1998). These conflicts include bears entering communities, camps, or industrial sites where they damage or destroy human property, raid food caches, attack dogs and people, and endangering public safety (Stenhouse et al., 1988). According to several scientists (Dyk, 2006; Derocher et al., 2004; Stirling and Parkinson, 2006) the potential for human- polar bear conflicts is increasing throughout the Arctic because of an increase in human population and development and an increase of the circumpolar polar bear populations since the implementation of recovery measures in 1973. This created more opportunities for people and bears to interact in (Miller, 2009).

Underlying factors

According to the Arctic Climate Assessment conducted by the Arctic Council (2005), the effects of climate change are experienced particularly intensely in the Arctic region. Here the rate of increasing average temperatures is almost twice as high as in the rest of the world. Evidence for Arctic warming can be found in terms of melting sea ice, glaciers and permafrost. Since polar bears depend on sea ice for foraging and resting, they face problems finding food when sea ice cover reduces as a result of global warming. As stated in the COSEWIC (Committee On the Status of Endangered Wildlife In Canada) report of 2008 on polar bears in Canada, climate warming results in earlier sea ice break up, which forces polar bears to spent longer times on shore where they get in contact with people. For example, in recent years a positive interaction between the time of sea ice break up and the number of problem bears per year was found in Western Hudson Bay (Stirling & Parkinson, 2006). Also an increased use of land by polar bears from the Southern Beaufort Sea subpopulation was observed (Schliebe et al., 2008a). It is expected that the same effects can be found in other Arctic regions and subpopulations. Although research shows that some polar bear subpopulations are in decline, local people claim to see more polar bears in close proximity of human settlements (Dowsley & Wenzel, 2008). This can be explained by the fact that polar bears which spend longer time on shore wander through settlements. Moreover, polar bears expand their range in search of prey and show up in places where they were never seen before (Meyerson, 2009).

Evidence exists that polar bears are attracted to human settlements more than before. Attractants in and around human settlements act as a magnet on polar bears coming to shore, especially to those suffering food stress. According to Medill (2009), many conflicts in Nunavut happen at places where sled dogs are kept and fed, food gets processed and near carcasses of whale, seal or caribou. This is also observed in Chukotka where walrus carcasses attracted polar bears to walrus haul outs close to the villages of Vankarem and Ryrkarpie (pers com. Tom Arnbom, June 1, 2011). The volume of attractants has also increased in some areas, since local communities shifted in their lifestyles. In stead of their nomadic lifestyle, they became more resident, which increased wastes and food storages in concentrated places. Moreover, hunting became more efficient by improved techniques and increased travel efficiency (Medill, 2009). Direct interaction between bears and people increases with increased travelling efficiency of hunters, since larger areas are covered by snowmobiles and motorized boats.

As a result of the reduced ice coverage economic activity rose and is projected to be rising even more in the future. An example is the expected effect of climate change on the economy of Greenland which could possibly flourish; transport will become easier, exploitation of mineral and oil deposits become feasible and viable and several fisheries are predicted to gain with expected northward shifts of fish stocks (Nyegaard Hvid, 2007). Beside the direct effects of these activities on polar bears, such as disturbance, an increase in conflicts and polar bear kills in defence of life and property can be expected by the increasing human populations (COSEWIC, 2008). Polar bear-related tourism is also increasing with the number of onshore bear visits (Miller & Reed, 2009). According to Pederson (2009) not only the increasing number of tourists has a direct effect on human- polar bear conflicts, but also the increased risks taken by these tourists.

Conflict characteristics

Several different types of locations can be identified where human-polar bear conflicts take place. In the study of Stenhouse et al. (1988) in 140 out of the 222 cases where circumstances surrounding the conflict were known, the conflict took place in native camps or involved Inuit who were travelling on land. Eighteen conflicts happened in larger settlements (at least fifty people living in permanent buildings on a long-term basis), sixteen on industry sites (includes permanent camps such as mines, well sites, Distant Early Warning (DEW) line stations and temporary exploration camps) and four on research locations. The study of Dyk et al (2006) also showed that most conflicts occurred in native camps, followed by settlements, industry camp types and research locations respectively. A main problem in deterring bears from settlements is the abundance of attractants such as the remains of whales and seals (Dyk et al., 2006).

Age and sex of polar bears also seem relevant characteristics of human- polar bear conflicts. In the studies of both Stenhouse et al. (1988), who analyzed 265 cases and Dyk (2006) who examined 618 conflict cases, over half of the involved bears were sub adult males. Several factors might explain why especially sub adult males get involved in human-polar bear conflicts. Male biased dispersal of sub

adults in species with polygynous mating systems is quite common (Greenwood 1980, Dobson 1982). Males also tend to be more aggressive than females (Tate & Pelton 1983; Ramsay & Stirling 1986), and sub adults may be more curious, less cautious, more easily habituated to humans, and possibly more nutritionally stressed than older bears (Stirling & Latour 1978, McArthur Jope 1983). Sub-adult males come into conflict more often than other polar bears.

In some cases polar bears get killed in defence of life and property (DLP). These kills are either counted in or on top of the set hunting quota. Bears killed by residents of North Slope Borough are counted toward the Beaufort Sea subpopulation harvest quota (Pederson, 2009).

There seems to be a lack of quantitative data on human- polar bear conflicts in the Arctic. Countries record different variables and use different definitions. This gap of important information might be filled when the database application presented by Wilder (2009) gets applied. The Polar Bear-Human Information Management System (PBHIMS) Access database currently under construction under the auspices of the IUCN Polar Bear Specialist Group (PBSG), is designed to track, record and analyze polar bear-human conflicts, sightings, natural history across the range states. The recent decision to develop a circumpolar conflict register is welcome and essential to monitor developments and to exchange mitigation experiences.

Since quantitative data on human-polar bear conflicts are incomplete and hard to access, a simple overview of conflicts per country will be given with data as far as available.

East Greenland: Ittoqqortoormiit and Tasiilaq

According to Blytmann (pers com. July 12, 2011), in the last five year, there are more conflicts in eastern and southern Greenland than before. The main reason seems an increase in seal populations near Greenlandic shores (over the last ten years the numbers of harp seals doubled, from five million to approximately ten million). With the growing prey-base, the number of polar bears is perceived to be growing as well. The past five years people see more polar bears which look healthy and fat. More female polar bears have been observed lately with two or even three cubs, instead of the usual one. “Problem” bears are single, young polar bears who come too close to populated areas. Most of them are scared away, by hunters, but few of them had to be put down. For this permission has to be granted by the central authority in Nuuk and hunters seem reluctant to seeks such a permission because polar bears killed in conflict are deducted from next-year’s quota (pers com. Aksel Blytmann, July 12, 2011). Most human- polar bear conflicts can be found in eastern and southern Greenland near sheep farms and densely populated areas, in and around village and scientific- and military facilities (pers com. Aksel Blytmann, May 13, 2011). Identified waste dumps near the settlements of Ittoqqortooriit and Tassilaq act as attractants as well as the presence of sheep in the utmost south of Greenland. Although polar bears are not usually entering this area, the presence of polar bears in this area is confined to several animals from the North occasionally wandering through). Storage of (dog-) food and for example seal meat has not changed since decennia and is therefore not regarded as an

attractant to polar bears (pers com. Aksel Blytmann May 13, 2011). However, when the number of bear increases, they might consider stored, easy accessible meat as attractive. Moreover, more people visiting the area means more food and garbage which will likely increase number of bears attracted to these places (pers com. Thor Larsen, July 17, 2011)

Blytmann's observation on increasing numbers of conflict in eastern and southern Greenland seems to be in line with conflict trends elsewhere in Greenland. Since the introduction of quotas in Greenland there has been an increase in number of polar bears that were killed in self-defence in Baffin Bay (Table 6). Also defence kills have been reported from East Greenland since 2006.

Table 6. Polar bears killed in Defence of Life and Property in Greenland between 2006 and 2008 (IUCN, 2009)

	Year		
Population	2006	2007	2008
Kane Basin	0	0	2
Baffin Bay	0	2	6
Davis Strait	1	3	0
East Greenland	0	4	2

The limited data available indicates that in Greenland the number of polar bears killed due to conflict is small but increasing. Anecdotal information indicates that the number of problematic encounters with polar bears in (East) Greenland is increasing steadily, resulting most often in the loss of property and livestock rather than loss of life.

There is no reason to expect that conflicts with polar bears in East Greenland, or in Greenland in general, will remain limited. This is because also in Greenland there is increasing human activity (tourists, scientists) within polar bear habitat and polar bears spending more time on land and wandering further afield outside their usual ranges in Greenland.

In Churchill and Vankarem the number of conflicts with polar bears has also increased substantially. On Svalbarbard the potential for human-polar bears conflicts increased.

Case study area 1: Vankarem- Chukotka- Russia

In the past polar bears migrated via sea ice to Wrangel Island North of the coast of Chukotka. Then they moved from Wrangel Island to the mainland also via frozen sea ice. Round October/ November hundreds of polar bears came to the coast. They migrated East along the villages, among them Vankaram and Ryrkarpiy, and then back onto the sea ice. Since around 1996, more and more walruses started to land in Vankaram earlier in the season. At some point up to 20,000- 30,000 animals were lying on the beach. This was the only place where they came to shore and this happened nowhere else in the area. The walruses were crowded on the beach and when scared, large stampedes moved to the sea, trampling old and young animals. In 2007 the villagers feared that these carcasses would attract polar bears and started to move the carcasses out to several feeding

spots. In 2006 the sea ice did not freeze back so the bears migrating were trapped in Vankaram. In the end there were about 200 bears, round 30- 40 in the village itself. A young girl was killed by a polar bear in Ryrkarpiy, which stressed that more precautionary measures were needed (pers com. Tom Arnbom, June 1, 2011). Conflicts with polar bears also occur in a settlement on the Novaya Zemlya archipelago; polar bears in the area are attracted by dumps in outskirts of the town. Also the risk of human-bear conflicts in the Kara Sea is comparatively high in the ten settlements situated on the coast and on islands (IUCN, 2009).

The Zdor report (2011) gives insight in the view of local people and hunters to polar bears in their villages. When asked how often there are polar bears in the vicinity of villages, 36% of the hunters said rarely, 27% said regularly, 32% said often, and 5% reported that they always wander around the village. Not one respondent hunter said that he had never seen polar bears near the village. Only 23% of the hunters believed that polar bears should be killed directly when entering the village, others preferred to chase it off or believed that polar bears pose no serious threat to humans.

Case study area 2: Churchill- Canada

According to Stirling et al. (1999), the early breakup of spring ice is associated with increased human-polar bear encounters in Churchill, Manitoba. Polar bears are increasingly coming around humans because of food stress in both Western Hudson Bay and Baffin Bay (Stirling and Parkinson, 2006).

