

LITERATURE REVIEW

Climate change: The physical effect on polar bears.

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Abstract

With the increase in climate change, studies are showing that the Earth's temperature is increasing at an alarming rate. New evidence is showing how negative the impacts are on the polar bears (*Ursus maritimus*) in the Arctic Regions. The aim of this literature review was to investigate what the new circumstances the polar bears are living and dealing with. The intention of this review was to portray the three main consequences in the result of climate change, specifically the negative impacts. This review will not explore the positive impacts of climate change. Although the idea of climate change, and all its negative impacts on species such as the polar bears, it is still a widely controversial topic, there are both many published and unpublished articles, papers, and websites stating true facts and figures on the topic. Most of the sources have concluded there to be three main negative issues affecting polar bears due to the fact. The themes are as follows:

1. Melting Ice Caps
2. Change in Eating Habits
3. Crossbreeding

The review shows that there is an increasing amount of ice melting which has decreased the amount of surface area that the polar bears can hunt on, reproduce on and rest on. All studies agree that the increase in crossbreeding, increase in mortality and increase in moving inland is due to the melting sea ice. Newer studies are showing that there is no way to prevent the inevitable melting ice, caused by climate change, as the Earth is warming too quickly to stop. The literature review also shows that due to the melting ice, the polar bears eating habits have changed, including eating their own cubs.

Key Words: Polar bears, *Ursus maritimus*, climate change, melting sea ice, eating habits, crossbreeding.

Introduction

Climate change, which is caused by the release of fossil fuels into the environment, aides in creating what is called the greenhouse effect (Kimmins 2004). The emissions from fossil fuel burning have raised carbon dioxide concentrations 35 percent higher than in the past millions of years (Carr 2018). Despite the Earth's multiple warnings, such as the rising global temperature, fossil fuels remain the world's primary energy source and global CO₂ emissions continue at a high-level (Hansen et al., 2016). Slowing down all the emissions outputted into the atmosphere will not stop climate change, ongoing sea-level rise, and the possible passing of thresholds to major and possibly irreversible changes in the climate system (Pittock, A., 2009).

As the Earth's temperature keeps rising, more issues due to the fact are coming to light. Anderson states "climate warming during the course of the twenty-first century is projected to be between 1.0 and 3.7 °C" (2016). Although the temperature may seem minute, species such as the polar bears are suffering immensely. The sea ice in the Arctic regions has begun to melt at an alarming rate. A study by Hansen et al. (2016) predicted that sea levels could rise as much as one meter by 2050 due to the melting sea ice. All of the melting ice means there is less surface area to hunt on, rest on and reproduce on. Kelly observed that ringed seals, much like the polar bears, have months where they are bound to ice and other months where they are free to roam the land (2010). Demonstrating that it is not just polar bears who are suffering immensely due to the lack of sea ice.

Melting sea ice has proven to also impact both the diet and breeding habits of polar bears greatly. With less of an area to hunt on, polar bears are forced to eat not only their own kind but their offspring in order to survive. Now with ice melting away, they have less time to hunt seals making the foods they consume onshore increasingly important in alleviating nutritional stress (Gomezano L and Rockwell R. 2013).

Crossbreeding now is being recorded more and more throughout the Arctic regions, as polar bears are moving more and more inland (Miller, 2015). This is because the decreasing amount of ice has allowed for grizzly bears to move further north, while pushing the polar bears inland. With climate change expected to not to stop, the interactions between the two bears will further lead to more hybrid crossbred bears being produced.

Melting Ice Caps

Melting ice caps are a growing problem and will continue to be a problem not only for Arctic animals as well as humans. Arctic ice caps are at risk to melting due to the increase in the population of the earth and the automobile use related to it, another large factor to the decline of ice caps is agriculture specifically cattle farms. Both factors contribute to the greenhouse effect. The greenhouse effect is when the radiation from the sun to the earth is trapped in the lower atmosphere. Carbon dioxide from car emissions and methane from livestock flatulence are the main causes of climate change, which is the source for melting ice caps, these molecules reflect the sun's radiation back to the earth causing increased warming.

Methane from cattle is much bigger of a particle and has a stronger “reflectivity” than carbon dioxide causing it to have 30x worse effects. Livestock accounts for 40 percent of the world's agriculture (Naqvi SMK et al 2011) this large portion of agriculture is cause for melting ice caps and other climate change problems such as more frequent wildfires. More than 50% (about 2/3rd) of the world’s anthropogenic methane emission is produced through agricultural practices (Naqvi SMK et al 2011) This number will only increase as the human population increases as a need for food becomes greater. Tactics to decrease this number is in effect such as changing the animal feed to produce less methane.

