

Master's thesis



Polar Bears and Iceland

An overview, history and proposed response plan

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Polar Bears and Iceland – An overview, history and proposed response plan

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Declaration

I hereby confirm that I am the sole author of this thesis and it is a product of my own academic research.

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Abstract

Polar bears are not native to Iceland but occasionally reach Iceland's shores. This is not a new phenomenon and occurred even prior to human settlement. Until recently all such incidents resulted in the destruction of the bear. However, recent media attention has stimulated debate on whether the rescue of some bears might be possible. This thesis gives an overview of polar bear occurrences in Iceland, analyzes relevant ocean current and sea ice movement which contribute to their arrival, and also suggests a plan outlining possible response options.

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Chapter 1

Introduction

In recent years Icelandic authorities have begun to seriously consider the most appropriate action to take when a polar bear (*Ursus maritimus*), a mammal on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species, reaches Icelandic territory (IUCN/SSC Polar Bear Specialist Group, 2010).

After two polar bears came ashore in northern Iceland in 2008, a committee was convened to recommend how authorities should best deal with this issue. The committee's conclusion was that the best option would be to destroy any such bear (Gudmundsson et al., 2008).

Three reasons were put forward to justify this decision (Gudmundsson et al., 2008):

1. The safety of people and farm animals
2. It would not make a difference to the population of the East Greenlandic stock if one or two animals, or even a few, were destroyed
3. The high cost of transporting a live bear back to its native habitat

Polar bears are not, and in recorded history, have never been native to Iceland. However, they have been occasional visitors (Haraldsson et al. 2004). When they have come ashore it has generally been in cold years when there is a large presence of drift ice (Jakobsson, 2003). However, during the latter half of the 20th century, polar bears were rarely seen in Iceland or surrounding waters, possibly as a result of a decrease in sea ice. Compared to the last quarter of the 20th century, in recent years, an increase in the number of bears reaching northern Iceland has been observed (Jakobsson, 2003). It has been determined that the bears reaching Iceland are primarily from the east Greenland population (Gudmundsson et al., 2008). Historically, the response has always been to shoot these bears (Gudmundsson et al., 2008). In recent years, both the Icelandic and international community have questioned whether it is possible to save polar bears that reach Iceland, and if so, how this could be achieved.

This thesis will examine the history of polar bears reaching Iceland, their provenance, and will analyze how, when and why bears end up in Iceland. It will also develop a response plan for these occurrences. The options that will be investigated include the capture and airlifting of bears to East Greenlandic sea ice, the transporting of a bear to a zoo and, lastly, destruction and disposal of a bear.

Chapter 2

Methodology

There are many references throughout recorded history to polar bears coming ashore in Iceland. This thesis will document the history of polar bear occurrences in Iceland. This information has been found in old literature such as the sagas and personal journals. Various place names also demonstrate that bears have been visitors to Iceland since settlement occurred (Áskelsson, 1938), (Benedikt, 1878), (Friðlaugsson, 1935), (Kristilig 1821), (Thoroddsen 1916-17).

There is detailed scientific literature on ocean currents and sea ice between East Greenland and Iceland. This thesis uses the Icelandic Meteorological Agency's, Sea Ice Division's publications, for information and graphs dating back to the mid 20th century (Jakobsson, 2003). Information on oceans currents and sea ice in the Danish strait was synthesized to show how bears actually move between Greenland and Iceland.

In examining the East Greenlandic bear population this thesis utilizes information from publications of the Greenlandic government, and Greenland's national newspaper, Sermitsiaq. Although studies on population's numbers are scarce, there is considerable information regarding the population itself (Born et al., 2002), (Rosing, 2002), (Simonsen, 2010). Newspaper articles were translated as they best illustrated the disagreements between scientists and local hunters.

There is little written about response plans for polar bears regardless of location in the circumpolar world. This is not to say that response plans do not exist. Many organizations, governments and individual people carry out minor and major polar bear response plans. However, there is very little literature on this topic. Protocols and illustrations, from the US Geological Service and the Ministry of Natural Resources of Ontario, on 'preparing for and capturing polar bears', were used as a guideline for recommendations in this thesis (USGC, 2010, MNR, 2010). The author reviewed various polar bear management documents and articles, many produced by national governments, sub-national governments and nongovernmental organizations. (Clark et al., 2010), (Clark et al., 2008), (Gudmundsson et al., 2008), (Jessen, 2009). Most of the literature focused more on quota management, cooperative management, hunting techniques, and aboriginal hunting. Actual response plans for polar bears were not

discussed. Therefore it was necessary to make personal contact with various Icelandic and international stakeholders involved in polar bear disciplines in order to obtain technical and practical information that is unpublished. Much of the information received relating to Iceland was published in Icelandic, and not translated into English. As a result, much of the key information in this thesis was obtained from interviews and personal exchanges.

To understand Icelandic law relating to the polar bear, recent and historical legal and legislative material was examined (Althingi, 1994). International law and acts pertaining to the movement of polar bears between nations is also discussed, most importantly the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2010).

This thesis has relied upon and utilized the knowledge of staff and publications of various organizations, including:

- Icelandic Government Departments (Environment Agency and the Meteorological Agency)
- The Icelandic Institute of Natural History
- Greenlandic Government's Department of Environment
- Polar Bears International (PBI), Sustainability Group
- The World Wildlife Fund's Arctic Program
- International Union for Conservation of Nature
- The Polar Bear Alert Program in Churchill, Manitoba Canada

Various academics and industry professionals have also been contacted for their professional opinions on specific questions that arose. The following individuals shared their expertise through both personal and emailed interviews and discussion: Hjalti Gudmundsson of the Environment Agency of Iceland, Aevan Petersen of the Icelandic Institute of Natural History, Douglas Clark of the University of Saskatchewan, Aqqalu Rosing-Asvid of the Greenland Institute of Natural Resources, Thor Jakobsson of the Icelandic Meteorological Office, Daryll Hedman of the Polar Bear Alert Program, Andrew Derocher of The University of Alberta, Amy

Cutting of Polar Bear International, Fernando Ugarte of the Greenland Institute of Natural Resources, and Bjarni Pálsson of the Environment Agency of Iceland.

Literature Review

This thesis compiles the knowledge and expertise of several countries, regions and individuals to develop a systematic way to deal with a rare but increasingly important occurrence. This thesis will hopefully contribute to the Icelandic Government's capacity to implement a response plan in the event of a polar bear arrival.

There are a small number of important works of Icelandic literature that were used for the history and background component of this thesis. These included two works by Aevor Petersen, from the Icelandic Department of Natural History, who is one of the foremost experts on the history of polar bears in Iceland (Petersen, 2010).

In terms of government actions and legislation, the contingency report by the 'Environment Institute's working group on polar bears', was used to interpret how the polar bear situation has developed with the arrival of bears over the last few years (Gudmundsson et al., 2008).

The response plan utilizes a considerable amount of information that was obtained through personal communication with experts in the field. Because it is the leading program in the world in terms of bear response, the Polar Bear Alert program in Churchill, Manitoba, Canada, was studied in detail. Over 100 bears are airlifted annually in Churchill. They possess a 30 polar bear holding unit as well as an abundance of traps and personnel (Manitoba Government, 2010). Amy Cutting, head of the sustainability branch of Polar Bears International, was instrumental in obtaining information regarding traps and holding units (Polar Bears International, 2010).

A section of this thesis contains information regarding the currents and sea ice between East Greenland and Iceland. These currents have been studied extensively (Pickart et al., 2008). However, less is known about sea ice conditions in the area. As a result, much information, both literature and interviews, was obtained from the Sea Ice Division of the Icelandic Meteorological Office (Jakobsson, 2003).

Considerable literature exists regarding the polar bear populations of Greenland (Born et al., 2002), (Born et al., 2007), (Born et al., 2008). However, the size of the East Greenlandic bear

population is not well known (Jessen, 2009). A survey of the population has never been done. Because of this many newspaper articles and government documents were translated from Greenlandic into English to get a better sense of relevant issues related to the population (Rosing, 2002),(Kristensen, 2010), (Simonsen, 2010). There was also frequent contact with the Department of the Environment of the Greenland government.

History, Naming and Occurrences

"The Polar Bear is but a casual visitor in Iceland. About a dozen come drifting every year from Jan Mayen or Spitzbergen, to the northern shores. Ravenous with hunger, they immediately attack the first herds they meet with (reindeer): but their ravages do not last long, for the neighbourhood, arising in arms, soon puts an end to their existence (Hartwig, 1874)."