In Churchill, over 90 conflicts were recorded in 2005, compared to 20 conflicts recorded in 1970 (Figure 4). Significantly, the increase also coincides with a 22% decrease in the subpopulation so meaning that fewer bears are creating an increased number of conflict incidences. The sea ice cover of the Western Hudson Bay melts on average three weeks earlier than in 1970. The problem for the bears is compounded by the sea ice returning later in the summer (WWF, 2009). Besides this, Derocher (2009) mentions the storage of meat by local people as a major causal factor for human-polar bear conflicts here. According to him, the increase in conflicts is the first evidence for the hypothesis that climate change will boost numbers of problem bears.

The study of Towns et al. (2009) examined the temporal and spatial patterns of 1,487 problem bears captured in the Churchill area from 1970 to 2004. The number of individual problem bears caught near Churchill varied from 10 to 90 individuals per year and increased over time. Most of the 'problem bears' were in close proximity of Churchill and involved sub-adult males (39%). The other conflicts involved sub-adult females (23%), adult males (18%), females with young (14%), and solitary females (6%). It is expected that nutritional stress and a northward shift in the distribution of the bears which spend the summer on-land in north-eastern Manitoba may account for the increase in problem bear numbers. The date of sea ice freeze-up, which is getting progressively later, was the best predictor explaining the annual variation in the occurrence of problem bears.

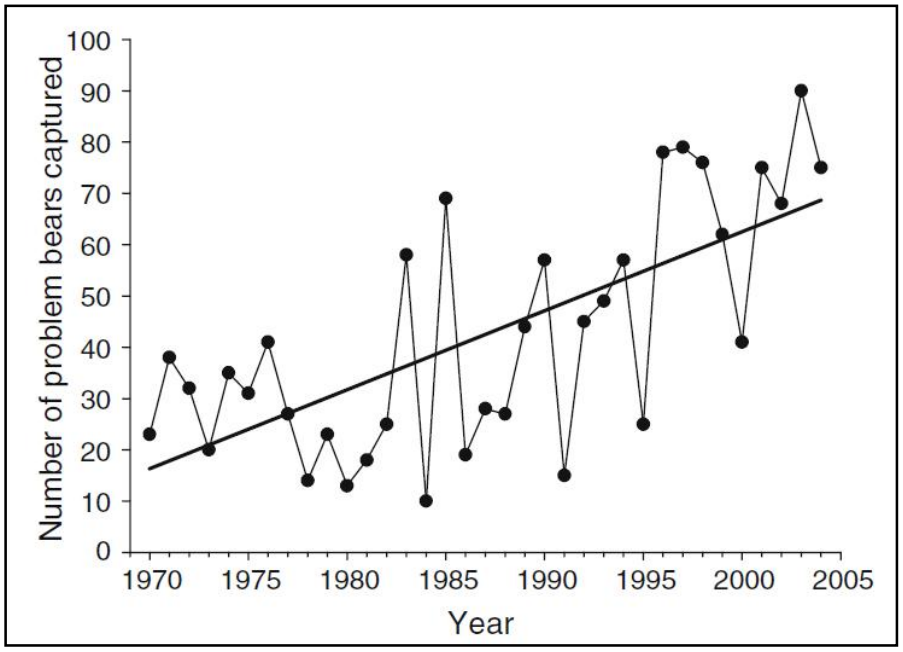


Figure 4. Number of problem polar bears captured in the core study area near Churchill, Manitoba from July to December over time, 1970– 2004 (Towns et al., 2009).

Local communities from Nunavut reached out to the government two years ago for help after experiencing more conflicts with polar bears than usually, mainly involving dogs. Many communities in this region have showed their interest in assistance form the government and WWF to reduce the number of conflicts involving polar bears (Geoff York, 2010; pers com. Clive Tesar, August 2, 2011).

Case study area 3: Svalbard- Norway

In the past a few people and polar bears were killed and injured in human-polar bear conflicts (Table 7). The last human fatality took place on August 5, 2011. A seventeen year old boy died and four others got seriously injured after being attacked by a polar bear. The victims were part of a group of British students camping on a remote Arctic glacier as part of a high-end adventure holiday. The bear was shot by one of the campers (BBC News, August 5, 2011).

In May 2011, a camper was dragged out of his tent by a polar bear. Although the tent was protected by trip wires, the bear managed to get past. The man survived but the bear was shot (Wolf, in Readers Digest, 2011).

Although these examples show recent conflicts between people and polar bears, no increase in the number of human-polar bear conflicts on Svalbard has been observed (IUCN, 2009; pers com. Thor Larsen June 20, 2011). Mr. Larsen stated that although the number of conflicts has not increased, the potential for interaction between humans and polar bears did increase in recent years. Both tourism and research activities have increased rapidly in Svalbard, resulting in more polar bear encounters. In the past coal mining was very important in Svalbard, comprising of about 90% of the total industry. Much has changed since with increasing tourism and research. Now coal mining is only 20% of the

industry, the rest is based on tourism and research activities, including much field research. According to Larsen, the main reason for an increasing risk for human-polar bear conflict is the fact that many visitors have no experience with bears and don't know how to defend themselves. Local people and researchers on the other hand do have adequate or much experience, most of them know how to behave and how to handle rifles. Although the potential is high, only few conflicts have been recorded in which no people or bears were killed. This might be explained by the shy nature of polar bears, which will not attack people without reason. However, polar bears tend to be curious, so people are advised to keep their distance.

Table 7. Serious confrontations between humans and polar bears in Svalbard between 1971 till June 2009 (Gjertz et al. and the Governor of Svalbard: www. Sysselmannen.no, in Keyser, 2009)

Type of conflicts	Year				Total
	1971/72-1980/81	1981/82-1990/91	1991/92-2000/01	2001/02- June 2009	
Confrontaties	32	39	30	21	122
Killed polar bears	28	39	29	20	116
Injured polar bears	1	0	1	1	3
Killed people	2	1	2	0	5
Injured people	2	0	1	0	3
Other	0	0	2	0	2
Total	65	79	65	42	251

4.2. Long term impacts

Long term impacts may affect polar bear subpopulations on a longer time scale and mainly have a global source. Since these are beyond the scope of this study, they will not be discussed here per case study area. In stead, their overall effect on polar bears is described.

4.2.1. Contaminants

Until the late 1960's contamination of the environment of Greenland was not an issue that was considered to any degree. After the opening of a lead-zinc mine at Uummannaq in West Greenland, which was the first to received environmental approval following impact assessment studies, the interest of Denmark and Greenland to contamination rose (Johansen et al., 2000). Studies were conducted around this and two other mines and revealed that significant local contamination by heavy metals had occurred as a result of the mining activities (Johansen and Asmund, 1999.). Further studies conducted in the 1970s indicated that pollutants originating from remote sources could also be detected in the environment of Greenland, and that these made a significant contribution to the general levels of contamination within the region (Johansen et al., 1980).

Since the 1950s, large quantities of organochlorine (OC) contaminants such as chlorinated pesticides (dichlorodiphenyltrichloroethanes (DDTs), chlordanes (CHLs), hexachlorocyclohexanes (HCHs), toxaphenes), industrial products (PCBs) and by-products (hexachlorobenzene (HCB), chlorinated dioxins and furans) have been released into the atmosphere in the Northern Hemisphere. The persistence and lipophility of these OC's has resulted in their accumulation in animals in the Arctic

marine environment following long-range atmospheric transport from their areas of use in the mid-latitudes of Europe, Asia and North America (Dietz et al., 2004). Polar bears are top predators in the Arctic marine food web and as such they are exposed to high levels of contaminants relative to other Arctic species (Braune et al., 2005; Letcher et al., 2010). Polar bears mainly prey on ringed seals (*Phoca hispida*) and bearded seals (*Erignatus barbatus*) (Thiemann et al., 2008) and their diets have a high fat content. Accumulation of high levels of contaminants have especially been observed in polar bears form East Greenland (Dietz et al., 2004).

Polar bears mate between March and May (Rosing-Asvid et al., 2002), but the active gestation period is delayed until September till October at the start of the hibernation period (Wiig et al., 1992). During this hibernation period (October till March) the female is fasting and is relying on fat reserves as energy source. As a result, fat accumulating contaminants that have been stored in adipose tissue are released into the blood stream and may cause adverse effects to the offspring during the pre- and postnatal periods (Letcher et al., 2010; Sonne, 2010). In addition, the cubs will also be exposed to high levels of OHC's (organohalogen compounds) during lactation (Bernhoft et al., 1997), as the milk has a high load of OHC's associated with a high mean lipid-content of 33% (Jenness et al., 1972).

Studies dealing with the effects on chlorinated hydrocarbon contaminants (CHCs) found in fat, liver and blood of polar bears sow that these contaminants may negatively affect endocrine functions and homeostasis, immune functions, cub and reproductive female survival and reproduction and development as listed by Fisk et al., 2005 in Verreault et al., 2005.

4.2.2. Human disturbance

Human disturbance to polar bears can be in the form of tourism activities, large scale activities related to the extraction of minerals such as oil and gas, and research activities in polar bear habitat. Beside the possible loss of suitable habitat by these activities, polar bears may also suffer from disturbance while foraging, migrating, denning and resting. Although extensive research has been done on the effects of disturbance on ungulates, birds, marine mammals, and carnivores in other parts of the world, not much information is available on the response of polar bears to human activity (Andersen & Aars, 2008). However, the study of Andersen & Aars (2008) on the short term behavioural response of polar bears to snowmobiles (used for tourism and hunting activities) showed that especially polar bears with small home ranges (185 km2, Mauritzen et al. 2001), might have difficulties in finding areas where disturbance is low. They also believe that repeated disturbance which leads to running and interrupted hunting might result in increased energetic stress of the animals. Moreover, in extreme situations, overheating from running could lead to death of the animal. Their study also indicated that females with cubs showed the strongest response to disturbance. The added stress to young polar bears can have negative effects on their survival. Such stress could involve more swimming in open water (polar bears tend to take refuge in water when startled) or more frequently interrupted suckling/ feeding bouts, both could affect body condition and growth. It is believed that denning polar bears are especially sensitive to disturbance and may abandon dens if annoyance is prolonged (Lentfer &

Hensel, 1980). However, the study of Blix & Lentfer (1992) showed that dry and wind-beaten arctic snow muffles both sound and vibrations extremely well, which makes it unlikely that polar bears in their dens will be disturbed by the type of petroleum-related activities measured, providing those activities do not take place within 100 m of the den. The level of disturbance possibly relates to the type of human activity, the distance to polar bear dens and the type of snow covering the den.

With diminishing ice covers, as a result of climate change, natural resources like mineral deposits, oil and gas are becoming more accessible for exploitation and increased shipping activity can thus be expected (ACIA, 2005). Potential impacts of shipping include physical disturbance, noise, waste and pollution. Local communities are concerned about the impacts of this activity and some hunting and trapping organizations have successfully moved shipping to alternative routes (IUCN, 2009). According to Armstrup (2009), extensive ice breaking activity can cause even greater reductions in available sea ice, apart from the direct effect of forming additional obstacles in polar bear movement routes.

The extraction of minerals bring more intensive shipping in the region, as well as the risk of oil spills. It is probable that an oil spill in sea ice habitat would result in oil being concentrated in leads and between ice floes resulting in both polar bears and their main prey (ringed and bearded seals) being directly exposed to oil. Another concern is that seals covered in oil may be a major source of oil to polar bears (Schliebe et al., 2008b).

