How does climate change impact the population of polar bears? Environmental threats, ecological dynamics and conservation efforts

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Summary

Climate change is one of the major drivers of recent biodiversity loss on a global scale. Some species try to adapt to such changes through shifting their range and behaviour due to their habitat being altered or damaged. Within the Arctic regions, temperature rise is three times higher than the global average, affecting various species at different rates in this ecosystem. Such a warming effect is detrimental to the Arctic ecosystem as it results in a rapid decline of sea ice during the summer months. Polar bears are considered an apex predator in the Arctic environment that rely on sea ice to sustain their life cycle. Unfortunately, the retreat of sea ice results in habitat loss for polar bears, as well as other native wildlife in the Arctic ecosystem. Sea ice serves many purposes to the polar bear's life cycle such as hunting prey, protection from potential human disturbance and raising cubs. The decline of sea ice over recent years has been rapid, directly related to a decrease in the survival capability of polar bears. As a result, the decline in population has proven to have an array of negative ecological consequences. Thus, this review seeks to gather a further understanding of various drivers and consequences that climate change causes, both direct and indirect, on the polar bear population as well as on the Arctic ecosystem by analyzing previous studies. Polar bears are a flagship species that serves as the symbol of the Arctic ecosystem and are a valuable indicator to the health of their local environment. Awareness, continued education, monitoring and synthetic assessment on polar bear populations with their surrounding habitat are necessary for both citizens and scientists. Therefore, societal effort is required to mitigate the adverse effects of climate change and reduce the risk of species extinction to preserve biodiversity and ecological dynamics.

Key words: animal ecology, Arctic ecosystem, climate change, conservation biology, habitat analysis, polar bear (*Ursus maritimus*), population dynamics and predation behaviour

1. Introduction

Climate change is one of the defining global issues of this century, with a range of negative impacts occurring across the globe. Climate change is expected to result in significant consequences on ecosystems and their associated diversity, with different species and regions being impacted at different rates (Hamilton et al., 2017). The Earth has been warming at an unprecedented rate, with polar environments warming faster than any other area on Earth, particularly in the Arctic region (Hoegh-Guldberg et al., 2018; Hunter et al., 2010). Such rapid warming in the Arctic region can have detrimental effects on the regional biodiversity, including changes in population dynamics, species distributions, ecological interactions and ecosystem processes among other factors (Hunter et al., 2010). As a result of the unprecedented warming in the Arctic region, scientists have noticed that sea ice in the summer has been rapidly retreating in past decades (Hoegh-Guldberg et al., 2018). Furthermore, sea ice thickness has also declined substantially in recent decades, with the decrease estimated to be 50% in the central Arctic region (Hoegh-Guldberg et al., 2018). The delayed and shorter winters, due to global warming in this region, significantly alters the Arctic environment, resulting in a reduced habitat and restricted range (Wilson et al., 2016). The breakup of sea ice in polar environments can be proposed to represent habitat fragmentation. This occurs when a certain habitat gets continuously separated into smaller and isolated patches because of ecosystem change (Biddlecome et al., 2020). Such fragmentation often results in habitat loss, affecting the surrounding biodiversity.

Species that rely on sea ice as their primary habitat, such as polar bears (*Ursus maritimus)*, are vulnerable to the fragmentation of sea ice as it results in the disappearance of their habitat (Molnár et al., 2011). Being a top predator in the Arctic ecosystem and an ice-dependent marine mammal living in this environment, polar bears are a valuable indicator of the health and stability of the Arctic ecosystem (Hunter et al., 2010). Considered the largest living bear, polar bears are dispersed throughout the ice-covered areas of the circumpolar Arctic in 5 countries: Canada, Denmark (including Greenland and the Faroe Islands), the United States, Norway and Russia (Thiemann, 2008; Fitzgerald, 2013; Wilder et al., 2017). This species prefers their sea ice habitat on the continental shelves, as they are more biologically productive and provide greater access to their preferred prey (Hunter et al., 2010).