This reference to the arrival of polar bears to Iceland by Hartwig shows that in the past, there may have been a misconception regarding the origins and even directions from which bears were coming from (Hartwig, 1874). As a result of many bears reaching the northeast coast of Iceland, people assumed that the bear came from northeast of Iceland, i.e. Jan Mayen or Spitzbergen. It has now been concluded that most polar bears reaching Iceland originated in east Greenland (Gudmundsson et. Al, 2008). There is a major ocean current that flows between East Greenland and the north eastern tip of Iceland, which explains the high number of bears reaching northeast Iceland (Jakobsson, 2003).

The number of bears reaching Iceland is well documented, despite general unawareness of the public. Aevar Petersen has compiled information on polar bear visits, stories and folklore in Iceland. This thesis draws heavily on two particular publications of his, to illustrate the history of bears in Iceland (Petersen 2010, Petersen and Haraldsson, 1993).

According to Petersen, there are three common names for the polar bear in Iceland. Isbjörn is currently the most frequently used. It is taken from the Danish word and has only been used in Iceland for the past two hundred years. Hvítbjörn is the original word for polar bears in Iceland, and is used in all the old literature, including the old law books from the 13th Century. Bjarndýr has been used in Iceland, especially in older times. It simply means bear, and in Iceland that can only mean the polar bear. In the literature there are also two nicknames, *bessi* and *bangsi* (teddy

bear). Names for polar bears are not area specific (A. Peterson, Personal Communication, January 20, 2011).

<u>Name</u>	<u>Translation</u>	<u>Notes</u>
Hvítbjörn	White bear	Oldest name for a polar bear in Iceland
Isbjörn	Ice bear	Most currently used name; usage starts in Iceland 200 years ago
Bjarndýr	Bear	Throughout history it has been occasionally used to mean a polar bear
Bessi and bangsi	Pet names, like teddy bear	Have been used in Icelandic records

Figure 1 Icelandic polar bear names (a. Peterson, Personal Communication, January 19, 2011)

Iceland's history is well documented as a result of the early sagas, farm records, stories, etc. There are various stories which relate to bears reaching Iceland. Many are associated with folk tales and it can be difficult to distinguish fact from fiction. There is written evidence of polar bears reaching Iceland since colonization, and the archaeological record provides evidence of polar bears well before human occupation (Petersen, 2010). Polar bears have occasionally reached Iceland in groups. When this does occur, it is usually a mother with cubs (Petersen, 2010).

There are a large number of bears recorded in certain years. In 1918, about 30 bears were recorded (Petersen, 2010). In 1881, the year still known to Icelanders as the giant ice winter, 71 bears were recorded (Gudmundsson et. Al, 2008). Some of these records may be duplicates but,

at the same time, if there were many bears, some probably went unnoticed and unrecorded. There have undoubtedly been other bears on the ice near Iceland, or that have made it to shore but were not spotted (A. Pederson, Personal Communication, January 20, 2011). It is important to note that the records are often not specific. Sometimes an author will say, “I think there were this many” or “there may have been this many”. A writer also does not always specify exactly where they saw a bear, or the exact date (A. Petersen, Personal Communication, January 19, 2011).

According to the most recent figures from March 2010, there have been total of 611 bears recorded in Iceland (Petersen, 2010). As previously stated, the numbers are probably not totally accurate. Records also vary in the reliability of the evidence provided; eg. In four cases only bones were found in the ground and in 11 cases only footprints were found (Petersen, 2010).

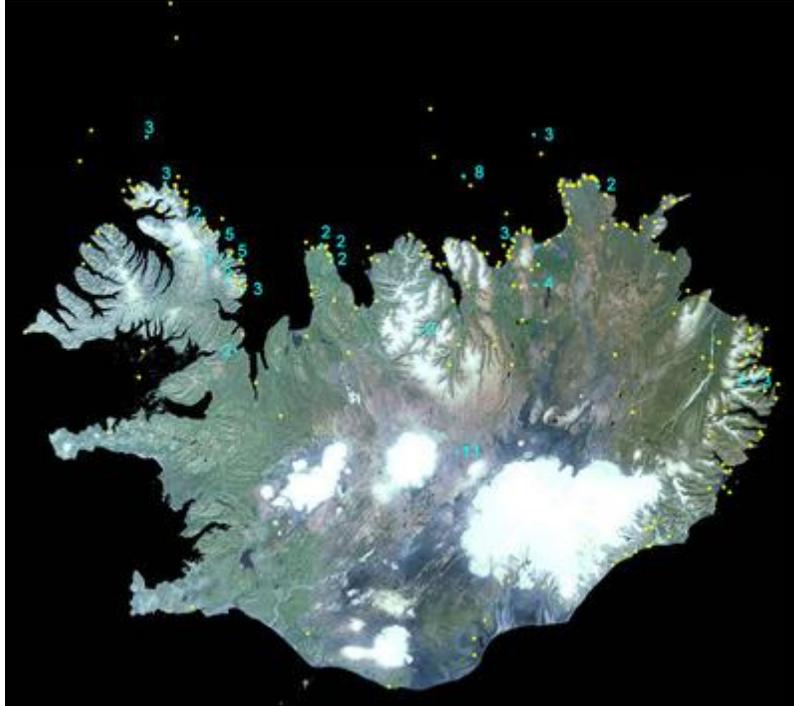


Figure 2 The distribution on polar bears recorded in Iceland. Each dot represents a record. The '13' in the middle represents recordings in unknown locations (Peterson, 2010).

The oldest reference is from the year 890 in Húnavatnssýsla (Petersen, 2010). In the settlement stories it is said that the settler Ingimundur the Old from Vatnsdalur came across a polar bear with a cub at the lake we now call Húnavatn (cub lake) and the whole municipality is called Húnavatnssýsla. He reportedly caught the bear alive and sent it to King Harald in Norway as a gift on board the timber cargo ship Stígandi. Reports are infrequent during the rest of the settlement period (Petersen, 2010). The oldest polar bear remains to have been dated are about 13,000 years old (Áskelsson, 1938).

Most material from the early centuries is in historical annals. Records of polar bears are more reliable after the 17th century, and especially since the advent of newspapers in the 19th century (Petersen, 2010).

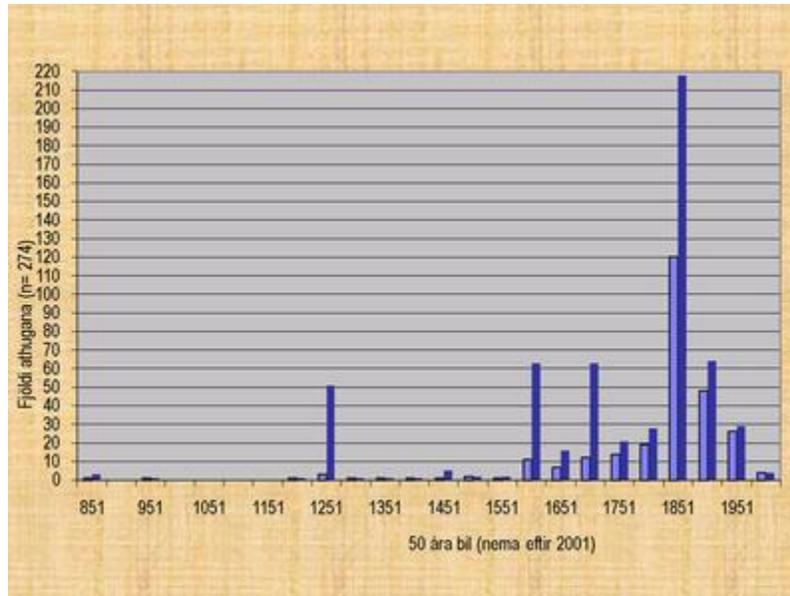


Figure 3 Polar bear sightings in Iceland. Light bars: sightings. Dark bars: bear numbers. The light bar is often lower as one sighting can constitute a mother with cubs (Petersen, 2010)

Prior to 1800, the true frequency of polar bear arrivals is hard to estimate. Since 1951 there has been, on average, one sighting every two years, compared to the first half of the 20th century, when there was one per year (Petersen, 2010). The peak numbers seem to have been in the second half of the 19th century when polar bears were seen, on average, two or three times a year. During that period an average of one or two bears arrived at a time. Compare this to the first half of the 18th century when, on average, five or more bears were seen at a time. It is worth noting that there were large differences from year to year (Petersen, 2010).