Tourism in the Arctic is increasing substantially, especially on Svalbard and in Churchill. According to Vongraven (2009), the greatest risk of tourism to polar bears seems to be the prolonged impact of disturbance rather than any immediate effects. Also in Nunavut tourism has been identified as an emerging issue with communities very concerned about the impact on wildlife (Peacock, 2009). According to Ovsyanikov (2009), the effect of tourism on polar bears depends very much on the type of activities, such as ship based sightseeing, eco-adventures and land based travelling in polar bear country. For ship based tourism, staff and guards may not be properly trained to manage landings without impacting polar bears. Some expedition leaders may even harass polar bears to move them into sight of tourist groups. Increased interaction between people and polar bears can result in human-polar bear conflicts and even bear mortality. In order to decrease the impact of tourism on polar bears, the Association of Arctic Expedition Cruise Operators created a list of rules for tour operators aimed at minimizing disturbance of polar bears (IUCN, 2009). Tourism can also be an important opportunity for the future conservation of polar bears by raising both awareness and funding.

With increasing human activity in the Arctic and within polar bear ranges, and with the general tendency of polar bears spending more and more time on land, the general expectation is that encounter rates between polar bears and humans will increase.

4.2.3. Climate change

General impacts on the Arctic

The global climate is changing, probably highly influenced by human activity with associated emission of carbon dioxide and other greenhouse gases, resulting in rising temperatures. The emission of greenhouse gasses does not primarily originate in the Arctic, yet this region will be, and is already the first to face wide range changes which will in the long term affect the whole planet. Climatic processes of the Arctic have significant effects on regional and global ocean and air currents and extreme weather events are predicted. With sea ice not being reliable in recent years, the people of the Arctic are feeling the effects of changes in their environment already in their daily lives as access to hunting and fishing grounds are being hampered. On the other hand, with diminishing ice covers, natural resources like mineral deposits, oil and gas are becoming more accessible for exploitation. More specifically, the report of Nyegaard Hvid (2007) gives an overview of the projected changes in Greenland as a result of climate change and their implications to both Greenland's natural world and social structure. In southern Greenland, an average temperature rise of 2° C is projected and in northern part the temperatures could even rise by 6-10° C in winter. Typically the ablation of the ice sheet increases by 30% for each degree of increase in annual temperatures. Besides the atmospheric temperature, also the ocean temperature will rise. Consequently, the thickness of the ice is projected to decrease by about 0.06 meters per °C implying a higher vulnerability of the sea ice cover. The economy of Greenland could possibly receive an impulse as a result of these predicted changes; transport will become easier, exploitation of mineral and oil deposits become feasible and viable and several fisheries are predicted to gain with expected northward shifts of fish stocks. Agricultural practices can increase since farmers will experience longer summers and less severe winters. However, shrimp fishery is likely to suffer from the predicted changes as well as the natural environment and traditional livelihoods of the people. Species composition, distribution and diversity will change which will not only have a negative effect on natural values, but also on the traditional hunting based culture in the smaller settlements. This is especially so if change will be very rapid and if climatic pressure on biodiversity and ecosystem functions is aggravated with pressure from new economic activities.

Effects on polar bears

A major impact to polar bears induced by climate change is the loss of sea ice habitat. Since polar bears completely rely on sea ice for foraging and travelling, changes to the distribution, characteristics and timing of sea ice can have major effects on numbers and distribution of polar bears in the Arctic (Stirling & Derocher, 1993). In periods of favourable hunting conditions polar bears build up fat reserves in order to survive in periods with low food availability (Ramsay & Stirling, 1988). Several studies showed that there is evidence for substantial variation in body size and reproductive output mediated by varying ice conditions (Stirling, 2002; Derocher & Stiring, 1995). The break up of spring sea ice in western Hudson Bay occurs approximately 2.5 weeks earlier tan it did 30 years ago (Stirling et al., 1999), which shortens the time polar bears are able to feed on seals. Significant relations have

been found between break-up of sea ice and the condition of polar bears when they come ashore. The earlier the sea ice breaks up, the earlier the bears are forced to come ashore and the less fat reserves they have to fast on during the 4-month open water period (Derocher et al., 2004). It has been observed that polar bears which come to shore are often in poor condition and suffer food stress, an example is Western Hudson Bay, where the condition of both males and females is significantly poorer than before (Stirling and Parkinson, 2006). Reduced body condition can result in declining reproductive rates, sub-adult survival, and body mass (Stirling and Derocher, 1993; Stirling et al., 1999). Moreover, pregnant females will find more difficulties in finding their presently preferred denning locations as the distance increases between the Southern edge of the pack ice, where some polar bear populations spend the summer, and coastal areas where pregnant females den (Derocher et al., 2004). However, the effects of reduced sea ice on body condition seems regional, since observations on the Eastern side of Greenland appears to point in the direction that polar bears are in generally good condition and litter sizes are larger (2-3) than before, while larger numbers of seals are encountered than in the past (pers com. Aksel Blytmann, July 12, 2011).

Not only the time polar bears can hunt reduces, the accessibility of prey decreases as well. Seal distribution and densities can be altered when sea ice conditions change. Polar bears hunt seals on sea ice where they guard breathing holes. Increased amounts of open water might reduce the hunting efficiency of polar bears because seals may become less restricted in their need to maintain breathing holes and haul-out sites and thus become less predictable for foraging polar bears. Besides, it is possible that the habitat, and thereby reproduction of the ringed seal (one of the primary prey species) may be reduced by climate change (Derocher et al., 2004).

When prey availability or accessibility reduces, polar bears will need to travel vast distances in order to find sufficient amount of food. However, increasing temperatures are likely to reduce sea ice thickness with the result that it will become more labile. If the ice begins to move more quickly, polar bears may have to use more energy to maintain contact with preferred habitats. Ultimately, increased energy use could result in both lower survival and reproductive rates (Derocher et al., 2004).

With increasing open-water periods caused by increasing temperatures, the time polar bears spend on land seems to increase. Polar bears have been observed in the vicinity of onshore oil and gas facilities and human settlements (Schliebe et al., 2008a). This was especially observed by native villagers near the Southern Beaufort Sea in Alaska. Moreover, females of this subpopulation shifted to denning more on land and less on the sea ice in recent years (Fischbach et al., 2007). The elongated time polar bears spend on land can result in an increase in human-polar bear conflicts.

4.3. Discussion

Population figures

For eight out of the nineteen subpopulation reliable population estimates are deficient since no inventories have been conducted for these subpopulations in recent years (IUCN, 2009). Although the overall trend of the world wide population shows a decrease in number of polar bears, some subpopulations show an increase (Schliebe et al., 2008b). Moreover, some local communities, such in East Greenland report increases based on increased sightings and encounters of polar bears in close proximity of villages (pers com. Aksel Blytmann, May 24, 2011). The overall scientifically used explanation for this is the prolonged period of time bears spend on shore as a result of habitat loss caused by climate change. However, as mentioned by Mr. Blytmann, in East Greenland an observed increasing number of seals (polar bears main food source) might play a role as well.

Such localized observations are hard to extrapolate to whole subpopulations. In an ideal situation local observations would be supplemented with scientific evidence for the whole subpopulation, which would enable determination of sustainable harvest levels so as not to detriment the future survival of the population. It is therefore very important to get more accurate information on subpopulation size and structure as well as of the reasons for the observed local increases in polar bear numbers.

Impacts

Figure 5 shows the most important factors which impact on polar bear subpopulations. We characterized these based on the criteria ‘effect on subpopulation’, on a scale between ‘immediate’ and ‘long- term’, and ‘source’ on a scale between ‘local’ and ‘global’. Non-natural mortality, mainly induced by harvests is one of the most important and immediate impacts on polar bear subpopulations. Although economic benefits have reduced over the last years, hunting still plays an important traditional role and still provides in livelihood of individuals in many Arctic communities. In recent years, additional non-natural mortality as a result of human-polar bear conflicts increases as was indicated by the case studies used in this study.