Considered habitat and predator specialists, polar bears require sea ice for various aspects of their life cycle and to acquire their prey, primarily feeding on ringed and bearded seals (Hunter et al., 2010; Wilson et al., 2016). Although, recent research suggests that some polar bear populations have developed opportunistic feeding methods in accordance with their changing environment, including feeding on terrestrial species, feeding on carcasses, and foraging for food on land and in towns (Wilson et al., 2016; Hamilton et al., 2017; Wilder et al., 2017). Previous studies concluded that polar bears are known to have higher survival rate with more hunting success in the average 30 years of their life cycle (Hunter et al., 2010). Like other Arctic species, polar bears have a variety of adaptation strategies to survive in this harsh landscape (Fitzgerald, 2013). An example is stated by Fitzgerald (2013), that polar bear's feet is designed to spend a lot of time in water and walk on sea ice. In addition to such specialized adaptations, Fitzgerald (2013) further noted that unlike other bears, polar bears are most active in the winter as it gathers its largest food source during this season, which suggests that some polar bears therefore do not enter torpor during this period.

Regarding the polar bears reproduction process, females are known to reproduce earliest during their fifth year, having litters of one to three cubs. The young are dependent on their mothers from birth up until the spring of their second year, which means that for reproductive females to be successful, they have an inter-birth interval of minimum 3 years (Hunter et al., 2010). Such a slow-reproducing species with low reproductive rates is one of the key reasons why this species is particularly vulnerable to the climate related threats that have been occurring at a rapid rate recently (Fitzgerald 2013; Molnár et al., 2011).

Other threats that polar bears face include reduced litter size, fragmented habitat, less feeding opportunities and more energy needed to get the same caloric intake resulting in poorer body condition (Hunter et al., 2010; Molnár, 2011). Although historically feared by society due to their size and predatory physiological features, over time the polar bears have become an international symbol of the Arctic with citizens, governments and scientists recognizing their ecological importance (Fitzgerald, 2013). Being a top predator in this Arctic ecosystem, the role of polar bears in the Arctic food web is critical to maintaining ecosystem function (Wiig et al., 2015). Any decline in polar bear populations will result in a multitude of environmental, economic and cultural consequences. As a result, studying the population dynamics and associated environmental threats that polar bears face in the 21st century is of vital importance to the scientific community to monitor changes within the Arctic ecosystem (Wilder et al., 2017).

By recognizing the importance of polar bear conservation, this review paper seeks to gather an in-depth understanding of the various impacts that climate change has directly or indirectly on polar bears. The intent of this paper is to analyse previous research findings to define two key issues, related to polar bears and their population decline in some regions due to ongoing climate change. The first concept that will be addressed are the drivers of polar bear loss. The second concept that is highlighted are the (associated) consequences of polar bear loss. Therefore, it is essential to gather an in-depth understanding of the main drivers and consequences that reduce and negatively impact polar bear populations. This is the starting point where collective societal efforts develop solid conservation methods to preserve polar bear habitat and reduce their risk of extinction.

2. The Drivers of Polar Bear Loss

Temperature rise in the circumpolar regions impacts various species at different rates that call this environment their home (Stirling et al., 2006; Wilder et al., 2017). Hamilton et al. (2017) noted that the Arctic environment has been warming three times faster than the global average while, as a result, the sea ice declines rapidly. It is predicted that the Arctic region can be seasonally ice-free as early as some time in the 2030s (Hamilton et al., 2017). Such warming that is occurring in the circumpolar regions at an unprecedented rate can have detrimental effects on polar bear populations throughout the Arctic region.

2.1 Sea Ice Loss

The Arctic environment is highly seasonal and has various biodiversity and trophic interactions that rely on certain climatic conditions to sustain their life cycle processes. This environment is currently under serious threat due to the changing climate (Hamilton et al., 2017). Polar bears are an apex predator in the Arctic environment that rely on sea ice to sustain their life cycle (Freitas et al., 2012). Unfortunately, retreating sea ice has been resulting in a loss of habitat for polar bears, as well as other native wildlife in the Arctic ecosystem (Freitas et al., 2012). Sea ice serves many purposes to the polar bear's life cycle, from hunting prey, providing shelter from extreme weather, and protection from any potential predators. Human disturbance, and raising young (Hamilton et al., 2017). The decline in sea ice over the years has been unprecedented and such a decline in sea ice is directly related to a decrease in the survival capability of polar bears (Biddlecombe et al., 2020).