In some years a large number polar bears came to Iceland. The following are examples (Peterson, 2010):

- 1274 (22)
- 1275 (27)
- 1621 (25)

- 1745 (39)
- 1881 (73)
- 1918 (30)

The majority of polar bear sightings came in the 19th Century (120 sightings and 218 animals). Polar bears may have been as common in previous centuries, but detailed records are not available. As previously stated, various place names in Iceland point to this, i.e. Hvítbjarnarey, Dýrhóll, Bangsaþúfa, Bjarnarbrunnur, Bjarndýrsklöpp, Bangsagjá, Húnavatnssýslur and others (Peterson, 2010).

Sea Ice and Ocean Currents

The East Greenlandic, East Icelandic and North Icelandic Irminger currents are an important factor in carrying polar bears to Icelandic territory, and, for this reason, this thesis has synthesized information relating to sea ice movement in oceans currents between Greenland and Iceland.

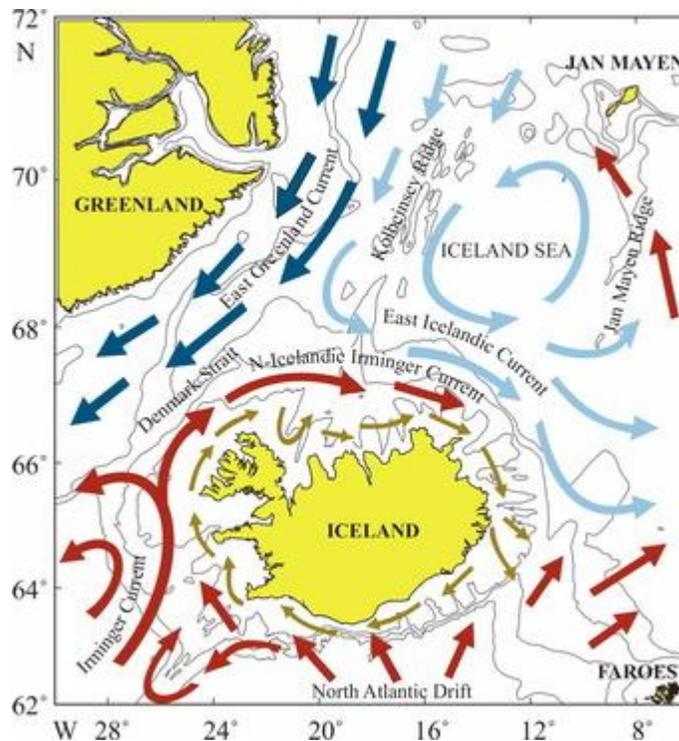


Figure 4 Ocean currents around Iceland (Icelandic Fisheries, 2010)

The East Greenlandic Current flows from north to south over much of Greenland's east coast (Woodgate et al., 1999). It extends from 80 degrees north to 60 degrees north along the continental margin and cuts across the Greenlandic, Norwegian and Icelandic Seas, and also through the Denmark Strait (Woodgate et al., 1999). The ice off East Greenland can move at a surprising speed in a southward direction (up to 30 km/h) (Born et. Al, 2002). Large quantities of polar ice are borne along by the current, some of it originating far to the north while some has formed further south along the route of the East Greenlandic Current (Jakobsson, 2003). The East Greenlandic Current flows from the Arctic Ocean into the North Atlantic, which is why sea ice often drifts from the Arctic Ocean to the North Atlantic (Woodgate et al., 1999). The direction of loose sea ice is very susceptible to winds, whereas the larger ice pack, and icebergs, generally move with the current (Pickart and Sutherland, 2008). A branch of the Gulf Stream system, the Irminger Current, encircles Iceland (Jakobsson, 2003). If ice gets into the North Irminger Current it is carried along the north coast of Iceland, from west to east.

One would assume that the largest number of bears would be seen in the Westfjords, because of its proximity to Greenland, but because of the flow of the North Irminger Current, a considerable number of bears are sighted along the north central and northeast coast (Petersen, 2010):

- Skagafjarðarsýsla (20)
- Eyjafjarðarsýsla (17)
- S-Þingeyjarsýsla (26)
- N-Þingeyjarsýsla (54)

The Icelandic Meteorological Office is responsible for monitoring sea ice in Icelandic waters (Jakobsson, 2003). The amount of sea ice can vary greatly between Greenland and Iceland, regardless of the season. For this reason information is collected by reconnaissance flights carried out by the Icelandic Coast Guard, satellite images, and sometimes by reports from ships in the area (Gudmundsson et al., 2008). Mathematical models are used to predict ice movement when there is a large amount of ice. The main purpose of the information is to ensure the safety of fishing vessels (T. Jakobson, Personal Communication, January 18, 2011). Sea ice reports

have been collected and recorded for by Icelandic officials and even by farmers over a long period of time (Jakobsson, 2003).

The amount of sea ice in the Danish Strait is usually dependent on the season. In midsummer, it is primarily open sea between east Greenland and Iceland (Jakobsson, 2003). In the winter, sea ice is present for roughly half of the distance between east Greenland and Iceland (Jakobsson, 2003). During the spring season Iceland will usually see a larger presence of ice, as it is usually the time of ice breakup on the Greenlandic side of the Strait (Jakobsson, 2003).

The course of a bear's drift from Greenland to Iceland is probably as follows:

- A bear would start by drifting from north to south in the East Greenlandic Current and then would drift into the North Irminger Current. Once in this current it would drift or swim ashore along the northern coast of Iceland.

An alternative course would be:

- A bear would start by drifting from the East Greenland Current into the East Icelandic Current. The bear would then drift from the East Icelandic Current into the North Irminger Current and, from that current, drift or swim ashore along the northern coast of Iceland.

The following shows the sea ice extent in the Danish Strait in June 2008, before the arrival of two bears to Iceland (Ingibjörg, 2008).

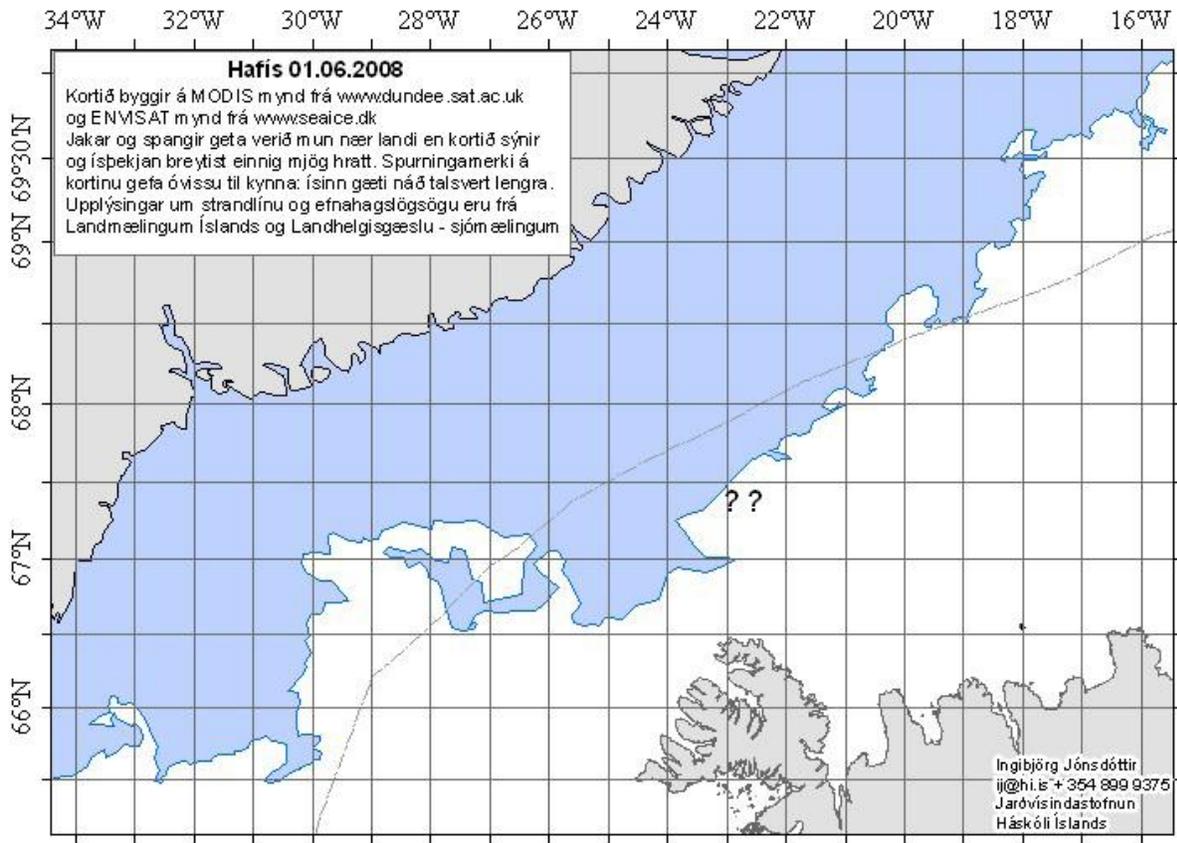


Figure 5 Sea ice extent in June, the question marks represent the two bears that later arrived (Ingibjörg, 2008)

The following figure shows the extent of sea ice in 1881 (Jónsdóttir, 2008), the year known as the ‘giant ice winter’, when there were 71 recordings of bears (Petersen, 2010).