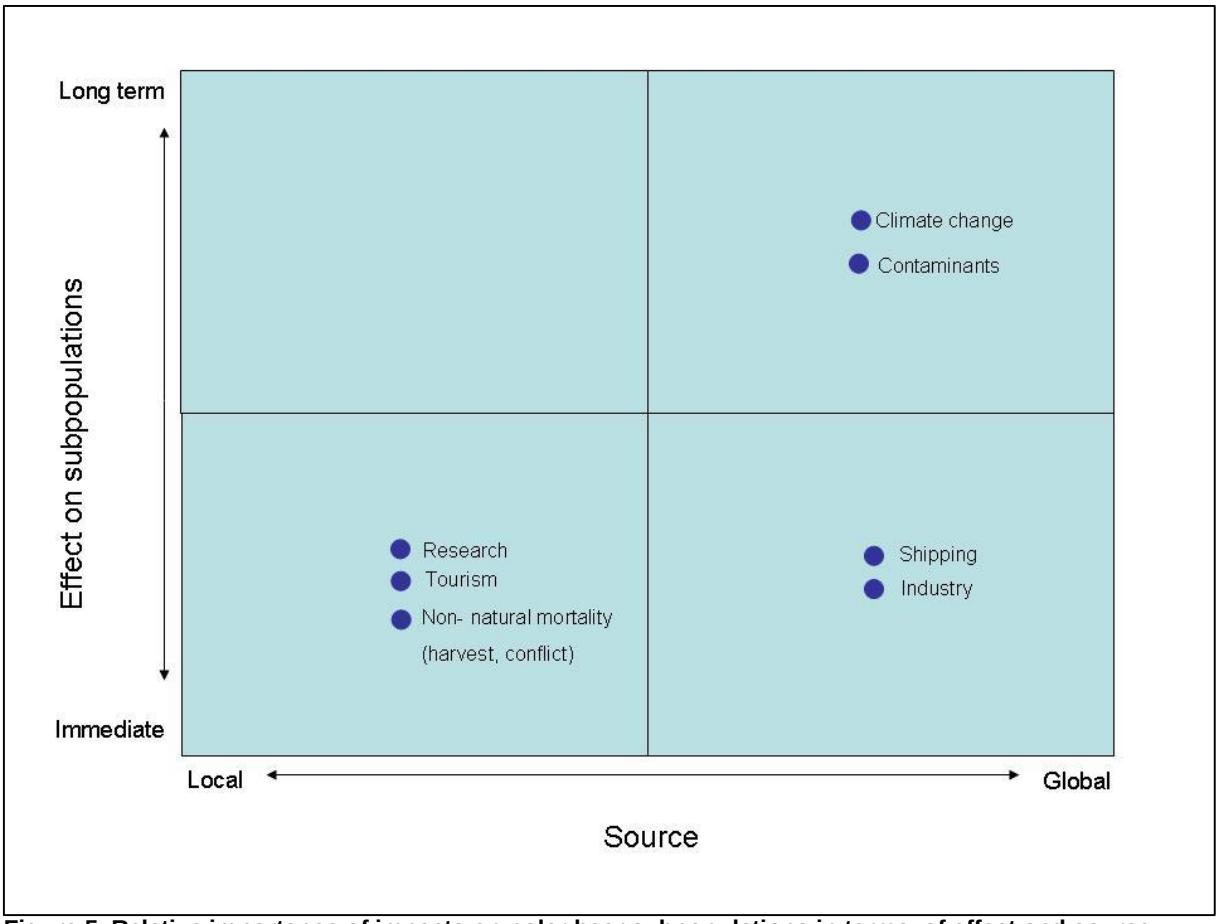


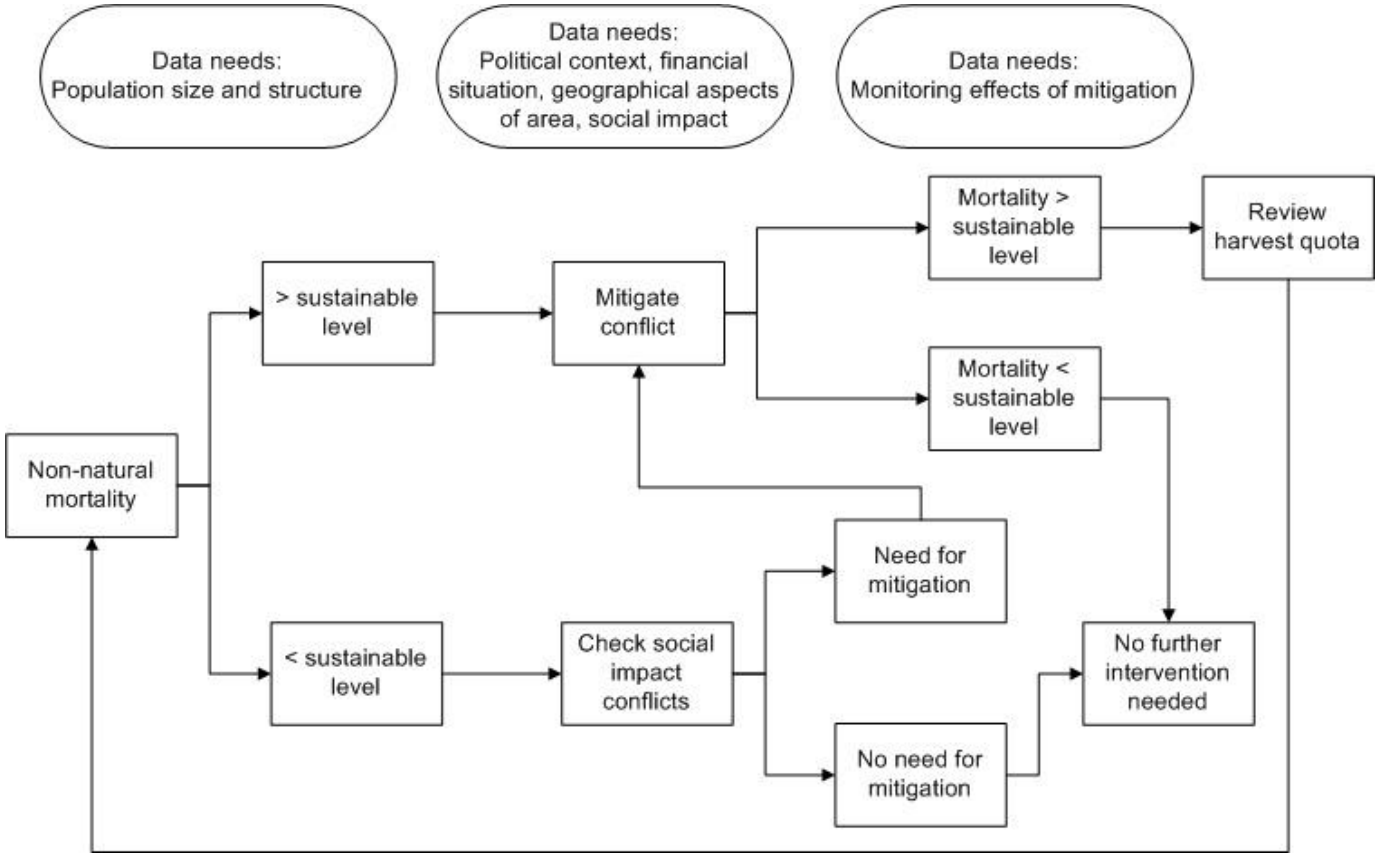
Figure 5. Relative importance of impacts on polar bear subpopulations in terms of effect and source (own interpretation, not based on accurate measurements).

As long as non-natural mortality is sustainable, the direct effect on polar bear subpopulations will be less immediate and the urgency to address this issue from a conservation point of view is limited. However, there are many social aspects related to human-polar bear conflicts which require attention. People's feeling of safety and even livelihoods can be at risk when no attention would be paid to the mitigation of conflicts. Therefore addressing human-polar bear conflict is always important from a social point of view.

When non-natural mortality exceeds sustainable levels, it becomes a high conservation priority on a local level. Although no complex global measures will be needed, dealing with the impact of harvests (i.e. introducing hunting regulations) can be difficult because of the high social value of hunting and personal livelihoods of individual people which are hard to intervene with. In cases where harvests are illegal, addressing them becomes virtually impossible because officially such harvests do not exist. This is a complicating factor for instance in Russia where between 100 and 120 animals are believed to be harvested illegally per year. Since capacity is lacking in Siberia, little control on harvest is executed. In order to reduce poaching, adequate law enforcement capacity needs to be established. Addressing human-polar bear conflicts is easier, and if local people perceive it to be a problem, measures should be acceptable and easy to implement. Thus in cases where the sustainability of the polar bear sub-population is at stake, and where conflicts occur, conflict mitigation should always be

pursued to limit the number of animals lost in conflict. If still non-natural mortality is higher than the carrying capacity of the sub-population, measures to limit harvests need to be put in place. In all these scenarios, a thorough understanding of the size and structure of the sub-population is a prerequisite. The decision model in figure 6 gives a schematic overview of the steps from population size and structure to the mitigation of conflicts and addressing harvest levels.

Figure 6. Decision model for non-natural mortality under or above sustainable levels



Human- polar bear conflicts should not only be addressed from a conservation point of view, social aspects should be taken into consideration as well. This also serves as an opportunity for conservation organisations to create goodwill among local people.

Although the direct effects of human-polar bear conflicts on population size may be small compared to the effect of harvest, it is important to reduce any additional non-natural mortality as accumulating effect. It is questioned whether local people actually perceive these conflicts as a problem, which is a prerequisite for conflict mitigation. Examples that local communities do see conflict as a problem are from Nunavut and Chukotka. In Nunavut local communities asked the government for help in reducing the number of human-polar bear conflicts, as was also shown in Chukotka where local people took the initiative of conflict mitigation work (pers com. Clive Tesar August 2, 2011; Viktor Nikiforov July 19, 2011; Mickael Stishov May 25, 2011). Even if other local communities would not perceive conflicts as a threat, the exact effects on the present polar bears subpopulation should be assessed before deciding *not* to address human-polar bear conflicts in a specific area.

In recent years the number of people associated to research and tourists visiting the Arctic has increased, especially in Svalbard and Churchill. This means more disturbance of polar bears and an increased potential for human-polar bear conflicts. Relatively simple measures, such as education programmes, should at least be implemented to reduce disturbance and the risk of conflicts. Recent incidents in Svalbard, where conflict avoidance measures were strictly imposed on researchers and visitors, indicate that conflict avoidance measures only work in a limited way and loss of human and polar bear life in conflict can be expected where tourism and research activity increases.

Shipping and industry can have immediate effects on polar bear subpopulations caused by habitat loss, disruption of migratory routes and disturbance. However, these impacts stem from more diffuse sources which are wide spread and are therefore difficult to address. Nevertheless, regulations must be put in place and enforced by Governments and best operational standards must be pursued by business and industry which ensure that critical habitats (denning sites, migratory routes, hunting grounds) are safeguarded from developments. These should also aim at avoiding pollution which may impact on polar bears (and the wider ecosystem). There are high economic benefits associated to the extraction of minerals and other resources, and a large part of the global industry is involved.

Contaminants in the Arctic may have severe effects on polar bear populations, especially in the long term due to accumulation of toxins in animals - passing toxics while weaning young they are transmitted from one generation to the other giving young animals a disadvantaged start in life. Most sources of contamination lie outside the Arctic region and regulations must be in place and enforced in the polluting nations. The scale of this problem is large and difficult to mitigate locally on a short time scale.

Climate change was classified as a mainly externally induced, long term impact. The effects of climate change on polar bear subpopulations can impossibly be mitigated locally and require international cooperation and legislation to reduce the emission of greenhouse gasses. However, negative effects on polar bear populations in addition to (long-term) effects of climate change need to be considered and possibly addressed already in order to reduce cumulative effects and maintain the resilience of poplar bear sub-populations to cope with climate change.

In summary:

- Uncertainty regarding sub-population size is complicating the ability to set sustainable quota levels which is the case in East Greenland;
- Climate change resulting in diminishing suitable habitat is the most important long-term threat to the survival of polar bears as a species;
- Non- natural mortality of polar bears (harvest and conflict) pose the most important short-term impacts to polar bear populations;

- Increasing human activity in the Arctic region and a tendency of polar bears spending more time on land results in increasing chance of encounters between people and polar bears;
- A growing number of polar bears is destroyed in conflict;
- Increased number of conflicts in East Greenland, Vankarem and Churchill, and an increased potential for conflicts on Svalbard;
- Evidence exists that polar bears are attracted to human settlements more than before;
- Sub-adult males come into conflict more often than other polar bears;
- The recording of human-polar bear conflicts is problematic;

- Priority should be given to minimising the loss of polar bears due to conflict over limitations of harvests. Only if sub-populations remain to diminish, further limitations of the harvest levels should be introduced;
- Polar bears getting lost is conflict is a conservation issue when non-natural mortality exceeds the carrying capacity of the population. Besides a conservation issue, conflicts with polar bears are a social issue for the communities living with polar bears in their vicinity;
- Since polar bear hunting is part of a deep rooted tradition in indigenous cultures, the accumulated effect of polar bears getting lost in conflict is more acceptable to address than the introduction of harvest limitations;
- As a matter of precaution it is advisable to ensure measures which seek avoidance and mitigation of conflicts.

Section III Mitigation

5. Mitigation strategies

In order to reduce the number and severity of human-polar bear conflicts, several mitigation strategies have been developed in Arctic countries coping with these problems. There are major differences in methods and associated costs between the used strategies, which is illustrated by the used case studies below.

It was difficult to get a clear overview of the effectiveness of each of the strategies used. The organisations responsible for these mitigation measures don't seem to record the precise effects of their programs, their strengths and weaknesses. However, most of the cases showed positive anecdotal results, such as reduced number of conflicts and increases in people's knowledge on how to deal with polar bears and prevent conflicts.

In some of the case study areas (such as Vankarem) the main initiative was taken by local people with little involvement of the government. However, in other areas (such as Churchill) programs focussed on conflict mitigation are managed by the government with less involvement of local people.