For example, in a study presented by Sahanatien & Derocher (2012), that monitored the sea ice fragmentation in the Hudson Bay, Hudson Strait and Foxe Basin regions in Canada, the authors found that the earlier break up of sea ice in the Western Hudson Bay and Southern Beaufort Sea resulted in these polar bear populations to have reduced caloric intake. This resulted in poorer body condition, reduced cub litter size and cub survivorship (Figure 1). Such declines in their health and reproductive success are said to be the reason for a decline in the Western Hudson Bay polar bear population. With the increasing habitat fragmentation and extended ice-free summers that these polar bear populations face, such factors may disrupt their annual return and cause further risk of altering their population boundaries or gene flow (Sahanatien & Derocher, 2012). In accordance with other results, this is possible as depending on the level of fragmentation, polar bears would have to possibly swim larger distances for an adequate habitat, where they can successfully hunt on their primary prey (Fitzgerald, 2013). Despite being known to swim large distances with the increasing retreat of sea ice, there have been more reports of bears swimming incredible distances and drowning for several of them (Fitzgerald, 2013; Hunter et al., 2010). For the bears that have successfully swam incredible distances to their specific habitat region, they still face a great energetic cost which could increase their risk of mortality (Molnár et al., 2011; Sahanatien & Derocher, 2012). Such energy costs are expected to be the norm in this seasonal environment as declining sea ice habitat and increasing icescape heterogeneity are expected to increase these bears interpatch movements (Bowne & Bowers, 2004; Sahanatien & Derocher, 2012). An example of the large increase in distances travelled by different polar bear populations can be seen in Figure 2, which shows a clear increase in the distance travelled by bears in Norway in 2002-2004 and 2010-2013 (Hamilton et al., 2017). The research presented by Sahanatien & Derocher (2012) concludes by reinstating that the largest drivers negatively affecting polar bear populations in the Canadian Arctic are habitat loss and fragmentation, hypothesizing that sea ice conditions will continue to become unfavourable.