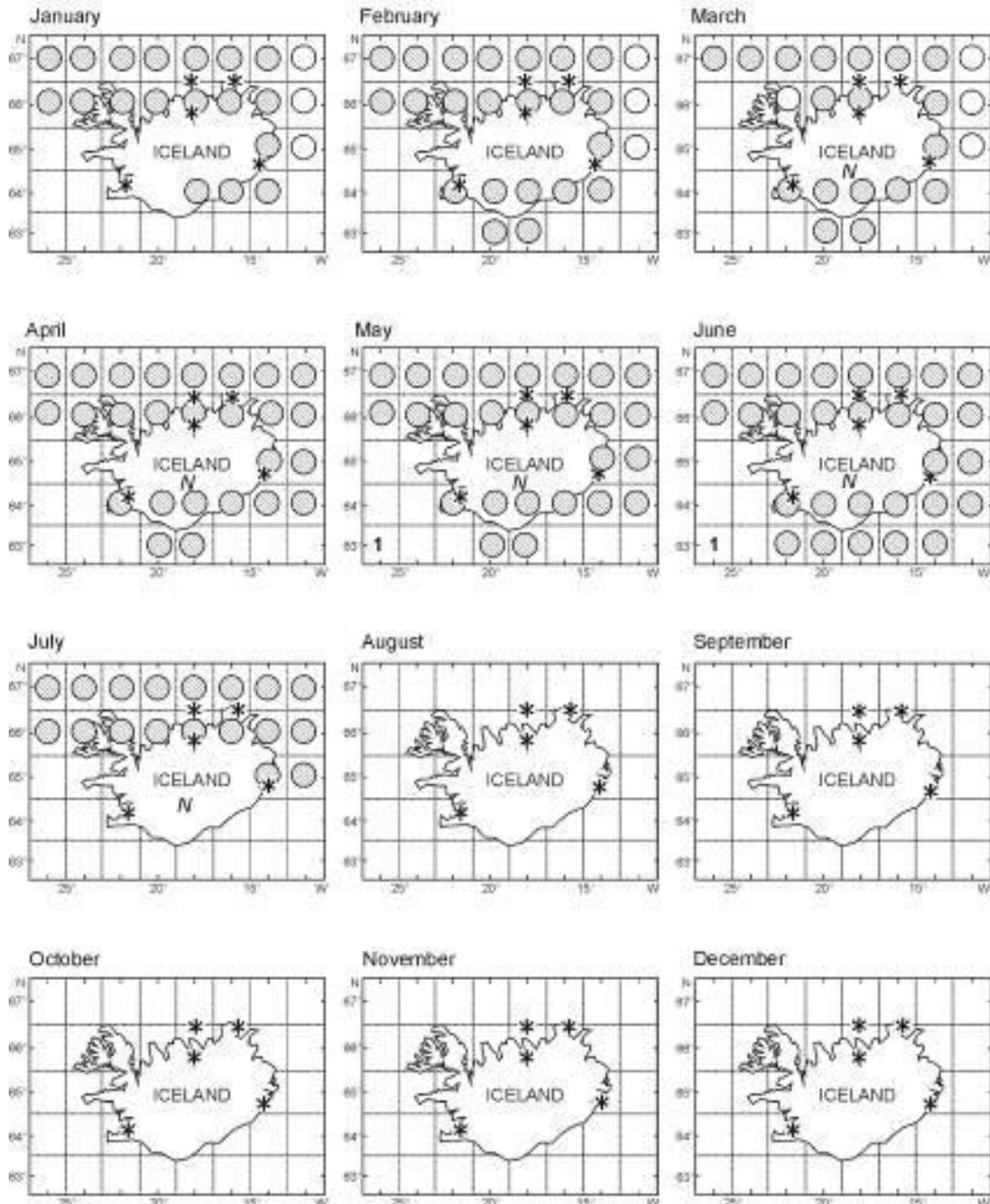


Figure 6 Sea ice extent in 1881 (Jónsdóttir, 2008)

The following figure shows the extent of sea ice in February of 1965.

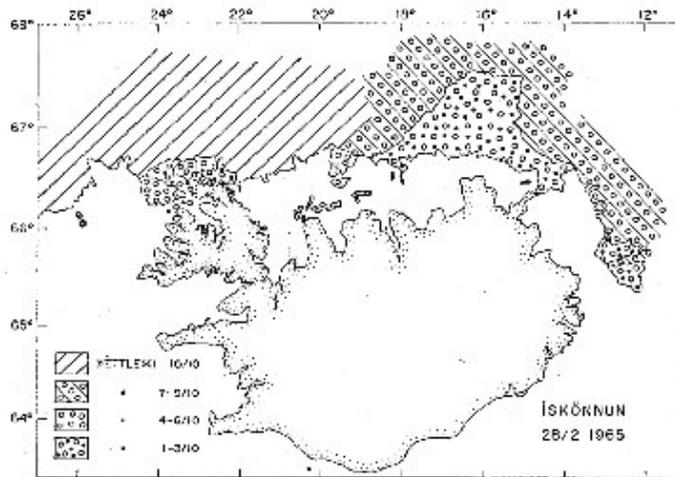


Figure 7 Sea ice in February 1965 (Jakobsson, 2003)

In 1968 sea ice near the coast of Iceland was more extensive than at any time since 1888 (Jakobsson, 2003). Sea ice extent was similar for several years thereafter, but more recently large amounts of sea ice have been seen only sporadically (Jakobsson, 2003).

The following shows the presence of sea ice in the summer of 1984 due to south-westerly/westerly winds.

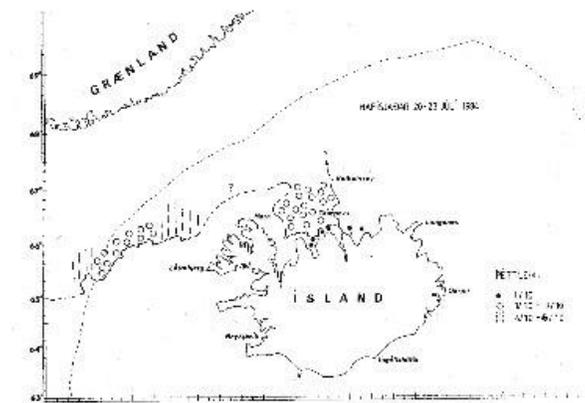


Figure 8 Sea ice in the summer of 1984 (Jakobsson, 2003)

East Greenland polar bear population

Polar bears reaching Iceland are probably all from the East Greenlandic polar bear population (Gudmundsson et al., 2008). As a result, it is necessary in this thesis to show current knowledge of the size of the bear population.



Figure 9 Polar bear population map, the east Greenland population is on the bottom centre (IUCN Polar Bear Specialist Group, 1997)

In East Greenland, as in many parts of the arctic, there is debate regarding the health of polar bear populations (Kristensen, 2010). A polar bear population study has never been completed for East Greenland (Kristensen, 2010). The Greenlandic Institute of Natural Resources (Grønlands Naturinstitut) plans to conduct a population survey in 2012 or 2013 (A. Rosing-Asvid, Personal Communication, January 27, 2011). They also wish to improve the monitoring of all polar bear populations in Greenland in order to improve management practices (Jessen, 2009).

Scientists believe that the number of polar bears in east Greenland has not increased, and that they have changed their behaviour as a result of climate change (Simonsen, 2010). Scientists are trying to convince people that there are more polar bears approaching communities in East Greenland because of a lack of ice, not an increase in numbers (Kristensen, 2010). However, this

position is not generally accepted by the local population who agree with the concept of a warming climate, but have not accepted the notion that polar bear numbers are decreasing. Scientists argue that less ice is forcing bears to go ashore in search of food, and this is the reason why people are seeing more bears than in previous years (Simonsen, 2010).