Case study area 1: Vankarem- Chukotka- Russia

In Cape Smith, or village of Rypkarpie the many walruses are protected. The protection was initiated by women organisations in the area. In 2007 WWF discussed with the local government to protect Cape Smith officially. Access to the Cape during walrus migration is prohibited and stray dogs were shot. Unlike firearms, which were banned, hunting with spears allowed people to hunt walruses without causing panic in the haul-out. Since that time the walruses returned each year, with numbers up to 40,000 animals at present (WWF, 2010). The protection status of this area is flexible, when no walruses are present people are allowed access to the area (pers com. Tom Arnbom, June 1, 2011)

To solve conflict between people and polar bears which were attracted by walrus carcasses, hunters began to clear away dozens of walrus carcasses after the walruses left the cape in fall (WWF, 2010). At the initiative of the people of Vankarem, in 2006 the World Wildlife Fund developed the Polar Bear Patrol project. The Umky Patrol, named after the Chukchi word for polar bear, works to ensure the safety of people living near polar bears, to preserve walrus haul-outs and other unique places, and to help local people participate in scientific projects on polar bears and other animals. In order to keep local people safe, Polar Bear Patrol members escort children to school and to day-care, patrol the village for bears, and keep people informed about the current situation (WWF, 2010). Moreover, in summer they keep people away from the walruses to prevent stampeding, and in fall when the bears are waiting for sea ice to form, the patrols try to keep bears out of town. Equipment used by these patrols includes long wooden poles, flaming brands, marine flares (when available), snowmobiles and all terrain vehicles. The patrol also offers education, attractant management and anti- poaching efforts (York, 2009).

Now additional Polar Bear Patrols have been created in other villages (in total 16). Moreover, in 2006 the people of Vankarem voted to make the walrus haul-out at Cape Vankarem a natural monument, a decision which was approved by the government of Chukotka in August, 2007 (WWF, 2010). The Umky Patrol has provided significant support to the people of the Arctic. In 2006, approximately 180 bears surrounded a village for several weeks. There were no humans or bears harmed because of the support provided by the vigilant Umky Patrol member (WWF, 2011).

The program proves to be effective with just small financial resources, the people involved in the Polar Bear Patrol mainly uses simple equipment such as wooden poles, flaming brands, marine flares (when available), snowmobiles and all terrain vehicles. This method is grass-root based since local communities took the initiative for the polar bear patrol. The government plays a minor role in this and funding is arranged by WWF- Russia. In the future generating of sufficient funding might become problematic since the patrol groups will have to become more financially independent from WWF and thus need to seek out for other sustainable financial sources (pers com. Mickael Stishov, May 25, 2011).

Case study area 2: Churchill- Canada

Since the 1960's the Manitoba Polar Bear Alert Program tries to reduce human-polar bear conflict by the following objectives: (1) protecting human life and property, (2) protecting polar bears of the Hudson Bay from unwarranted demise or harassment, (3) minimizing potential food-conditioning and (4) ensuring safety of the Manitoba Conservation staff (Hedman, 2009).

The Polar Bear Alert Program has a holding facility where bears can be kept after a conflict before releasing them back into the wild. Different priority zones are used for polar bear management. Bears found in Zone 1 are trapped and sent to the holding compound for 30 days. The holding facility can accommodate up to 28 bears. After 30 days are up, bears are transferred 40 miles north of Churchill. In the past Conservation Officers used to take them up to 200 miles to the south, but they frequently came back. If the bear comes back to Zone 1, it is captured and put into the holding compound until the ice freezes in November. The holding compound buys time that helps to accomplish the first 2 objectives of the Polar Bear Alert program. Zone 2 has roughly the same policies as Zone 1, though with some mildness. If a polar bear comes into Zone 2 it is monitored and encouraged to leave the area. Conservation officers "walk the bear out" of the area by herding them with vehicles and harassing them with cracker shells (Hedman, 2009). An overview of the number of interactions between the Manitoba Polar Bear Alert Program and polar bears can be found in table 8.

Table 8. Nr. of interactions between the Manitoba Polar Bear Alert Program and polar bears between, 2005–2008 (IUCN, 2009)

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

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

The Polar Bear Alert program includes a lot of bear handling, though it was modified recently to reduce the amount of handling. The most bears that they've handled was 176 bears in 2003. Since then, they've been stricter about zone boundaries and, as a result, they trap fewer bears. A roughly equal number of male and female sub adults wander into Zones 1 and 2 and are trapped or harassed (Hedman, 2009). Traps are baited with seal meat and the bears generally walk in. Manitoba Conservation has used snares, but the bears eventually became snare savvy and avoided them. Trapping a family group can be problematic. The adults can be sedated by a "green charge" from a dart gun in relatively close proximity; however, the same charge will hurt cubs. The officers open the traps and inject the cubs with a dart pole. This puts the officers in some danger of being swiped by the cubs. Officers weigh and tattoo the trapped bears. They try to keep the polar bears sedated lightly enough so that they wake up and climb out of the helicopter cargo net just as they are being released.

Beside these activities, The Polar Bear Alert Program is also involved in giving safety recommendation to workers and visitors to the coast of Hudson Bay. These include proper understanding of polar bear behaviour, designating a bear monitor in the group, proper disposal of wastes and storage of food items, how to deal with polar bears present at working sites, etc. (Hedman, 2009).

Two years ago the Government of Nunavut, Canada began a collaborative project with WWF Canada to mitigate human-polar bear conflicts. Local communities reached out to the government for help after experiencing more conflicts with polar bears than usually, mainly involving dogs. In an attempt to mitigate these issues, electric fence enclosures were build for the dog teams and the dog handlers were instructed on their use and maintenance. Moreover, interested residents were selected by the Hunters and Trappers Organisation (HTO) to receive large metal food storage bins for use in town or at remote hunting camps. Traditionally hunted food is often large in volume, hung outside to dry, or, as winter weather takes hold, left outdoors for cold storage. The idea is to make sure this traditionally stored food is no longer accessible to wayward polar or brown bears around the Hamlet or near camps. Both projects were warmly received by residents and the HTO directorate. Concern about human safety, property safety (dogs, cabins, etc.), and the unnecessary taking of polar bears were common themes expressed by local people. Many communities have showed their interest in

assistance form the government and WWF to reduce the number of conflicts involving polar bears, but a lack of financial means does not allow for this (Geoff York, 2010, pers com. Clive Tesar, 02-08-2011).

Case study area 3: Svalbard- Norway

The main focus for the mitigation of human-polar bear conflicts on Svalbard is on people's behaviour. When visitors arrive to Svalbard they get safety instructions, and information on how to deal with polar bears. People who stay in the field are advised to keep one person on the look out 24 hours a day or use trip wires around their camp. The Governor (Sysselmann) requests that rifles are carried when in the field outside the settlements. Tourists who travel in groups are accompanied by guides who carry rifles and have experience with polar bears. Others who go hiking and camping, e.g. by snow scooters, skiing, kayaking or boating are requested to report their routes and agendas to the Governor prior to departure. Researchers and students who work in the field get rifle training and are advised about how to behave when encountering polar bears (pers. com. Larsen, 20-6-2011.) The measures taken on Svalbard are coordinated by the government, with little involvement of local people.

5.1. Discussion

From the cases described in the last chapter it seems that several strategy types might work in mitigating human-polar bear conflicts. Three levels of strategies were used in the selected case studies. In Svalbard most attention is paid to the lightest type, including deterrence and conflict avoidance. The main goal of these measures is to inform people on how to protect themselves from polar bears. In Chukotka more intensive measures are being used by polar bear patrols including monitoring, creation of feeding spots and educating people. The main purpose is to deter polar bears from human settlements and to inform people on how to make their village bear safe. In Churchill the most extreme and expensive measures are used, including relocation of polar bears after keeping them in a holding facility.

Table 9 shows an interpretation of the mitigation measures which are being used in the case studies. The capital intensity, involvement of stakeholders and effectiveness differs between strategy levels should be taken into account when looking for suitable mitigation measures. Capital intensity means the level of financial investment which is needed for the implementation of a mitigation measure. For some measures high involvement of local people is needed in order to succeed in the mitigation of conflicts. For others, governments play an important role and need to be involved, especially to guarantee long term funding. The time scale in which measures are successful is vague, but for example, destruction of problem animal has short term effect. On the long run, another bear can enter the area and cause conflicts when no measures are taken to prevent this. Moreover, the destruction of problem bears is not favoured from a conservation point of view. Education and polar bear patrols on the other hand focus more on the prevention of future conflicts, have long term effects and pose no threat to the conservation of polar bears.

Table 9. Typology of mitigation measures as used in case studies

Intensity of intervention	Mitigation measure	Capital intensity	Involvement local people	Reliance on government	Short term effectiveness	Conservation appropriateness
Light	Education on conflict prevention	Low	High	Low	Medium	High
	Deterrence (wooden poles, flaming torch, marine flares, cracker shells, etc.)	Medium	High	Low	High	High
Medium	Polar bear patrol (deterrence, monitoring, creation of feeding spots)	Medium	High	Medium	Medium	High
	Relocation polar bears	High	Low	High	High	Medium
High	Destroy problem bears	Low	Low	Low	High	Low

In all polar bear programmes as described in the case studies, methods are being used to deter polar bears from villages and scientific or industrial sites. These methods include the use of wooden poles, flaming torches, marine flares and cracker shells. The effectiveness of methods like these is being questioned mainly because animals might get habituated to loud noises or bright light as was described by Connover (2002), Treves & Karanth (2003) and Shivik et al. (2002) in the paper of Nuggraha & Sugardjito (2009) on the effects of several deterrents on tigers in Indonesia. They argue that because stimuli like noise do not really pose genuine threats to the animal, the target animal will ignore these stimuli after experiencing them several times. This might also be the case with polar bears. To prevent habituation, the stimuli ought to be modified periodically by using a modern technology (Connover, 2002; Treves & Karanth, 2003; Shivik et al. 2003. In Nugraha & Sugardjito, 2009). Although quantitative data on the effectiveness of the methods used in the case studies is lacking (number of polar bears entering communities, number of polar bears being shot in defence of life and property since the implementation of polar bear programmes), some anecdotes suggests that the used deterrents seem to work in chasing off polar bears. In Chukotka for example, sixteen new polar bear patrols have been implemented using similar measures which suggests that the used measures have proven to be successful. However, in Svalbard polar bears managed to get past trip wires placed round camps. This shows that avoidance measures are important but do not guarantee everlasting solutions - one way to prolong their effects and prevent habituation is to shift between different deterrent methods.

Although relocation of problem animals is a very costly method to solve human- wildlife conflicts, it is often being used worldwide (Karanth & Madhusudan 2002; Treves & Karanth 2003, in Nugraha & Sugardjito, 2009). However, the effectiveness has been questioned as well. According to Linnel et al., 1997 (In Nugraha Sugardjito, 2009), translocation projects involving bears in North America and felids in Africa showed that the animals caused similar problems in their new sites. However, in the case of the extremely sparsely populated Arctic this will likely not be a factor. For instance, in Churchill, where polar bears are being captured on land are released far out on the sea ice, far from human habitation.