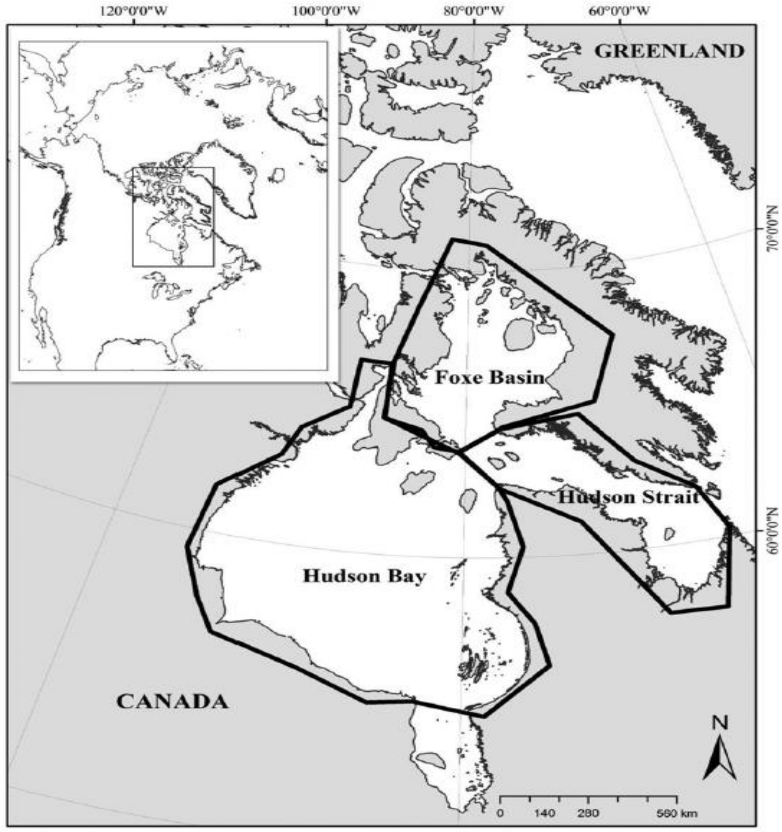

Figure 1. Map showing the marine regions of the Hudson Bay, Hudson Strait and Foxe Basin in the Canadian Arctic. The coverage of this map is the field investigation of the survey team, led by Sahanatien & Derocher (2012), in the Arctic Sea area.

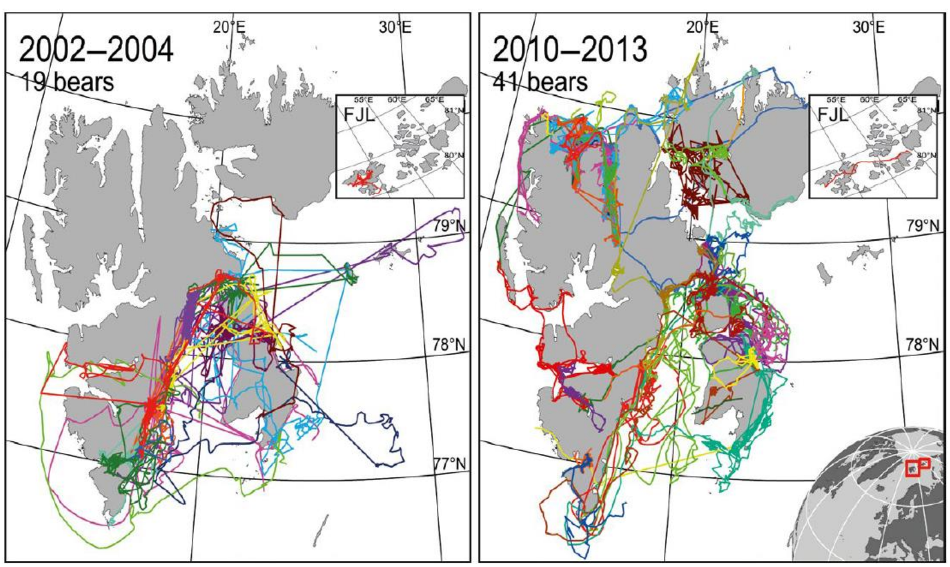

Figure 2. Two maps display the tracks of polar bears that were equipped with satellite collars in Svalbard, Norway in 2002-2004 (left map) and 2010-2013 (right map) during the summer months. The inset maps show two bears that travelled to Franz Josef Land (Hamilton et al., 2017).

2.2. Reduced Reproduction

As stated in the previous section, the decline of sea ice would be considered by some researchers the main drivers of polar bear loss that leads to increased sea ice fragmentation and reduced habitat. In addition, more subtle ecological drivers also contribute to polar bear loss along the trend of sea ice loss. The reduced polar bear population is driven by the reduced litter size and cub survival throughout the Arctic region (Molnár et al., 2011; Sahanatien & Derocher, 2012). In the research conducted Molnár et al. (2011), the authors attempted to predict how the largest drivers resulting in polar bear loss, specifically climate change and its associated consequences, impact polar bear litter size under predicted circumstances of further jeopardising polar bear populations. Molnár et al. (2011) made these predictions from the data that were obtainable under present conditions as well as the use of mechanistic energy budget models. With their study location occurring in the Western Hudson Bay, they noted that based on historical data, polar bears in this location used to come ashore in early August. However, due to increasing temperatures in this region, the negative phenomena such as sea ice loss, habitat fragmentation and seasonal sea ice breakup have made polar bears come ashore earlier recently (Molnár et al., 2011). With the ice breakup occurring earlier in the recent summers, this has resulted in trends towards earlier polar bear onshore arrival, leading to these populations to have reduced feeding time and extended fasting time ((Fitzgerald, 2013). Such behaviours are expected to persist with continued warming. The food stress is predicted to result in reduced energy stores for females at den entry (Molnár et al., 2011). According to some climate predictions models developed by the IPCC (Hoegh-Guldberg et al., 2018), their models predict that the breakup of sea ice and polar bear arrival in the Western Hudson Bay could occur approximately one month earlier than the 1990s. Based on these models, Molnár et al., (2011) predicted that 40-73% of pregnant females could fail to produce a litter in the new trend. Furthermore, if sea ice break up occurs two months earlier, they predicted that 55-100% of pregnant females could fail to reproduce. This would result in substantial declines in mean litter sizes, with females either producing less offspring, or females being unable to successfully raise their cubs due to reduced energy stores (Fitzgerald, 2013; Hunter et al., 2010).