Carbon Dioxide is the other large factor for the greenhouse effect. In a study in a coastal city in China showed a steady increase in carbon emissions which will ultimately progress the melting of arctic ice caps. The study showed the average annual increase rate was 8.46% in 2000-2005 (M Chun et al 2010). To combat the many companies have resorted to creating more environmentally friendly products, Tesla for example with fully electric cars taking carbon emissions out of the equation. The computed temperature rise at the lateral 80° South could start rapid deglaciation of West Antarctica, leading to a 5 m rise in sea level (Mercer JH). The temperature rise due to global warming will continue to melt the ice caps. In this study computers calculated the temperature rise at the latitude 80° S will melt the ice caps exponentially causing a sea level rise. This sea level rise will result in cities such as Richmond to flood in parts due to the low elevation they are built on.

Ice caps are home for many arctic animals, mainly for breeding and hunting purposes, with a decrease in ice caps these hunting and breeding grounds are taken away from the animals preventing them from the necessities for life. Polar bears affected greatly by this as their life depends on the ice to hunt seals that can rest on the ice. With the ice, melting seals have new areas polar bears are not able to reach due to distance or difficult terrain. Polar bear breeding is also a problem due to the sea ice melting, causing the polar bears to move to more stable breeding areas. Sea ice melt restricts polar bear movement greatly preventing all these survival tactics. Increased ice drift could significantly affect the movements and the energy balance of polar bears (*Ursus maritimus*) which forage, nearly exclusively, on this substrate (Durner G et al). Decreasing energy in polar bears also affects their hunting not allowing their full potential to gain the nutrients they need for survival. Increased melting in sea ice (Figure 1), will require the polar bears to move more frequently to swim and find a stable area to hunt which uses a great deal of their energy rather than years ago when the bears could stay on ice the whole time to hunt.



Figure 1. amount of melted sea ice over thirty-six years, via the National Snow and Ice Data Center [NSIDC], 2017.

Eating Habits

With Arctic ice declining at a rapid rate, polar bears are resorting to different strategies to achieve the satisfactory amount of nutrients they need to survive throughout the spring and summer. According to data published in 2013 polar bear diets are expected to change in response to climate-induced shifts in the abundance of distribution patterns of arctic and subarctic marine mammals (Mckinney M et al. 2013). The ice loss rate is at 9.8% per decade for the Greenland Sea which is one of the highest rapid rates in all the Arctic. The East Greenland polar bear subpopulation is in the convergent ice ecoregion which is essentially the meeting place for ice from all ecoregions. Collectively the convergent ice ecoregion has more ice surface than any other ice ecoregion in the surrounding area. Researchers stated that convergent subpopulations may initially be less affected by ice loss than those in seasonal or divergent ecoregions as they have access to ice all year (Mckinney M et al. 2013). Although it may seem that some species may benefit over others, they have predicted that the East Greenland population will be extirpated within the next 75 years.

Polar bears diet consists mainly of a few specific seal species such as ringed seals, bearded seals, and the occasional hooded seal. Bears hunt for prey during the spring so they can survive off their fat reserves throughout the summer as the ice melts and the seals move farther out into the sea. Gaining most of their energy from the consumption of ringed seals, polar bears capture them after March of each year which coincidentally lines up with the production and maturing of pups (Gormezano L and Rockwell R. 2013). They prefer to prey on pups as they are an incredibly easy target for adults proving that maturing pup season is the ideal hunting time. Now with ice melting away, they have less time to hunt seals making the foods they consume onshore increasingly important in alleviating nutritional stress (Gormezano L and Rockwell R. 2013). Looking specifically at polar bears in Hudson Bay we see that with less seal availability they resort to terrestrial prey by exploiting species such as Caribou (*Rangifer tarandus*) and Snow Geese (*Chen caerulescens caerulescens*). During a 4–5-month ice-free period, it is clearly harder for polar bears to capture their desired prey showing an increase in alternate prey. The bears feed on the snow geese eggs saving them the wasted energy of running across the tundra to collect food which ultimately could help the species in the long run. They have been observed walking, running, and even climbing cliffs to catch alternate prey showing the desperation for food when seal species are lacking (Gormezano L and Rockwell R. 2013). Ultimately researchers found that polar bears will pursue the most readily available food source to them whether it is seal or algae.