Still, even in de sparsely populated Arctic, one needs to consider best release sites; bears released up to 200 miles to the South of Churchill frequently came back; not a single bears returned after being relocated at least 40 miles North of Churchill,.

Lethal methods (shoot problem bears) are probably the most cost effective and cheapest to resolve human-polar bear conflicts. However, this is not desired from a conservation point of view. Moreover, when conflicts are increasing and bears are merely killed, the reduced number of bears will in the long run have a negative effect on the livelihood of people who depend on hunting directly and polar bear related industry such as tourism.

The suitability of any measure to solve human-polar bear conflicts depends highly on the local situation. Financial means, political context, involved stakeholders and geography differ substantially per area, determining the suitability of specific measures. A good example of geographical importance was given by Mr. Aksel Blytmann (pers com. July 12, 2011); in Chukotka walrus carcasses are moved away from human settlements by hunters who create feeding-spots for polar bears elsewhere. In East Greenland this would be impossible since there is a lot of drift ice around the villages. If walrus carcasses would be relocated on this ice, they would drift away and no longer serve as food source for polar bears, making them even more food stressed. Another example given by Mr. Blytmann was the use of guard dogs in the South. Greenland huskies are much valued for their power and guarding abilities under harsh conditions. No other dog breeds are allowed in northern regions of Greenland, and the Greenlandic husky is not allowed South of the Polar circle to prevent crossbreeding. Dog breeds in the East and South have less guarding instinct and will be less appropriate for defending communities from polar bears, which forecloses the use of Greenland Husky as guard dogs in the South of the country. This shows that local policies affect the suitability of mitigation measures.

In some cases, such as Churchill and Svalbard, the government is highly involved in conflict mitigation work which provides the best possible funding in the long term. In Chukotka on the other hand, the government is not involved and all funding is provided by WWF- Russia. The polar bear patrol in Chukotka may need fundraising or involvement of government to guarantee sustainable funding on the long term.

Before addressing human-polar bear conflicts in a specific area, it is important to know whether the local communities actually perceive conflict as being a problem. If local people do not see conflict as problem, than there is no point to start mitigation work (in order to safeguard the survival of the sub-population) which involves their active participation. Preferences and capacity of local communities also largely determine what mitigation measures are feasible. According to Mr. Nikiforov (pers com. July 19, 2011) mitigation strategies which need to involve the participation of local communities can only work when local communities acknowledge their problem and are willing to do something about it, as was the case in Chukotka and Nunavut. Here local people took the lead in conflict mitigation or reached out to the government for help. The selected measures became much more effective, since people were highly motivated to cooperate. The polar bear patrols in Chukotka and Churchill work on a range of activities, such as monitoring of polar bears and walruses is executed by these groups. For these types of activities it is very useful to have local communities involved since they have a lot of

knowledge about the area. Moreover, their feeling of involvement will increases which in turn benefits conflict mitigation programmes.

In summary:

- Education on waste management, food storage and polar bear deterrence is important to anticipate future situations with increasing interactions between people and polar bears;
- Suitable measures need to be identified by examining the local situation;
- Before addressing human-polar bear conflicts in a specific area, it is important to know whether the local communities actually perceive conflict as being a problem;
- Preferences and capacity of local communities largely determine what mitigation measures are feasible;
- Involvement of local communities in monitoring activities benefits conflict mitigation programmes and safeguards long term mitigation work.

Section IV Discussion and advise

6. Overall discussion

One of the main challenges of this study was the collection of data. A questionnaire was designed and send to several respondents to get detailed information on trends in polar bear numbers, trends in human-polar bear conflicts and how people deal with this, the relative impact of conflicts to polar bears compared to other threats, and possible mitigation strategies. Most of the respondents were not able to fill in the questionnaire or could not be reached by mail or phone. The subject of human-polar bear conflicts may be low on their priority list, or the questionnaire was simply too long and time consuming for respondents to fill in. Moreover, in the Arctic countries the summer (and field) season is short and respondents were probably out of office for most of the time. For future studies or nature conservation programmes it is essential to have a better relationship and intensive contact with other WWF offices and governmental organisations.

Data on polar bear numbers was difficult to obtain for some subpopulations since some information sources used data on country level, while others used the level of polar bear subpopulation. It might be difficult to standardize these data because of a variation in data collection per area. However, consistent data collection and storage will benefit future research tremendously. It was also hard to get a proper understanding of the involvement of local communities and whether people actually perceived human-polar bear conflicts as a problem. This can possibly only be reached when local people are being interviewed face to face.

The most important data missing in this report is information on the effectiveness of mitigation measures used in the three case studies. No reports seemed to be available with analysis of strength and weaknesses of measures used. This can be due to a lack of funding for the follow up of the programmes, or a lack of priority for making such analyses. For future conflict mitigation work it is important to learn from past experiences to be able to define best management practices.

The study limited itself to data which have been officially recorded and released by the different authorities and data presented in IUCN-SSC Polar Bear Specialist Group reports. This was supplemented with data presented in scientific papers, anecdotal information in reports and information gained from a few phone interviews with experts. As a result only few of the stated research questions could be answered of which most answers were comprised of expectations and ideas rather that facts and figures.

7. Conclusion and recommendations

Despite the fact that the collection of both sufficient quantitative and qualitative data proved to be challenging, this report attempts to contribute to an increased understanding of the status of polar bears and conflicts with people in East Greenland with an aim to come-up with an advise of measures to be taken to mitigate these conflicts.

Since the most important impact on the long term survival of polar bears in the Arctic, climate change, is classified as a mainly externally induced, long term impact, mitigation may be difficult because much international cooperation, campaigning and legislation is needed to reduce the emission of greenhouse gasses. However, locally attention can be paid to the mitigation of other impacts such as harvest and human-polar bear conflicts. This is important because all impacts on polar bear sub-populations are highly linked and their individual effect is accumulative. Addressing climate change and mitigation of conflicts etc need to be addressed simultaneously.

In order to set sustainable quota and to find out what the effect of conflict induced non-natural mortality is on the polar bear population, reliable information on the structure and numbers of the East Greenland polar bear subpopulation is needed. All information on polar bear population structure and the number of human-polar bear conflicts should be recorded in the Polar Bear-Human Information Management System managed by the PBSG, to make sure these data are stored in a structured way, easily accessible for future needs.

Besides the effect of conflicts on the polar bear subpopulation, insight on how local communities perceive human-polar bear conflicts is essential. Do they actually see the presence of polar bears in close proximity of villages as a problem? If conflicts are perceived to be problematic, local communities need to be asked what kind of solutions they would suggest and whether they are willing to cooperate in taking mitigation measures, what their needs are and what role they can play in addressing conflict.

Mitigation measures should be focussed on both conflict hotspots and at the entire range in which polar bears can be found. Conflict hotspots need specific measures such as polar bear patrols using deterrents, creating feeding spots, and in extreme cases relocation of problem bears. More general solutions should be addressed to the entire area. At a minimum education programmes are important to anticipate to expected increased human-polar bear interactions and to inform local communities and visitors how to prevent polar bears coming close to people. This can include information on proper waste management, how to store food items in and around villages and camps.

Suitable measures need to be identified for the mitigation of human-polar bear conflicts in East Greenland. Important factors to take into account are: the political context, whether the government or local people will be able to manage such program, and the availability of financial means. These factors need to be studied in more detail for selecting the best measures.

In summary:

- For the mitigation of human-polar bear conflicts in East Greenland, first more research is needed on polar bear population size and structure, trends in conflict numbers over time and the perception of local people on conflicts;
- If research shows a need of conflict mitigation, concrete measures such as improved waste management, food storage and fencing of waste dumps and dog facilities should be selected in cooperation with local people. In the case of significant conflicts and high involvement of local communities and the government, polar bear patrols can be established for long term polar bear deterrence and population monitoring;
- Even if conflicts are not perceived to be problematic, anticipation on future situations with expected increased interaction between people and polar bears is important;
- Long term impacts such as climate change, and mitigation of conflicts needs to be addressed simultaneously;
- At a minimum education programmes are important to anticipate on expected increased human-polar bear interactions and to raise awareness among local communities and visitors on how to increase conflict avoidance.

References

Aars, J., Marques, T. A., Buckland, S. T., Andersen, M., Belikov, S., Boltunov, A. and Wiig, Ø., 2009. In IUCN, 2009. Proceedings of the 15th working meeting of the IUCN/SSC polar bear specialist group, 29 June-3 July 2009, Copenhagen, Denmark. Occasional paper of the IUCN species survival commission No. 43.

ACIA (Arctic Climate Impact Assessment), 2005. Cambridge University Press, 1042p. Available at: http://www.acia.uaf.edu, visited March 1, 2011.

Amstrup, S. C., McDonald, T. L., Stirling, I., 2001. Polar bears in the Beaufort Sea: A 30-year mark-recapture case history. *J. Agr. Biol. Environ. Stat*. 6: 221-234.

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

Armstrup, S. C, 2009. In IUCN, 2009. Proceedings of the 15th working meeting of the IUCN/SSC polar bear specialist group, 29 June-3 July 2009, Copenhagen, Denmark. Occasional paper of the IUCN species survival commission No. 43.

Andersen, M., Aars, J., 2008. Short-term behavioural response of polar bears (*Ursus maritimus*) to snowmobile disturbance. *Polar Biol* 31: 501-507

BBC News, 2011. Polar bear kills British boy in Arctic. Available at: http://www.bbc.co.uk/news/uk-14415592, accessed August 8, 2011

Belikov, S.E., Boltunov, A.N., Ovsyanikov, N.G., Mordvintsev, I.N., Nikiforov, V.V., 2009. Polar bear management and research in Russia, 2005–2009. In IUCN, 2009. Proceedings of the 15th working meeting of the IUCN/SSC polar bear specialist group, 29 June-3 July 2009, Copenhagen, Denmark. Occasional paper of the IUCN species survival commission No. 43.

Bernhoft, A., Wiig, Ø., Skaare, J.U., 1997. Organochlorines in polar bears (*Ursus maritimus*) at Svalbard. *Environ Pollution* 96: 159-75.

Blix, A.S., Lentfer, J.W., 1992. Noise and vibration levels in artificial polar bear dens as revealed to selected petroleum exploration and developmental activities. *Arctic* 45: 20-24

Born, E.W., Heilmann, A., Kielsen Holm, L., Laidre, K.L., 2011. *Polar bears in Northwest Greenland. An interview survey about the catch and the climate*. Museaum Tusculanum press

Braune, B.M., Outridge, P.M., Fisk, A.T., Muir, D.C.G., Helm, P.A., Hobbs, K., 2005. Persistent organic pollutants and mercury in marine biota of the Canadian Arctic: an overview of spatial and temporal trends. *Sci total environ* 351-352: 4-56.

Bugge Jensen, D., Diget Christensen, K., 2003. The biodiversity of Greenland- a country study. Technical Report No. 55, December 2003, Pinngortitaleriffik, Grønlands Naturinstitut.