The future predictions of litter size of the Western Hudson Bay polar bear population serve as an indicator that this population will not remain feasible with continued warming. Similar declines in litter size and survival rate are predicted to occur to approximately one third of the global polar bear populations as they follow similar patterns of earlier sea ice retreat and extended fasting (Molnár et al., 2011). Based on these results, reduced energy storage and feeding opportunities occur under the trend of increasing temperatures and sea ice loss, which are predicted to have detrimental effects on polar bear populations across the globe, with less reproductive success and decreasing the population potential (Hunter et al., 2010). Further research, monitoring, and assessments of various polar bear populations, their behaviours and reproductive success are necessary for the development of habitat management policy to reduce extinction risk.

2.3. Less Hunting Opportunities

Climate change and its associated effects on the Arctic environment have been resulting in population declines of polar bears across the globe (Hamilton et al., 2017). Polar bears primarily feed on seals, using the sea ice to either stalk seals or using this habitat as a method of still hunting seals at breathing holes (Hunter et al., 2010). The associated threats that polar bears face, because of the effects driven by the climate change are enormous. Over the past few decades researchers have discovered that the loss of sea ice results in less primary feeding opportunities for polar bears (Hamilton et al., 2017). The retreat of sea ice and increased fragmentation of habitat area are expected to increase nutritional stress, as these bears depend on the sea ice to successfully hunt their preferred prey (Hunter et al., 2010; Hamilton et al., 2017). Similar to the threats that female polar bears face when trying to raise their young, the retreat of sea ice forces bears to rely on their accumulated body fat, leading some bears to end up starving if they did not accumulate enough fat before fasting seasonally on shore (Hunter et al., 2010; Molnár et al., 2011).

In addition, bears that do not acquire enough prey and are food deprived will expend all their energy trying to feed on their preferred prey. For example, in recent years it has been found that polar bears have travelled substantial distances in search for adequate sea ice for hunting during the summer months, which occurred in the Svalbard population as shown in Figure 2 (Fitzgerald, 2013; Hamilton et al., 2017; Hunter et al., 2011). In many instances, drowning was recorded for the bears that swam incredible distances to new sea ice fragments (Fitzgerald, 2013). Cubs are of particular concern, as they do not have the same physical strength as adult bears to swim these large distances, and in some cases these cubs are also vulnerable to attaining hypothermia (Sahanatien & Derocher, 2012). Recent years have provided more evidence of drowned, emaciated and cannibalized polar bears (Hunter et al., 2010). Fitzgerald (2013) points out that although previous research has found that this is not a new phenomenon, it has been occurring more frequently in recent observations. For example, Fitzgerald (2013) noted that when the freeze up of sea ice occurred quite late in 2009, the population was exceptionally emaciated and there were 8 known instances of cannibalism on cubs that year in comparison to the recorded 3 instances that occurred within the previous 30 years. Although there are many drivers contributing to polar bear loss and their risk of extinction, few populations have developed new forms of adaptations to survive amidst these changing conditions. For example, some bears have spent more time foraging bird eggs to sustain their energy stores while others have changed their hunting approach to capture seals (Iverson et al., 2014): with a few specialised aquatic techniques to capture their prey (Hamilton et al., 2017). Unfortunately, very few polar bears have acquired such specialized hunting strategies and the reduced spatial overlap of habitat dynamics (predator-and-prey encounters) results in most bears being at risk of mortality (Hamilton et al., 2017).