East Greenlandic people believe that scientists are incorrect in their assumptions that bear numbers are decreasing (Kristensen, 2010). They believe that evidence is lacking (no population survey) for scientists to make this assumption, and because of this lack of evidence, scientists should be careful with their recommendations as polar bear hunting is so integral to the East Greenlandic way of life (Simonsen, 2010).

The Greenlandic Government (Naalakkersuisut) has been encouraging cooperation between scientists and local hunters to attempt to determine population numbers (Simonsen, 2010).

The main reason East Greenlandic people think that the bear population is greater than scientists believe, is that there are a greater number of female bears with cubs being spotted near the communities of Ittoqortoormit and Tasilaq. Polar bears are even being spotted as far south as Kangaatsiaq (Kristensen, 2010). The polar bears spotted around East Greenlandic settlements are usually in very good shape, with a lot of fat and very good fur (Kristensen, 2010). They think this explains why there are more cubs, as healthy bears get pregnant more frequently (Kristensen, 2010).

If the East Greenlandic bear population is increasing, this could mean that bears are competing for territory, and could be part of the reason bears are being found further away from their usual territory. Another phenomenon some scientists believe is occurring in various polar bear populations is food stress. Food stress causes bears to go after one another, resulting in increased cannibalism and fighting. This could be a reason, especially for older bears, to stray further from their natural territory (IUCN/SSC Polar Bear Specialist Group, 2010).

Jan Mayen

As a result of its proximity to Iceland, 550 km to the northeast (Norwegian Polar Institute, 2011), and the presence of a small number of polar bears on Jan Mayen (Larsen, 1972), it is possible that a bear from Jan Mayen could reach Iceland (Peterson, 2010). However, if this has occurred,

it is much more likely to have been well in the past during a period of colder climate and greater sea ice extent.

It is possible, from blood and tissue samples, to tell if a polar bear is from the Barents Sea population, as there is little mixing of that population with other bear populations. However, there is evidence that there has been some mixing of the Kara Sea population and the East Greenland population, as they have low genetic differentiation (Patkeau et. Al, 1999).

Icelandic Legislation

In 1849 the Hunting Directive was introduced, and stated that anyone is allowed to stalk and kill a polar bear (Petersen, 2010). Such a law indicates just how dangerous polar bears were considered to be, by Icelanders. This law stood until the current law came into effect in 1994 (Gudmundsson et al., 2008). The current law protects polar bears, except when they threaten people and farm animals. Polar bears may not be killed at sea, whether swimming or on ice (Althingi, 1994).

The current law regarding the polar bear in Iceland is in the ‘Protection and Hunting of Wild Species Act, 64/1994’. The act regarding the polar bear is in Article 16 (Althingi, 1994).

It is important to note that this act has not yet been officially translated into English. The general purpose of this act is to protect all indigenous wildlife in Iceland. By exemption, a few species of birds and animals are hunted (H. Gudmundsson, Personal Conversation, January 20, 2011).

The following is the section on Article 16 that deals with polar bears (Althingi, 1994):

- The first paragraph of article 16 states that polar bears are protected according to this act, on land, on sea ice and when swimming but with special reference to paragraph 3.
- The second paragraph states that when a polar bear reaches land where people and farm animals are not considered threatened, the Environmental Agency is permitted to capture the bear and transport it to a location where it is not considered dangerous.
- The third paragraph state that a polar bear can be put down (killed) if it has entered land and is considered a threat to humans and farm animals.

- The fourth paragraph states that if a bear has been put down (killed) according to paragraph 3, the Minister for the Environment should be notified without delay and the Minister can order that the bear be transported to the Icelandic Institute of Natural History and the cost of this action will be paid by the State.

International Legislation

The most important current international law that is relevant to Iceland's polar bear situation in the event of relocation is the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). CITES is an international agreement between governments. Its' aim is to ensure that international trade of wild animals and plants does not threaten their survival. All circumpolar countries with polar bear populations, including Iceland, are voluntary members of CITES (CITES, 2010).

“CITES works by subjecting international trade in specimens of selected species to certain controls. These require that all import, export, re-export and introduction from the sea of species covered by the Convention have to be authorized through a licensing system. A CITES license will have to be issued to transport a polar bear between Iceland and Greenland (CITES, 2011)”.

The species covered by CITES are listed in three appendices, according to the degree of protection they require (CITES, 2011):

- Appendix I includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances.
- Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival.
- Appendix III contains species that are protected in at least one country, which has asked other CITES Parties for assistance in controlling the trade.

*The polar bear is listed in Appendix II (CITES, 2010).

Chapter 3

Response plan

The response plan outlined in this paper has several goals. The response plan should be economical. In the last three years three polar bears have reached Iceland (Petersen, 2010). Through recorded history bear arrivals average one every two years (Petersen, 2010). These are not large numbers, and therefore a goal for the response plan proposed in this thesis should be economical. This thesis does not advocate the creation of new government departments, new personnel positions, or new large scale infrastructure. Changes could be made within existing departments to accommodate this response plan. There currently exists a Wildlife Management Office in the Department of Natural Resources at the Environment Agency of Iceland, with eight staff, three of whom are responsible for dealing with polar bear situations. These three staff would require formal training, such as certification for the use of a tranquilizing gun (Bjarni Pálsson, Personal Communication, February 2nd, 2011).

To ensure a good outcome, it is important that there be an agreed upon response plan prior to the next bear's arrival in Iceland. All parties should be aware of the plan, as it will affect various organizations and individuals.

It is important to note that when the second bear arrived in 2008 the preliminary stages of a rescue plan were undertaken (Gudmundsson et al., 2008). A Danish authority from the Copenhagen Zoo flew to Iceland with a polar bear cage (Gudmundsson et al., 2008). However, attempts to track down the tranquilizing gun were unsuccessful, as the gun had not been used for such a long period, that authorities were unsure of its whereabouts (A. Petersen, Personal Communication, January 19, 2011). A satellite tracking device was also sent by Greenlandic authorities in the event of relocation. However, it was not used as the bear was put down (F. Ugarte, Personal Communication, May 14, 2010). The intent was to airlift the bear from Iceland to Greenland, and return it to the ice pack off East Greenland (F. Ugarte, Personal Communication, May 14, 2010).

Options

There are several response options possible for a bear occurrence in Iceland which include:

1. Capturing the bear and airlifting/shipping it back to Greenland
2. Capturing the bear and transporting it to a holding unit in Akureyri, and then airlifting/shipping it back to Greenland
3. Capturing the polar bear and transporting it to a holding unit in Akureyri, and then transferring it to a zoo
4. Killing the polar bear as a result of either a threat to humans/livestock, a lack of funding, or poor health of the bear

Parties involved

Regardless of which option in the response plan is chosen, the same core parties should be involved. The following is a general list of tasks as well as which agency/party is involved with that task.

Heli-lifting

Coast Guard (possibly marine assistance from ICE-SAR)

The Coast Guard has the means and personnel to transport a polar bear between Iceland and Greenland. They are accustomed to responding when time is of the essence, and are trained in a variety of situations (Icelandic Coast Guard, 2009). ICE-SAR is the Icelandic Volunteer Search and Rescue group. They have personnel throughout the country, and possess the appropriate equipment, including heavy lift helicopters, that could be essential to a rescue (ICE-SAR, 2010).

If a coast guard helicopter is unavailable at the time of a bear arrival, another helicopter could be chartered in Akureyri by the Wildlife Management Unit, if heavy lift capability were available.

Organization of a response

- Wildlife Management Unit of the Environment Agency

The wildlife management unit has a staff of eight, three of whom would be involved in the polar bear response plan (B. Pálsson, Personal Communication, January 31, 2011).

The only tranquilizing gun suitable for a polar bear is in Egilsstaðir, and is under the supervision of a veterinarian. At the present time, no one in the Wildlife Management Unit has training in the use of a tranquilizing gun (B. Pálsson, Personal Communication, January 31, 2011). In order to provide a faster response time, members of the Wildlife Management Unit should be trained in the use of the gun, and there should be a tranquilizer gun located in Akureyri. The Wildlife Management Unit should also acquire a satellite tracker in the event a bear relocation takes place. This would be useful to track the movements of the relocated bear.

- Police

Police will be essential in ensuring the safety of the public. It is the police who will decide whether or not to shoot the polar bear. This has been the normal procedure in Iceland (Gudmundsson et al., 2008). For this reason, the police must be aware that there is a polar bear response plan in place. They must also know the response plan options. The Environmental Agency has the knowledge to determine an appropriate response plan after evaluating the circumstances. Therefore, effective communication between the police and the Environmental Agency is instrumental in choosing the appropriate option of the response plan.