COSEWIC, 2008. Assessment and update status report on the polar bear (*Ursus maritimus*) in Canada. © Her Majesty the Queen in Right of Canada, 2008. Catalogue No. CW69-14/351-2008E-PDF ISBN 978-0-662-48897-2.

Derocher A.E., Lunn, N.J., Stirling, I., 2004. Polar bears in a warming climate. *Integr. and Comp. Biol*. 44: 163-176.

Derocher, A. E. and Stirling, I., 1995. Temporal variation in reproduction and body mass of polar bears in western Hudson Bay. *Can. J. Zool*. 73: 1657-1665.

Derocher, A.E., 2009. In WWF, 2009. Hungry polar bears means more conflict. Available at: http://enviroconflict.org/hungry-polar-bears-means-more-conflict/109, accessed June 27, 2011.

Dietz, R., Riget, F.F., Sonne, C., Letcher, R., Born, E.W., Muir, D.C.G., 2004. Seasonal and temporal trends in polychlorinated biphenyls and organochlorine pesticides in East Greenland polar bears (*Ursus maritimus*), 1990–2001. *Science of the total environment* 331: 107-124.

Dobson, F.S., 1982. Competition for mates and predominant juvenile male dispersal in mammals. *Animal Behaviour* 30: 1183-1192.

Dowsley, M. and Wenzel, G., 2008. The time of the most polar bears : A co-management conflict in Nunavut. *Arctic* 61 (2): 177-189.

Dyk, M.G., 2006. Characteristics of polar bears killed in defence of life and property in Nunavut, Canada, 1970-2000. *Ursus* 17(1): 52- 62.

Fischbach, A.S., Amstrup, S.C., Douglas, D.C., 2007. Landward and eastward shift of Alaskan polar bear denning associated with recent sea ice changes. *Polar Biology* 30: 1395-1405.

Fisk, A.T., de Wit, C.A., Wayland, M., Kuzyk, Z.Z., Burgess, N., Letcher, R.J., 2005. An assessment of the toxicological significance of anthropogenic contaminants in Canadian Arctic wildlife. Science of the Total Environ 351- 352: 57- 93.

Gjertz, I. and Scheie, J.O.,1998. Human casualties and polar bears killed in Svalbard, 1993-1997. *Polar Res*. 34: 337-340.

Greenland in figures, 2009. Statistics of Greenland, Greenland Home Rule Government. Available at: http://www.stat.gl/LinkClick.aspx?link=Intranet %2FGIF_2009_WEB.pdf&tabid=57&mid=473&language=en-US, accessed May 8, 2011.

Greenwood, P.J., 1980. Mating systems, philopatry and dispersal in birds and mammals. *Animal Behaviour* 28: 1140-1162.

Hedman, D., 2009 in 3rd International bear-people workshop, 2009. Polar bear focus day summary.

IUCN, 2009. Proceedings of the 15th working meeting of the IUCN/SSC Polar bear specialist group, 29 June-3 July 2009, Copenhagen, Denmark. Occasional paper of the IUCN species survival commission No. 43.

IUCN PBSG, 2011. Agreement on the conservation of polar bears, available at: http://pbsg.npolar.no/en/agreements/agreement1973.html, accessed July 18, 2011

Jenness, P., Erickson, A.W., Craighead, J.J., 1972. Some comparative aspects of milk from four species of bears. *J Mammal* 53: 39- 47.

Johansen, P., Muir, D.C.G., Law, R.J., 2000.Contaminants in the Greenland environment. *The science of the total environment* 245: 1-2

Johansen, P. & Asmund, G., 1999. Pollution from mining in Greenland- monitoring and mitigation of environmental impacts. In: Azcue JM, editor. Environmental impacts of mining activities- emphasis on mitigation and remedial measures. *Springer Verlag*, 1999: 245-262.

Johansen, P., Kapel, F.O., Kraul, I.,1980. *Heavy metals and organochlorines in marine mammals from Greenland*. ICES C.M. 1980/E: 32. Copenhagen.

Keyser, M.N.S., 2009. Isbjørn og mennesker på Svalbard. En spørreundersøkelse blant turister i Longyearbyen. Masteroppgave i utmarksbasert næringsutvikling Universitetet for Miljø- og Biovitenskap Universitetssenteret på Svalbard.

Kishigama, N., 2008. A cultural anthropological study of subsistence activities with special focus on indigenous hunting, fishing and gathering in the Arctic regions. Draft prepared for the 2008 ICASS, Nuuk, Greenland. Available at: http://www.minpaku.ac.jp/staff/kishigami/subsistence_paper.pdf, accessed June 7, 2011.

Larsen, T., 1986. Population biology of the polar bear (*Ursus maritimus*) in the Svalbasrd area. *Norsk Polarinstitutt Skrifter* 184: 55.

Lentfer, J.W., and Hensel, R.J. 1980. Alaskan polar bear denning. In: Martinka, C.J., and McArthur, K, L., eds. Bears - Their biology and management. *Bear biology association conference series* No. 4. 101-108

Letcher, R.J., Bustnes, J.O., Dietz, R., Jenssen, B.M., Jørgensen, E.H., Sonne, C., 2010. Exposure and effects assessment of persistent organohalogen contaminants in Arctic wildlife and fish. *Sci Total Environ* 408(15): 2995-3043.

Manitoba hunting guide, 2011.
Available at: http://www.gov.mb.ca/conservation/wildlife/hunting/pdfs/huntguide_2011.pdf, accessed June 8, 2011.

Mauritzen, M., Derocher, A. E. and Wiig, Ø. 2001. Space-use strategies of female polar bears in a dynamic sea ice habitat. *Can. J. Zool*. 79: 1704-1713.

McArthur Jope, K.L., 1983. Habituation of grizzly bears to people: a hypothesis. *International conference on bear research and management* 5: 322-327.

Medill, S., 2009 in 3rd International bear-people workshop, 2009. Polar bear focus day summary.

Meyerson, R., 2009 in 3rd International bear-people workshop, 2009. Polar bear focus day summary.

Miller, S., 2009 in 3rd International bear-people workshop, 2009. Polar bear focus day summary.

Miller, S. and Reed, J., 2009 in 3rd International bear-people workshop, 2009. Polar bear focus day summary.

Nanoq.gl, 2011. Available at:
http://dk.nanoq.gl/Emner/Erhverv/Erhvervsomraader/Fangst_og_Jagt/kvoter_raadgivning/Havdyr/Isbjørne-hvalros/2011.aspx, accessed May 23, 2011.

Nugraha, R.T., Sugardjito, J., 2009. Assessment and management options of human-tiger conflicts in Kerinci Seblat National Park, Sumatra, Indonesia. *Mammal Study* 34: 141-154.

Nyegaard Hvid, H., 2007. Climate change and Greenland society. WWF Denmark, October 2007.

Ovsyanikov, N., 1998. *Polar bears*. Voyageur Press, 1998, page 57.

Ovsyanikov, N.G., 2009. In IUCN, 2009. Proceedings of the 15th working meeting of the IUCN/SSC polar bear specialist group, 29 June-3 July 2009, Copenhagen, Denmark. Occasional paper of the IUCN species survival commission No. 43.

Paetkau, D., Amstrup, S.C., Born, E.W., Calvert, W., Derocher, A.E., Garner, G.W., Messier, F., Stirling, I., Taylor, M. K., Wiig, Ø. And Strobeck, C., 1999. Genetic structure of the world's polar bear populations. *Molec. Eco*. 8: 1571-1584.

Peacock, E., 2009. In IUCN, 2009. Proceedings of the 15th working meeting of the IUCN/SSC polar bear specialist group, 29 June-3 July 2009, Copenhagen, Denmark. Occasional paper of the IUCN species survival commission No. 43.

Pederson, M., 2009. In 3rd International bear-people workshop, 2009. Polar bear focus day summary.

Piniarneq, 2011. Aallaaniartunut atassuteqaat pisanillu nalunaarsuiffiit jagtinformation og fangstregistrering (Greenlandic hunting magazine). Available at: nanoq.gl, accessed June 8, 2011.

Prestrud, P. and Stirling, I., 1994. The international polar bear agreement and the current status of polar bear conservation. *Aquat. Mamm*. 20: 113-124.

Ramsay, M.A., and Stirling, I., 1986. On the mating systems of polar bears. *Canadian journal of zoology* 64: 2142-2151.

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

Regehr, E.V., Armstrup, S.C., Stirling, I., 2006. Polar bear population status in the southern Beaufort Sea: U.S. Geological Survey Open-File Report 2006-1337. 30 pp.

Rosing-Asvid, A., Born, E.W., Kingsley, M.C.S., 2002. Age at sexual maturity of males and timing of the mating season of polar bears (*Ursus maritimus*) in Greenland. *Polar Biol* 25: 878-83.

Sandell, M., Sandell, B., Born, E.W., Dietz, R. And Hansen, C.S. 2001. Isbjørne i Østgrønland: En interviewundersøgelse om forekomst og fangst, 1999 (Polar bears in eastern Greenland: An interview survey about the occurrence of polar bears and the hunt, 1999) Greenland Institute of Natural Resources. Technical Report No. 40 (In Danish with English summary).

Schliebe, S., Rode, K.D., Gleason, J.S., Wilder, J., Proffitt, K., Evans, T.J., Miller, S., 2008a. Effects of sea ice extent and food availability on spatial and temporal distribution of polar bears during the fall open-water period in the Southern Beaufort Sea. *Polar biology* 31 (8): 999-1010.

Schliebe, S., Wiig, Ø., Derocher, A. & Lunn, N. 2008b. *Ursus maritimus*. In: IUCN 2010. IUCN red list of threatened species. Version 2010.4. Available at: www.iucnredlist.org, accessed April 20, 2011).

Sonne, C., 2010. Health effects from long-range transported contaminants in Arctic top predators: an integrated review based on studies of polar bears and relevant model species. *Environ Int* 36: 461-91.

Stenhouse, G.B., Lee, L.J., Poole, K.G., 1988. Some characteristics of polar bears killed during conflicts with humans in the Northwest Territories, 1976-1986. *Arctic* 41(4): 275-278.

Stirling, I., 2002. Polar bears and seals in the eastern Beaufort Sea and Amundsen Gulf: A synthesis of population trends and ecological relationships over three decades. *Arctic* 55: 59-76.

Stirling, I. & Calvert, W. 1983. Environmental threats to marine mammals in the Canadian Arctic. Polar Record 21(134):433-449.

Stirling, I., and Latour, P.B., 1978. Comparative hunting abilities of polar bear cubs of different ages. *Canadian Journal of Zoology* 56: 1768-1772.

Stirling, I. and Derocher, A.E., 1993. Possible impacts of climatic warming on polar bears. *Arctic* 46: 240-245.

Stirling, I., Lunn, N.J., Iacozza, J., 1999. Long-term trends in the population ecology of polar bears in western Hudson Bay in relation to climate change. *Arctic* 52(3): 294-306.

Stirling, I. and Parkinson, C.L., 2006. Possible effects of climate warming on selected populations of polar bears (*Ursus maritimus*) in the Canadian Arctic. *Arctic* 59(3): 261-275.