The environmental changes that have occurred throughout the Arctic regions in response to climate change has resulted in a correlation between the poor body condition of polar bears and the faster retreating sea ice (Fitzgerald, 2013). For this apex predator to survive and prosper in the Arctic environment, abundant sea ice habitats are required to provide hunting grounds for polar bears (Molnár et al., 2011). The loss of sea ice habitat over time would lead to the possible extinction of this species. Polar bears have evolved to dominate this habitat and therefore at the rate that ice is currently retreating, this species cannot adapt fast enough to escape their dependence on sea ice (Fitzgerald, 2013).

3. Consequences of Polar Bear Loss

The ecological changes that have occurred to this unique environment resulting in polar bear loss can prove to be consequential and will therefore be discussed further. Polar bears are an apex predator in the Arctic environment that is dependent on sea ice to establish a platform and hunt prey such as seals and other mammals (Iverson et al., 2014). The breakup of sea ice has decreased the available time for polar bears to hunt seals (Parkinson & Evengård, 2009). As a result, many polar bears are not able to gain enough calories to sustain themselves. This can directly modify the ecological dynamics of the habitat area where polar bears are active and indirectly contribute to their extinction. The trophic interactions in the Arctic Circle are most likely to be modified in unfavourable conditions to polar bears. This can be shown in the inter-specific competition of food sources and the alteration of predator-prey relationships (Harley, 2011). The reconstruction of food webs and rapid environmental changes establish a new ecological system on prey populations (Harley, 2011).

3.1. Potential Human-Bear Conflict

As a result of the key drivers of polar bear loss, subsequent consequences occur as polar bears that suffer lack of nutrition can appear on shore, where humans inhabit, in a desperate attempt to search for food (Wilder et al., 2017). This can result in potential human-bear conflict, where a bear may attack humans and as a result, later suffer the associated consequences (Stirling & Parkinson, 2006). Although the probability is rare, human-bear interactions have certainly increased in recent years with polar bears more frequently reaching inland towns in search of food, resulting in higher chances of potential negative human-bear interactions (Wilder et al., 2017). This causes a greater risk that humans and polar bears can encounter interactions that are most likely to result in conflicts (Derocher et al., 2004).

Figure 3. A polar bear killed by a German cruise guard (Polet & Hilderink, 2018)

Polar bears attacks towards humans are not frequent. Although if an attack occurs, it typically results in a negative public reaction and a lack of social tolerance towards the bear, where a bear may end up destroyed, as displayed in Figure 3 (Löe & Röskaft, 2004; Wilder et al., 2017). Consecutive conflicts between humans and polar bears impede support for wildlife conservation (Madhusudan, 2003). Therefore, it is necessary that the conflict between humans and polar bears is better understood and managed effectively to ensure the co-existence of the two within the Arctic Circle (Madden, 2004).

3.2. Impact on Seal Populations

Ringed seals are also native to the circumpolar Arctic and are a pinniped that requires sea ice to give birth and nurse their pups (Hamilton et al., 2017). On sea ice, they use the snow cover for breathing holes to care for their offspring (Lydersen & Gjertz, 1986). The distinct form of snow lairs is prepared for protection from adequate thermal regime and predator threat for the pups. Their diet is mainly ice-relevant prey (Reeves, 1998). Polar bears are the strongest predator against them and to hunt seals, the bears need a sea-ice platform, stalking seals and hauling the sea ice of seals by detecting breathing holes (Hamilton et al., 2017; Stirling, 1974; see Figure 4).

