The Negative Impact of Human Activities on Polar Ecosystem

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Keywords: Distraction, Animal Habitats, Global Warming.

Abstract: In recent years, the rapid development of science and technology has led to the emergence of many environmental challenges, which have aroused wide attention of the international community. The uninterrupted advancement of human society has exerted innumerable impacts on the natural world, with the most striking example being the striking alterations in Arctic Sea ice. The Arctic Sea ice coverage is projected to plummet to an unprecedented low in 2023, heralding a distressing new era. Recent studies indicate that the Arctic might experience an almost complete absence of floating ice in the summer by the 2030s, approximately a decade earlier than previously anticipated. Catastrophic consequences have been attributed to anthropogenic global warming, with researchers estimating that as much as 90 percent of the glacier's melting can be attributed to human activities. Even with the implementation of stringent emission reduction measures, the current situation appears to be irreversible. Furthermore, global warming has profoundly influenced the polar ecological environment. This paper, through comprehensive data and research reports, ascertains that a multitude of human activities have significantly impaired the living environment and behavioral patterns of polar organisms in various aspects. It is hoped that this article will enlighten the public about the deleterious effects of human activities on the environment.

1 INTRODUCTION

As science and technology continue to evolve, the degradation of natural resources and the environment is escalating, particularly in polar regions. This has caused irreparable harm, leading to the extinction of many species and permanent damage to their habitats. The Arctic ecosystem, spanning approximately 14 million square kilometers, is composed of three subregional systems: the high-latitude polar desert in eastern Canada, primarily composed of bare soil and rock with scattered plant communities; a layer of permafrost, consisting of continuous, open plains with vegetation at low altitudes; and forest permafrost, a transitional zone from northern forest to southern forest, featuring continuous forest cover and scattered open lands akin to tundra (Antarctica et al., 2012). In recent weeks, temperatures have soared to over 30 degrees Celsius above the Arctic Circle in northern Sweden, and in northern Siberia, temperatures reached 32 degrees Celsius earlier this month (Antarctica et al., 2012). Typically, the average temperature in the region during this time of year is only 10 degrees Celsius. Data from the US National Snow and Ice Data Center reveal that abnormally high temperatures have accelerated the melting of Arctic Sea ice this summer, resulting in an unprecedented loss of sea ice along the coasts of northern Europe and northwestern Russia. The disappearance of sea ice not only imperils the survival of species like polar bears but could also exacerbate abnormal weather patterns in the Northern Hemisphere (Retejum, 2021). Currently, the warming rate in the Northern Hemisphere is faster than the global average, leading to drier and more flammable forests. A recent study discovered that forests in the Northern Hemisphere are burning at a rate not witnessed in at least 10,000 years, with over 50 forest fires occurring in Sweden alone.

2 THE IMPACT OF HUMAN ACTIVITIES ON POLAR ECOSYSTEM

2.1 The Destruction of Animals

The melting of Arctic Sea ice has a profound impact on the distribution and population structure of ice dependent species, including polar bears. Using remote sensing sea ice concentration data and satellite

Wang, Y.
The Negative Impact of Human Activities on Polar Ecosystem.
DOI: 10.5220/0013852900004914

In *Proceedings of the 2nd International Conference on Renewable Energy and Ecosystem (ICREE 2024)*, pages 168-171
ISBN: 978-989-758-776-4

telemetry data from Baffin Bay, Canada, author studied adult female polar bears in the 1990s (n = 43) and early 2000s (n = 38) to try to determine whether changes in sea ice habitat affected migration and habitat selection of these organisms (Summerson and Bishop, 2012). Polar bears, living in the Arctic, heavily rely on sea ice for survival, using it for hunting and breeding. Sea ice provides them with abundant food and essential resting areas. Seals, found on sea ice, are their main source of food. However, climate change is causing rising temperatures and melting glaciers, shrinking sea ice. This threatens polar bears, as the loss of sea ice means their hunting grounds are disappearing, forcing them to face harsher feeding conditions. Without sea ice, they must swim longer distances to find food, expending much energy and often unsuccessfully (Chwedorzewska and Korczak, 2010). The lack of stable ice and hunting resources is also affecting their ability to reproduce. Research shows many polar bears are struggling to reproduce successfully, leading to a decline in their population. The loss of polar bear habitat not only endangers the species but also harms the entire ecosystem. Their disappearance will likely cause unpredictable changes in other species in the ecological chain. To address this issue, it's crucial to prioritize environmental protection and global warming mitigation. The international community must work harder to create stricter environmental protection plans and reduce greenhouse gas emissions (Laidre et al., 2018). Enhanced protection measures for polar bears are necessary to ensure their survival and promote sustainable habitats.