- Veterinarian

If the bear is transported back to a holding unit in Akureyri, it offers an excellent opportunity to examine the condition of the bear. This is an important benefit of transporting any bear caught to a holding unit. If the bear is in a holding unit and staff is unsure of its condition, the services of a vet could be called upon. This service may not be available outside of Akureyri.

The general public assume that a polar bear reaching Iceland would be starving. This seems logical as Iceland is, at the very least, 300 km from Greenland, and is not the natural habitat of polar bears. However, this assumption is invalid. Polar bear researcher, Andrew Derocher, states that polar bears that have not eaten for even as long as eight months, may be hungry but are probably not starving, and that physiologically polar bears are very well adapted to extended fasts (A. Derocher, Personal Communication, May 1, 2010). It is easy to tell if a bear is starving, as they are literally skin and bones (A. Derocher, Personal Communication, May 1, 2010). It is not often that polar bears are seen in this state. Starvation usually only occurs with bears that are at least 25 years old. However, sometimes very young bears may starve (A. Derocher, Personal

Communication, May 1, 2010). Polar bears in East Greenland have a large home range. A study done in the mid 1990's tracked two female bears over a four year period and found they had a home range of 242,000 and 468,000 square kilometres respectively. Seventy percent of their time is spent on the sea ice, excluding denning time (Born et. Al, 2002). In January of 2011, a polar bear with a radio collar was tracked having swum over 700 kilometres in the Beaufort Sea (Bouzane, 2003).

Capturing the bear

Capturing the bear will require the use of a helicopter with slinging ability of at least 500kg. The Wildlife Management Unit and their supplies are in Akureyri, and it would be most efficient if the helicopter used comes from Akureyri.

To ensure appropriate manpower, probably two members of the Wildlife Management Unit should be in the helicopter. Any member of the Wildlife Management Unit who is not in the helicopter should prepare the holding unit in Akureyri, and should also be available to act as an intermediary between the members in the helicopter and other authorities.

It is easiest to dart a bear from the air (USGC, 2010). Once the bear is darted, the helicopter should be set down and the net should be unfolded. The bear should be placed in the net and slung back to Akureyri below the helicopter. The amount of tranquilizer administered should depend on the flying time to Akureyri. In order to dart the bear from the helicopter, the helicopter used must have a large window, and personnel shooting the bear should have appropriate training in shooting from a helicopter. If training is not undertaken, it would be preferable to set down the helicopter, in order to shoot the bear from the ground.

See appendix 1 for guidelines in the capturing, helicopter positioning, fuel/time, darting, assessment, drugs and processing.

Holding unit

If a bear is captured, it is preferable that a holding unit be available. It may be possible to sling a bear directly back to Greenland. However, the Greenlandic authorities may not accept the bear. This would put the transporting helicopter staff in a very difficult position.

Fortunately, there is a cage in Iceland that could function as a holding unit.



Figure 10 Current cage in Akureyri

Akureyri is situated on the central north coast of Iceland, and is the ideal location for the holding unit, as most bears reaching Iceland come ashore on the north coast. Akureyri is Iceland's second city and possesses the necessary infrastructure to deal with a captured bear (tranquilizer, speed boat, helicopter, and trained personnel). It is also the headquarters of the Environmental Agency's Wildlife Management Unit.

One holding unit is probably suitable for Iceland's needs. The present unit is only suitable for a brief holding period. A better, yet economical option for Iceland would be the conversion sea-can storage container, as illustrated below. These are readily available in Iceland, and can be easily converted into a suitable holding unit. See appendix 2 for information on such a conversion. This conversion design is by Polar Bears International in Alaska.



Figure 11 Sea can storage units

Once a bear is in a holding unit, it is accepted practice by agencies throughout the circumpolar world, including the Polar Bear Alert program in Churchill which captures many bears, that it not be fed. It is given only fresh snow, even if held for as long as a month (D. Hedman, Personal Communication, December 23, 2010). However, the risk arising from feeding a bear in a holding unit i.e. habituation and food conditioning, is not relevant to Iceland's situation, as any bear will be transferred a considerable distance from Iceland and is unlikely to return.

Trap

Traps are another option in the capture bears, usually used in areas that are road accessible, and in areas with large numbers of bears. This is not Iceland's situation. It should be noted that a trap can be used instead of a tranquilizing gun. A culvert trap with baited fish could be flown to any area where a bear has been spotted. Culvert traps can be slung by helicopter. The trapping of a bear is however a more precarious and less reliable capturing technique than tranquilizing. For

this reason, this thesis is not recommending the use of traps as part of a response plan for Iceland.

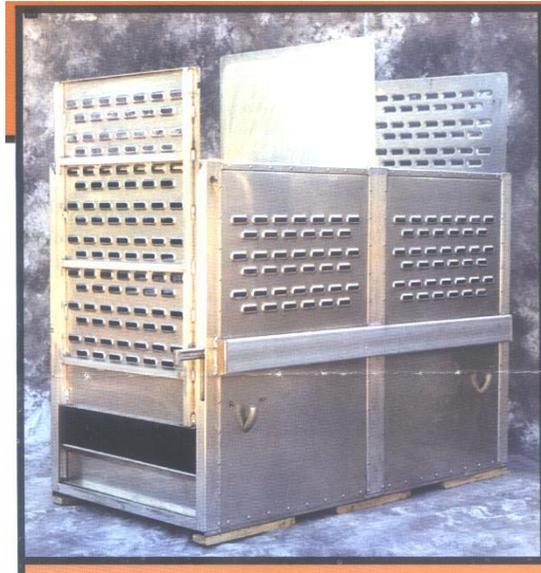


Figure 12 Culvert trap

Zoo

The procedure described above would be followed, whether a bear was being relocated to Greenland or to a zoo. It would be captured and brought to the holding unit in Akureyri in either case. If an agreement were in place with a zoo, an official from the zoo would probably travel to Akureyri to formalize arrangements and monitor the bear. This could be a lengthy process, and a larger holding unit, such as the proposed sea-can storage unit, would be better suited.

Destroying a bear

If police feel that the public are at risk, the bear should be destroyed. This decision should remain with the police.

The Icelandic Government may want to consider discussing with their counterparts in Greenland, the compensation to hunters in Greenland, if it were agreed that any bear killed in Iceland was removed from the East Greenlandic quota. The current hunting quota 50 bears annually (A. Rosing-Asvid, Personal Communication, May 4, 2010).

Health

The following is a chart which outlines polar bear health based on weight:

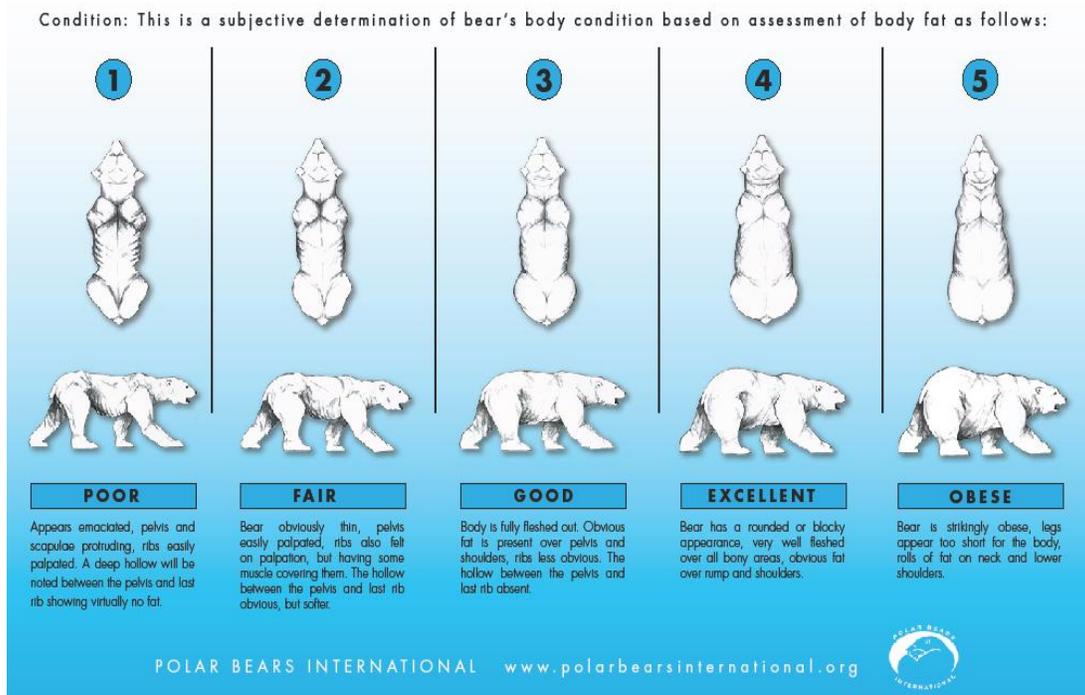


Figure 13 Polar bear health based on weight (Polar Bears International, 2010)

This chart should aid in deciding the appropriate response option. Any bear that is rated by this chart to be in good, excellent or obese condition should be airlifted back to Greenland if possible. Depending on the behaviour of the bear, staff will have to make a decision as to the suitability of transport. Consultation with a veterinarian may aid in this determination.