Svalbard information website, available at: http://www.spitsbergen-svalbard.info/index2.html, accessed July 7, 2011.

Tate, J., and Pelton, M.R., 1983. Human-bear interactions in Great Smokey Mountains National Park. *International conference on bear research and management* 5: 312-321.

Taylor, M. K., Laake, J., McLoughlin, P.D., Born, E.W., Cluff, H.D., Ferguson, S.H., Rosing-Asvid, A., Schweinsburg, R., Messier, F., 2005. Demography and viability of a hunted population of polar bears. *Arctic*. 58 (2): 203-214.

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

Thiemann, G.W., Iverson, S.J., Stirling, I., 2008. Polar bear diets and Arctic marine food webs: insights from fatty acid analysis. *Ecol Monogr* 78: 591-613.

Towns, L., Derocher, A.E., Stirling, I., Lunn., N.L., Hedman, D., 2009. Spatial and temporal patterns of problem polar bears in Churchill, Manitoba. *Polar Biology* 32: 1529-1537.

U.S. Fish and Wildlife Service (USFWS), 2010. Polar bear conservation issues.
Available at: http://alaska.fws.gov/fisheries/mmm/polarbear/issues.htm, accessed June 8, 2011.

Verreault, J., Muir, D.C.G., Norstrom, R.J., Stirling, I., Fisk, A.T., Gabrielsen, G.W., Derocher, A.E., Evans, T.J., Dietz, R., Sonne, C., Sandala, G.M., Gebbink, W., Riget, F.F., Born, E.W., Taylor, M.K., Nagy, J., Letcher, R.J., 2005. Chlorinated hydrocarbon contaminants and metabolites in polar bears (Ursus maritimus) from Alaska, Canada, East Greenland, and Svalbard: 1996-2002. Science of the Total Environment 351-352: 369-390

Vongraven, D., 2009. IN IUCN, 2009. Proceedings of the 15th working meeting of the IUCN/SSC polar bear specialist group, 29 June-3 July 2009, Copenhagen, Denmark. Occasional paper of the IUCN species survival commission No. 43.

Wenzel, G., 2004. From TEK to IQ: Inuit Qaujimajatuqangit and Inuit cultural ecology. *Arctic Anthropology* 41(2): 238-250.

Wiig, Ø., 1995. Distribution of polar bears (*Ursus maritimus*) in the Svalbard area. *J. Zool.* 237:515-529.

Wiig, Ø., Gjertz, I., Hansson, R., Thomassen, J., 1992. Breeding behaviour of polar bears in Hornsund, Svalbard. *Polar Rec* 28: 157-9.

Wilder, J., 2009. in 3rd International bear-people workshop, 2009. Polar bear focus day summary

Winter Hansen, A., 2009. Polar bear management in Greenland, 2005–2008. In IUCN, 2009. Proceedings of the 15th working meeting of the IUCN/SSC polar bear specialist group, 29 June-3.
July 2009, Copenhagen, Denmark. Occasional paper of the IUCN species survival commission No. 43.

Wolf, D.T., 2011. In Readers Digest May 2011: 103-107

WWF, 2009. Hungry polar bears means more conflict. Available at:
http://enviroconflict.org/hungry-polar-bears-means-more-conflict/109, accessed June 27, 2011.

York, G., 2009. in 3rd International bear-people workshop, 2009. Polar bear focus day summary.

Zdor report, 2011. Indigenous peoples of Chukotka of the polar bear and selected by the US-Russian agreement on production quotas of this kind for the needs of indigenous people Chukotka Association of Traditional Hunting hunters and World Wide Fund for Nature.

3rd International bear-people workshop, 2009. Polar bear focus day summary, November 18, 2009, Canmore, Alberta. Available at: http://www.bearsmart.com/report/1037, accessed May 2011.

Acknowledgement

I would like to thank Gert Polet for giving me the opportunity to conduct my MSc internship at WWF-Netherlands. He gave me much needed support in writing this paper by sharing his knowledge and contacts in the WWF network. Moreover I highly appreciated his fun, patience, and trust in my work. The other staff members of WNF and especially Gernant Magnin, Frans Schepers and Christiaan van der Hoeven warmly welcomed me at the office and in the cluster of Ecological Networks and Species in Zeist. Thanks to Geoff York, who helped me with collecting information and sharing contact details of respondents, and to James Wilder, Craig Perham, Peter Ewins, Clive Tesar, Mickael Stishov, Viktor Nikiforov, Aksel Blytmann, Thor Larsen, Ko de Korte, Michael Campbell, Tom Arnbom, and Margrete Nilsdatter Skaktavl Keyser for sharing information and ideas. I would like to thank Arjen Buijs for his guidance during this internship and his visits to the WWF- Netherlands office.

Appendix I Questionnaire

Polar bears: conflicts and mitigation strategies

Polar bears

1. Do you notice any trend (increase/ decrease/ stable) in numbers of polar bears spending time on land in close proximity of human settlements over time?

2. If possible, can you provide a time series of number of polar bears in the area + indicate on what basis these estimates are made?

Conflicts

3. Do you or does your organization/government report and track annual polar bear human interactions/conflicts?

4. If yes, can you provide a year-by-year overview of human-bear conflict incidents.

5. How does this information reach you (telephone, paper report, email, FAX, radio, personal conversation)?

6. How is this information archived (if at all)?

7. Who is responsible for recording this information?

8. In what type of settlements (village, scientific setting, hunting/fishing camp or industrial/military facility) did most human-polar bear conflicts take place?

9. In your opinion, what factors were associated with these events?
    - Were most bears adult or juvenile animals, what was their gender and were they solitary or family groups?

    - Has human population changed in this location? (please provide human population data over time)

    - Do people take precautionary measures such as proper storage of (dog-) food items?

    - Has there been a change in population of prey species for polar bears in this area?

    - Can you provide an overview of the number of polar bears being hunted illegally in this area each year?

- Is the number of illegally hunted bears going up or down?

- Are there more polar bears using this area compared to the past? E.g. do people report more polar bear sightings at this location than in the past?

- Are there any observations on the physical condition of polar bears in this area and how does that compare to the past?

- Are there any other factors of which you think might play an explaining role?

10. In how many of the events were polar bears being killed? If possible, can you provide data over the past 10 or 20 years?

11. How many human injuries were reported after conflicts with polar bears? What was the nature of the injury (mild/moderate/severe/fatal)? If possible, can you provide data over the past 10 or 20 years?

12. What do you know about the effects of the following threats on polar bear populations?

Please fill in the table below for each of the high conflict areas separately. Mark the most appropriate answers (**X**) for each of the given threats and give other possible explaining factors with associated importance in the area.

Threats	This threat in this particular area is:		
	Important	Somewhat important	Not important
Human induced threats			
Pollution (contaminants, hydrocarbons and oil spills)			
Human disturbance • more tourism			
• more economic activity (e.g. oil & gas, shipping)			
• more movement by local people, more polar bear encounters			
Natural threats			
Parasites and disease resulting in poor physical condition of polar bears			
Many young, inquisitive polar bears in the area			
Low natural prey availability			
Large nr. of prey species close to settlements, attracting polar bears			
Poor sea ice conditions hampering movement of polar bears			
Other			

13. If you list the threats to polar bear populations given in question 11, can you put them in order of relative importance – starting with the most important threat as number 1.

Mitigation

1. Is the polar bear patrol the only measure used to mitigate the human-polar bear conflict, or are other measures taken as well? If so, which?

2. Can you describe how the polar bear patrol works, what mitigation measures & techniques they use? (Eg sticks, sound, gun, removal of walrus carcasses/polar bear food far away of human settlements, etc.)

3. By who was the patrol group initiated and how was this mitigation method selected and implemented (was there any use of literature/ suitability assessment/ use of expertise/ other)?

4. Which people or organisations are involved in the patrol other than local communities and the WWF? And what is the role of the government in this?

5. How is the patrol team coordinated?
   - How many people work in these patrol groups?
   - What kind of rules and regulations apply for this measure?
   - Are there any protocols?
   - What kind of education activities are conducted?
   - How is dealt with attractant management and anti- poaching efforts (what people are targeted, where, how is this coordinated)?
   - How are the patrol activities recorded?
   - Does the patrol also note polar bear sightings? If so, can you provide polar bear sightings over the last years?
   - Does the patrol also note human-polar bear conflicts? If so, can you provide an overview of recorded conflicts & nature thereof over time?

6. How effective is this method since it's application in terms of trends in:
   - Number of recorded conflicting situations;
   - Number of polar bears being scared off or relocated;
   - Number of killed polar bears;

- Number of human injuries;

- Does the patrol intercept illegal hunters? How often over time?

7. Which factors contribute to the success or failure of the polar bear patrol?;
   - What pro's and cons were identified?

   - What should be done differently when a new patrol group would get in function? (Eg polar bearss get used to sound and will not scare them of anymore, sticks must be short / long, etc.)

   - What parts of the polar bear patrol set-up are most suitable for replication elsewhere? (Eg always involve local community, never arm a patrol with guns, etc.)

   - Are there any limiting factors for the success of the patrol, such as sufficient funding, staff or involvement of local people?

8. How are local people involved in the patrol groups mitigating human-polar bear conflicts?
   - Are patrol members all from the community?

   - How are they selected and by whom?

   - Is there or should there ideally be a representative of the government (eg. Wildlife ranger) in the group? Does patrol has legal power to confront poachers?

   - How were partnerships build with communities?

   - Do they receive education about precautionary measures people can take such as proper storage of food items, use of weapons for self-defence, etc.?

   - Is the community happy with the patrol and how do you ensure that community supports the patrol / is happy with the patrol?

9. How do people in the area respond to conflict with polar bears themselves? What measures do they take to prevent conflict and if there is a conflict, how is it usually resolved?

10. Are you familiar with other polar bear conflict mitigation techniques, eg as taken in other areas? Do you think they would be suitable for your area? Why or why not?

Appendix II List of respondents

Country	Organisation/ expertise	Name	Contact
Alaska	USFWS database	James Wilder	Phone and send database
	USFWS industry, communities	Craig Perham	Phone and send info
Canada	WWF Canada	Peter Ewins	Phone, redirected me to Daryll Hedman who I did not manage to reach
	WWF Global Arctic Programme	Geoff York	Phone/ mail, helped to find data and informants
	WWF Global Arctic Programme	Clive Tesar	Phone and send info
	University of Manitoba	Michael Campbell	Discussed the topic in Wageningen en send info
Russia	WWF Russia	Mickael Stishov	Phone, send Zdor report
	WWF Russia	Viktor Nikiforov	Spoke to Gert about Umky patrol in Russia
Greenland	KNAPK	Aksel Blytmann	Phone
Norway	Norwegian Polar Institute	Thor Larsen	Phone
	Governor of Svalbard	Margrete Nilsdatter Skaktavl Keyser	Received MSc thesis report
	Biologist and tour operator	Ko de Korte	Appointment in Amsterdam
Sweden	WWF Sweden	Tom Arnbom	Discussed the topic in Zeist