Figure 4. A polar bear hunting a seal (Hopegood, 2015)

However, the population of seals has also decreased due to the decline of sea ice in the Arctic Circle (Iverson et al., 2014). As a result, both polar bears and seals, which inhabit around the Svalbard Archipelago, Norway, have adapted new strategies which are more relevant to land rather than sea ice (Lydersen et al., 2014). While many polar bears are tied up on land due to limited access to sea-ice platforms, few of them have developed a drastic tactic to move further North to pursue their traditional sea-ice platform during the ice retreats in summer months (Lydersen & Gjertz, 1986; Lydersen et al., 2014). Otherwise, especially female polar bears with dependent cubs, occupy the ice near glacial frontline in the spring to hunt seals (Freitas et al., 2012). The loss of sea ice that has been resulting in decreasing polar bear populations has also shown to have similar negative effects on their prey. Such a loss of trophic interactions and a decline in relevant species result in damaging effects to the Arctic ecosystem, especially on scavenging species such as various birds or Arctic foxes, relying on these interactions for their food source (Fitzgerald, 2013). The loss of this predator-prey relationship due to the key drivers discussed in the previous section is likely to result in an array of consequences for the entire Arctic ecosystem.

3.3. Impact on Bird Nests

The forecasts of climate change that affect biotic interaction is largely focused on the tolerance of individuals against environmental changes (Thomas et al., 2004). This also has a major impact on the interactions of species that affect the dynamics of populations and communities in the Arctic Circle. Thus, predator-prey relationships are affected due to such consequences (Harley, 2011). Recently, the bird eggs of some nesting colonies have been more frequently plundered by polar bears in the Arctic Circle (Dey et al., 2017). Under the trend of global warming reducing available sea ice coverage, some polar bears tend to move inland, targeting bird eggs more frequently during the nesting season to attain sufficient calories (Iverson et al., 2014; see Figure 5). This new plundering behaviour toward bird micro habitat has become a new trend as a result of the sea ice season becoming shorter in the last decades that resulted in a lack of primary hunting platforms for polar bears.

Figure 5. A polar bear foraging on a bird nest (BBC, 2010)

Historically, the predation of bird nests by polar bears was not common (Gormezano & Rockwell, 2013). Hence, the breeding birds in the Arctic Circle had been under little pressure to adapt anti-predator strategies against polar bear predation. However, in recent years, polar bears have begun to experience thin sea ice on shore and a lack of food sources. This has become a chronic problem that results in a polar bear's behavioural response to feed on terrestrial species in the Arctic Circle (Dickey et al., 2008). As a result, breeding birds and polar bears have recently shared habitat that overlaps significantly. This has increased the frequency of polar bears preying the eggs of breeding birds nearshore (Iverson et al., 2014). Iverson et al., (2014) confirmed that the colonies of eider and murre have increased seven-fold in 25 years (between 1987 and 2012). The presence of polar bears in certain regions has been strongly predicted to target these bird nests during the ice-free period. Likewise, polar bears had almost not been observed in eastern Greenland and Spitsbergen for 30 years (in between 1975 and 1995). Recently, however, there are about 5 to 20 'bear days' in a year (Prop et al., 2015). The cost-benefit analysis of searching for bird eggs remains unclear so far (Dey et al., 2017). Nevertheless, the predation of bird eggs has become more frequent in the observable areas. This means that polar bears are obliged to change their predation habits to search for new nutrition sources. Climate change is predicted to have various consequential effects on the Arctic ecosystem due to new and unusual biological interactions (Prop et al., 2015). Such new adaptations can have consequential influences on sea bird success in the coming years if such bear-bird interaction continues (Dey et al., 2017)

3.4. Infection

In the absence of polar bears, the relationship between host and parasite can change as well (Harley, 2011). As the number of polar bears decreases, the survival rate for some prey populations of polar bears may have increased along the prolonged ice-free period in the Arctic Circle. This means that these animals may have more opportunities to carry infections to humans (Parkinson & Evengård, 2009). For instance, the expansion of the boreal forest in northern Canada and Alaska has been a favourable change for beavers (Parkinson & Evengård, 2009). The microparasite, *Giardia lamblia*, has also advanced with the expansion of beaver habitats. *Giardia lamblia* can infect other mammals and humans are not exceptions (Ankarklev et al., 2010; Parkinson & Evengård, 2009). Likewise, the temperature rise in the Arctic Circle coupled with the loss of polar bears can lead to consequential infections to other mammals (including humans). This loss allows the opportunity for voles and foxes that carry fox tapeworm (*Echinococcus multilocularis*) and other diseases to expand their habitats (Nakao et al., 2010) and replace the empty lands where there are no longer polar bears (Parkinson & Evengård, 2009).