Costs

Costs will obviously vary in every case. Variables include which option of the response plan which is chosen, location, weather, number of personnel, transportation distance, and helicopter costs. The working group created in 2008 to develop a contingency plan, estimated that a rescue would cost tens of millions of kroner (Jonsson, 2008). The government must decide what it is willing to spend on a response plan and necessary infrastructure.

It is not uncommon for conservation organizations to contribute to the costs of polar bear management initiatives in the circumpolar world and they may well contribute to the cost of a successful rescue in Iceland (A. Cutting, Personal Communication, December 29th, 2010).

Summary of Recommendations

These recommendations have been formulated using information gathered through interviews and governmental guidelines. They offer a step by step guide to aid in the management of a polar bear occurrence in Iceland's unique situation:

1. When a polar bear comes ashore, the Wildlife Management Unit should be ready to act quickly. This includes coordination with the coast guard for helicopter assistance, or if not available with a private helicopter company. Equipment should be ready for use at all times (i.e. tranquilizers gun, medication and holding unit).
2. An emergency polar bear hotline number should be created.
3. Police must be notified in order to control the area and to ensure public safety. Ongoing public education and awareness programs of current management of polar bear incidents should occur.
4. Members of the Wildlife Management Unit should arrive in the controlled area by helicopter.
5. Coordination between the police and Wildlife Management Unit will determine the appropriate response option.
6. If a bear is captured it will be transported to a holding unit in Akureyri
7. Once a bear is in the holding unit, the Environmental Agency will determine an appropriate course of action.
8. If it is decided to airlift a bear to Greenland, action should be taken immediately to prepare for the trip. Samples for scientific and veterinarian study could be taken at this time. This would also be an appropriate time to consider the fitting of a radio collar. The appropriate tranquilizing drug and dosage will be decided.

The most economical fuel option is for the bear to travel in a sling. When lifting the bear, the hind end should be lower than the head. This keeps weight off the lungs, and prevents suffocation (Polar Bears International, 2009).

Note: Bears in a family group captured in the Polar Bear Alert program in Churchill are airlifted and dropped together. Icelandic authorities should follow this same procedure (D. Hedman, Personal Communication, December 9, 2010).

9. If a bear is to be transported to a zoo, it would first be transferred to the holding unit in Akureyri. Once in Akureyri, zoo officials will determine whether the bear is a suitable specimen. Zoo officials and the Wildlife Management Unit would work together to transport the bear to the zoo.

10. A CITES license is required by international law prior to the transport of a bear between Iceland and Greenland.

Chapter 4

Discussion

The killing of three polar bears in Iceland in 2008 and 2010 garnered much attention, both domestically and internationally. Many considered it unfortunate that Icelanders should be killing bears at the same time as most international opinion feels they require special protection. Historically it was logical to kill any bear reaching Iceland as they would be a threat to people and to precious livestock, and their meat and fur may have been valuable to people living a subsistence economy. Polar bears are completely dependent on ice for long term food supply, and would only remain in Iceland if stranded (Stirling, 2006). With today's knowledge of bears and bear relocation, a response plan that includes relocation is a viable option.

The hunting directive of 1849, allows for any person to kill a polar bear regardless of circumstances. The new legislation of 1994 is quite different. Firstly, it is clear that no one can shoot a bear while at sea (Althingi, 1994). This is also true for an occurrence on land, unless livestock or humans are at risk. In the event of a polar bear occurrence, the Minister of the Environment must be notified and will make the final decision involving the management of the situation, unless the bear is shot because of an urgent threat to safety. If a response plan is in place, it will make for more consistent decision.

Because a CITES license is always required in the event of the transport of a bear between Iceland and Greenland (CITES, 2011), regular ongoing discussions between officials of both countries should take place. This would expedite attempts at relocation.

There has been much discussion whether bears reaching Iceland are now doing so because of climate change, and there is speculation that if this is the case, increased numbers of bears will reach Iceland. The bears in 2008 arrived in summer. Many feel this illustrates that climate change is a factor. However, the arrival of bears in summer has been well documented in the past prior to any evidence of climate change.

The frequency of bears reaching Iceland in the last decade (2001-2010) has been on average the same as in the preceding half century and, 50% lower than the 1901-1950 average. The year's 1851 to 1900 stand out particularly for the high frequency of bear visits, averaging two or three

every year. There are no signs of change in the frequency of bears reaching Iceland, nor does their arrival in summer point to any major change from previous periods (Peterson, 2010).

Although sea ice is closer to shore in both winter and spring, it can reach Icelandic territory at any time. Regardless of the trend of decreasing sea ice now seen in the Arctic, the East Greenland Current will continue to bring ice into Icelandic waters.

When the two bears arrived just weeks apart in 2008, there was no drift ice close to shore and the general perception was that the bears had swam from Greenland. While bears can swim great distances, it is more likely that the bears swam from drift ice that was closer to the Icelandic coast than the main ice pack. Ice conditions between Greenland and Iceland are monitored by reconnaissance flights and also satellite. The polar bears that reached Iceland were probably on small pieces of ice that had broken or blown away from the main pack (T. Jakobsson, Personal Communication, January 19, 2011). However, it should be noted, polar bears can swim great distances, as was the case with a bear swimming 700 km in the Beaufort Sea this year (Bouzane, 2003).

A survey of the East Greenlandic polar bear population will be undertaken in the near future. If evidence appears that suggests the East Greenlandic bear population is in trouble, there may be more urgency felt to rescue rather than to destroy bears. Iceland would be well regarded if a response and rescue plan were already in place. Regardless of the East Greenlandic polar bear population, Icelanders and the international community have made it known they would like to see a response plan.

The Icelandic government and the Icelandic public should discuss the cost benefit value of an organized approach to bear occurrences and the development of a bear response plan. In this thesis, the basics of such a plan which could be used in Iceland are proposed. By discussing and developing a considered response to polar bear occurrences, Icelandic authorities would be perceived to be showing a responsible approach to a mammal that is on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species.

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Appendices

Appendix 1

Immobilization procedures

The following are field protocols used and developed by the United States Geological Survey (USGC), for capturing, tranquilizing and processing polar bears.

Capture

1. Before initiating a capture, the flight crew should examine the immediate area for safety concerns and decide whether it is safe to proceed.
2. If the bear is not in a location that allows for a safe capture, it may be necessary to wait or herd (haze) the bear to a safer area.
3. Sometimes it is not possible to find a safe location (e.g. if the bear is swimming a lead that is too wide to cross in the helicopter) and the bear must be passed up.
4. The primary safety concerns when deciding whether it is safe to capture a bear are:
 - Safety of the helicopter: darting runs occur at low elevation, so look for pressure ridges, thin ice, and open water.
 - Safety of the bear: avoid darting when there is open water and bad ice conditions.
 - A darted bear may head toward open water, where it feels more comfortable. A darted bear must be prevented from swimming, as it may drown once the drug takes effect.
 - A bear should not be allowed to go down in heavily deformed or unstable ice if at all possible as it will be difficult to reach and/or re-position.

Fuel and time

1. Assuming the capture goes as planned, a bear can be darted and go down in about 20 minutes of flying (When within distance to the polar bear). Once on the ground a single bear can be processed in about 45 minutes.

2. It is not uncommon, however, to make several darting runs before firing the dart gun. Darts can fail to inject, or inject into fatty tissue that prevents drug uptake. It is possible that a dart misses the bear altogether.
3. Consider these factors when deciding whether there is sufficient time and fuel to capture a bear.
4. Once the decision to capture a bear is made, the researcher in the back of the helicopter will load the dart and make other preparations.
5. If the bear does not require herding, pick a safe spot to set down and roll off the throttle to conserve fuel until the gunner is ready. Keep in mind that while saving several minutes of fuel is desirable, losing an already-sighted bear and/or wasting a lot of fuel trying to relocate it are not. Therefore, do not set the helicopter down if you cannot keep the bear in sight.