Food consumption is essentially the greatest factor in polar bear reproductive and survival rates. As they lose more and more of their habitat polar bears are exposed to a rapid decrease in survival and reproduction. It is commonly found that with a decline in ice caps polar bears are experiencing a decline in body condition and body size as well as altered movements and distribution due to lack of food sources (Derocher A et al. 2013). Researchers have also noticed a decrease in population size, sea ice denning habitat, and reproductive success rates. Although polar bears have found other means of food, some choose to fast during the summer months and eventually die of starvation. Studies predicted that adult male mortality from starvation would increase 28-48% in any year the fasting period is 30 days longer than in past decades (Derocher A et al. 2013). Some management methods are being practiced such as diversionary, supplemental feeding, rehabilitation, and translocation. These practices are to ensure that polar bears are either moved to an environment where they can better hunt for food or give them the resources they need to survive and reproduce. We can expect the numbers to increase year after year as the climate is only getting warmer, meaning that polar bear populations will begin to rapidly decrease without proper management systems.

Cross Breeding

Freeman (2009) describes the polar bears as a living symbol of the Arctic who have become so due to rising campaigns to battle climate change. Stirling (1998) observed that the Arctic bears preferred to stay on the ice for as much of the year as possible due to its variety of uses. Though once the ice started to melt, the polar bears had to travel miles and miles just to have access to nutrition such as seals (Stirling 1998). The amount of travel done per polar bear per year increases each year due to the lack of sea ice. This also means that their summer period is longer, leading some bears to increase their use of the land. A study completed by Miller (2015) shows their first interactions documented the interaction of polar bears and grizzly bears throughout the years 2005-2007. As the years have continued, these interactions only increased.

With the Earth warming and less sea ice, the polar bears have nowhere to go except for the land. This poses serious difficulties seeing as they are marine animals who rely on the ice for hunting and breeding purposes. A lack of sea ice means that the Arctic bear is now having to move inland (Miller, 2015). Furthermore, due to the decreasing amount of sea ice to reproduce on, the polar bears have turned to an alternative means of mating, crossbreeding with grizzly bears.

However, polar bears are not the only species who are suffering from climate change. Species such as grizzly bears are also suffering the consequences of climate change, as individual differences in body size, sex, and reproductive status can affect needs (Poppitt et al., 1994). The grizzly bear, an inland species, will remain where its major food sources are. They hunt salmon, eat berries, and unlike the polar bears, hibernate during the winter months. As a result of climate change, the grizzly bears have an increased amount of land to travel to, being observed to venture as much as 500km or more from their homes in the mainland (Doupé et al., 2007). In the last decade, grizzly bears are being spotted more and more in the Arctic, an idea that is aligned with environmental change. The range expansion is thought of to be linked to climate change (Pongracz et al., 2017), resulting in the hybrid bear of both the polar bear and the grizzly bear.

Images of the polar bear-grizzly bear hybrid are being captured more frequently in the Arctic regions. Images such as Figure 2, capture the mixed features of the bear-grizzly hybrid bears. While the fur is still white, its head is larger, a feature that grizzly bears would commonly possess. Behavioral differences were even noted as female polar bears with cubs were more likely to display aggressive behavior than other social classes (Miller et al., 2015). Another hybrid bear identified through DNA analysis as an offspring of a male grizzly and a female polar bear was found to have white, brown eye patches, and large paws and claws (Oryx, 2006).



Figure 2. Photo posted CBC via Didji Ishalook, Arviat Nunavut.

Conclusion

The purpose of this literature was to investigate the factors affecting polar bears due to climate change. Among different studies, many pointed towards the increasingly negative effect of climate change creating these large issues. While greenhouse gasses are the leading factor of climate change due to the greenhouse effect, there is no real chance of stopping how much is being outputted into the air. Furthermore, with all the gas that is trapped, the Earth will continue to warm consequently melting more ice.

Moreover, as the global temperature continues to rise, the negative impacts will continue to visually show its effects on the polar bears, among other species. The Arctic regions are suffering the most, as the sea ice is melting at a rapid pace. The loss of habitat also means that the polar bears are having to travel long distances to find a sufficient food source. A lack of sea ice also translates into changing eating habits in order to survive. While the polar bears have no

seals to eat, they are sometimes forced to turn on one another, even going as far as to eat their own cubs. Without food, however, the polar bears will die.

The loss of an area to reproduce on (i.e., sea ice) indicates the polar bears are having to move inland, while providing more of an area for the grizzly bears to venture into. This increases the number of interactions between the two species, subsequently leading to more hybrid bears being produced.

Recommendations

While there is a multitude of studies on climate change as a stand-alone, further effort should be placed into studies directed towards the physical effect it has on polar bears. Further studies should be aimed towards cost-saving methods to decrease greenhouse gas emissions to reduce the negative effects that they are creating. It is also important to note that although there have been quite a few sightings of these crossbred bears, there are few studies on the subject. Moreover, it would be beneficial to investigate the genetic makeup of these crossbred bears as well as their eating habits, resting places, and offspring. Studies could also investigate the eating habits effects on the polar bears both presently and in the future.

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