4. Conclusion – A step forward for conservation efforts

Polar bears are one of the largest extant bears that are strictly carnivorous and the only bear that is classified as a marine mammal, surviving in the Arctic ecosystem which they call home (Hunter et al., 2010). The range of polar bears is distributed throughout the Arctic Circle where the land is minimally resided or occupied by humans. Still, there are a lot of serious environmental threats against polar bears. As a result, the potential for large reductions in the polar bear population will most likely continue under the global warming projection against sea ice loss (Wiig et al., 2015). The consequences of multi-stressors, such as climate change and relevant reformation of ecological interaction, have negative effects on the security of habitats for polar bears (Norris & Eid, 2002).

The Range States (i.e. the territories relevant to the habitat range of polar bears) are formed to secure the safety of humans and polar bears in co-existing communities, recognising the necessity of comprehensive strategies to control the conflicts between humans and polar bears as human activities are expanding in the

Arctic Circle and polar bears are suffering from nutritional stress as a result of retreating sea ice (Directorate for Nature Management, 2009). However, the conflicts between humans and polar bears are poorly documented, especially in the extreme North. Thus, some local communities that have encountered polar bears tend to have misinformation and misconception about polar bears in a negative sentiment (Towns et al., 2009).

The Range States have collaborated with Norway and the United States for the development of an analysis system to manage the conflicts between humans and polar bears (Directorate for Nature Management, 2009). Wilder et al. (2017) have identified necessary data to minimize the risk of polar bear attacks in the future to mitigate potential conflicts while promoting safety for both humans and polar bears.

The main drivers that polar bears face comes from the lack of sea ice in the Arctic environment which is a direct result of climate change (Hamilton et al., 2017; Wilson et al., 2016). Therefore, the way to save polar bears is through changing our daily life, through climate action. The use of energy is a source of greenhouse gas emissions that are generated by human activities (Hoegh-Guldberg et al., 2018). About two thirds of the global greenhouse gas emissions are linked to the usage of fossil fuels for our everyday lives (Reset, 2020). Switching to renewable or less harmful energy sources will directly reduce CO_2 emissions and its associated climatic changes (Hoegh-Guldberg et al., 2018). For example, changing the mode of transport from airplane to train and from car to bike is a step towards mitigating climate change (Reset, 2020). Hence, saving polar bears is not a grand plan but begins with being mindful of our daily habits.

Figure 6. Polar bears roaming in their habitat (Palmer, 2014)

There are regions in the Arctic Circle where the temperature increase is far greater than other regions that even in the winter the sea ice is not stable enough for polar bears (Biddlecombe et al., 2020). As a result, they do not reside in these regions anymore. That is because sea ice does not remain long enough for polar bears to hunt and live (Norris & Eid, 2002). The fossil records in southern Norway and Sweden showed that polar bears existed about 11,000 years ago. However, both ice and bear did not exist in these regions (Palmer, 2014). Andrew Derocher, former chair of the International Union for the Conservation of Nature's (IUCN) Polar Bear Specialist Group, made a final remark during an interview with Jane Palmer, a BBC reporter: "*it is really quite simple and I come back to it time and time again: It's just the habitat loss issue. If there's not enough ice, we won't have bears. I think it's very clear that we're going to lose the vast majority of them, not within my lifetime, but certainly within the lifetime of children of mine*" (Palmer, 2014). Therefore, continued education, awareness, monitoring, and assessment on polar bears in conjunction with their surrounding habitat are necessary if society is to make a change in their daily lives to conserve this species and prevent the unfortunate fate of this unique predator.

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