Positioning

1. The pilot should work with the spotter to position the bear prior to making a darting run.
2. The gunner will be leaning out of the rear shooting window during the run. To prevent the dart from being caught in the rotor wash, the shooter must be close and almost directly above the bear. This will require the helicopter to descend to about 15 feet above the animal and mirror its movements.

Darting

1. The gunner will notify the pilot when dart preparation is complete and they are ready to dart (i.e. harness on, dart and charge in rifle).
2. Prior to each darting run, the pilot will confirm with the gunner and spotter that the area is safe (no water or other hazards) and that they are initiating a darting run. All three must agree.
3. As the pilot starts a run, the gunner will open the shooting window and prepare to lean out of the aircraft. The pilot should notify the gunner at 100 ft of elevation. At this point the gunner will go to a hot microphone and lean out of the helicopter in a shooting position.

4. Once the gunner is outside the aircraft, they will have the best view of the bear and should communicate with the pilot as to its movements. Even with the best approach, it is often necessary to abort a darting run (e.g. the bear changes speed or direction).
5. If anyone decides that the darting run must be aborted, notify the gunner immediately, who will then bring the gun inside the helicopter because at low temperatures the drug may freeze in the dart.
6. Sows with cubs are often the most difficult to dart as they are defensive of their young and may keep turning to rejoin them.

Assessment

1. Once a dart has been placed in the bear, the entire crew should monitor the bear's movements and the surrounding terrain. Gaining elevation at this point affords a better field of vision.
2. Keep the bear in a safe area and haze it towards a flat, stable surface as it begins to show signs of ataxia.
3. Pay attention to the bear's position as it goes down to ensure that it maintains an open airway.
4. Once a bear is immobilized in a safe area, land the aircraft at least 30 yards away with a clear view of the bear.
5. The time it takes for a darted bear to go down is variable; a good neck shot may put a bear down in 2 minutes, although it often takes up to 10 minutes. Bears that do not go down in about 10 minutes may require a second dart.

Drugs

There are various mixtures of immobilizing drugs used throughout the circumpolar world on polar bears. Iceland's best option, as it is unlikely to be dealing with high numbers of polar bears, is to keep it simple. Many organizations use the drug Telazol, a dissociative anaesthetic. The USGC uses Telazol when immobilizing polar bears, and has a good baseline for dosage amounts.

- 1) General guidelines for initial dosing of polar bears with Telazol (200 mg/ml):

- a) Dart adult males with one 10 cc dart.
- b) Dart adult females with one 7 cc dart.
- c) Dart older cubs with one 5 cc dart.
- d) Dart younger cubs with one 3 cc dart.
- e) Hand-inject cubs in the neck. For average-sized cubs, use 0.5 cc Telazol. For smaller cubs (e.g. a 20 lb cub) use 0.3 cc. Larger cubs (either single cubs or multiple cubs toward the end of a capture season) may require 0.6 cc. Cubs may require a second injection of Telazol if they become active during processing. The goal is to not sedate the cubs too heavily, as they should come around before the mother. This prevents the mother from rolling onto the cubs and suffocating them as the sedation wears off.

Various organizations, such as the Ontario Ministry for Natural Resources, in Canada, used Telazol combined with other drugs in order to try and achieve better results. However, the organizations that attempt these types of mixtures often deal with a high number of polar bears. As stated earlier, keeping the formula simple is probably preferable.

Processing

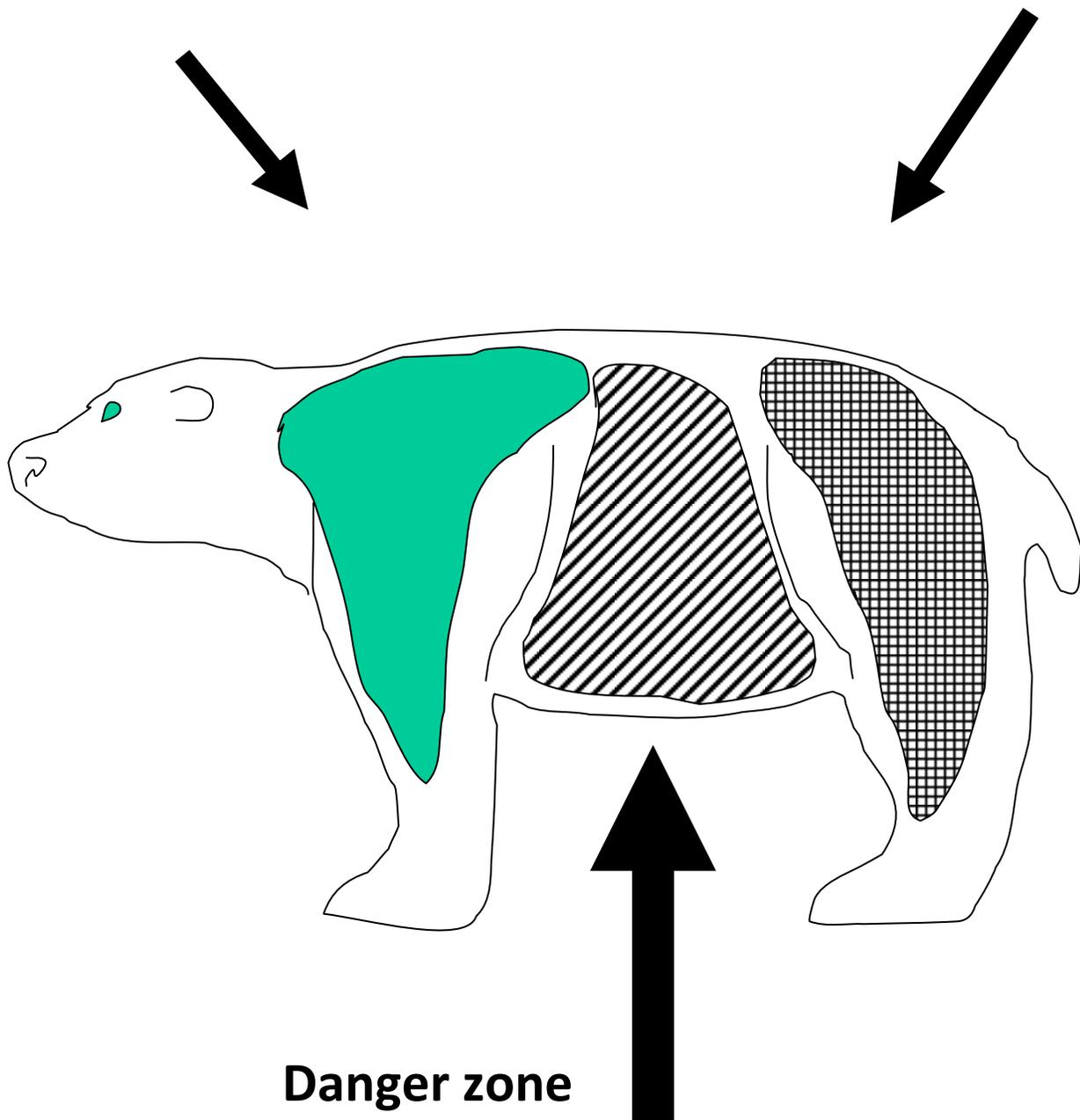
It is important that polar bears taken back to Greenland are processed. On occasions where there are time constraints, the most important steps, which must always be completed, are listed below.

1. Apply or record marks – tattoos or markings (will need to be obtained prior to event). In Churchill, they mark polar bears with a dot to signify that the polar bear has been caught before, and that a drug was administered. The dot wears off in a month or two. Perhaps a similar procedure should be adopted so that if the polar bear is caught in Greenland, they know it was tagged in Iceland.
2. Extract a vestigial premolar.
3. Take skull measurements.
4. If time permits, obtain blood and tissue samples

(USGC, 2010)

Best dart location during any season: neck near shoulder, shoulder, and forward region of upper front leg.

The rump may be a good place for darts on **THIN** bears. However, it's best to dart the shoulder.



Appendix 2

Holding Unit

The following are the specifics for turning a sea can storage container into a polar bear holding facility. These specifics were designed by Polar Bears International in Alaska.

- 8' Wide X 20' long X 8.5' high container (no insulation but possibly a generator for electricity, lighting and maybe heat).
- Personal door (8.5' X 3') with steel plate and hasp (steel outer door), window in door to ante-room.
- 8' wide x 5' long x 8.5' high room divided from the polar bear holding area by reinforced stainless steel mesh fencing.
- Polar bear's holding room 8' wide X 15' long X 8.5' high. This area opens to the outside via 8' x 8.5' heavily secured door/reinforced end of container.



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