The colossal Pacific walrus, characterized by its immense size, resides within the continental shelves of the Bering and Chukchi Seas, with its annual range encompassing these aquatic regions. Between 2006 and 2009, discrete selection models were employed to investigate the availability of benthic caloric biomass and sea ice concentration within the ice-covered St. Lawrence Island, a renowned walrus wintering site in the northern Bering Sea, with the objective of deciphering the location behavior of radio-tagged adult walrus. The study revealed that the research area contains a considerable portion of the total caloric biomass of dominant large animals, with over 60% constituted by bivalve Nuculidae, Tellinidae and Nuculanidae (Jay et al., 2014). The model estimates clearly show that there is a strong correlation between walrus location and the distribution of iodiform bivalves' caloric biomass. Walruses were observed to be attracted to areas with reduced ice concentrations, a trend consistent with the high ice concentrations available to them. Notably, akin to other studies, areas with high average predictions of walrus siting exhibited a strong correlation with areas possessing high organic carbon inputs. This suggests a potential correlation between walruses' preferred habitat and the accessibility of food resources. Considering the expected decrease in sea ice in the frozen area of Saint Lawrence Island and the possibility of a simultaneous decrease in bivalves in the area, it is reasonable that the wintering grounds of walruses in the northern Bering Sea may move northward. The Falkland Islands serve as a crucial breeding ground for three penguin species, including the Papua Penguin, the Southern Rockhopper penguin, and the Magellanic penguin. The aggregate population of penguins in this region underwent a distressing 84% decline between the 1980s and 1990s. However, this decline was not observed in coastal South America, prompting an investigation into the potential causes of the Falkland Islands' precipitous population decline (Bingham, 2002). The primary suspect is the extensive commercial fishing in polar area in order to decrease drastic in the availability of fish and squid, the penguins' primary sources of sustenance. Populations of rockhoppers and Gentoo penguins have stabilized since 1995, albeit at much lower levels than prior to the initiation of fishing commercially. This has been accompanied by an increase in chick-rearing success and chick's rate of survival. In contrast, the number of Magellan penguins in the Falkland Islands continues to decline. Dietary analysis shows that Magellan penguins rely more on commercially caught squid and fish. To make matters worse, oil drilling began around the Falkland Islands in 1998, despite warnings of inadequate environmental protection. Within a month, the first of three leaks occurred, resulting in the death of hundreds of penguins and pollution. Five months later, the rig stopped operations and left the Falkland Islands. Fortunately, there was no further oil spill. Unfortunately, in the near future, even though oil exploration is planned to be completed, strengthening environmental protection is still not a priority.

The endangered beluga whale population in the St. Lawrence Estuary (SLE) in Quebec, Canada, is threatened by historical large-scale hun ting, anthropogenic pollution, and human activities in the region. The main factor cause of death in its population is infectious diseases. The protozoan parasite Toxoplasma gondii has been discovered in

various marine mammal species, including beluga whales. In this study, the te 55 different samples (heart and brain) from 34 stranded SLE belugas, employing PCR methods. Subsequently, author conducted DNA sequencing and restriction fragment length polymorphism (RFLP) analysis to determine the prevalence and genotype of Toxoplasma gondii in these whales. Of the 34 beluga whales tested, the result state that 44% are found to be infected with Toxoplasma gondii undergoes polymerase chain reaction. It is worth noting that compared to females, male mice have a higher infection rate, and the infection rates of newborn and juvenile mice are higher than those of adult mice (Iqbal et al., 2018 & Braun et al., 2012). Molecular analysis shows that the stranded SLE beluga whale infected with Toxoplasma gondii belongs to genotype II and is commonly present in humans. Although the findings illustrate a significant prevalence of stranded beluga whales infected with toxoplasmosis PCR-positive, low percentage of deaths can be concluded by toxoplasmosis, according to published autopsy. Toxoplasma gondii is capable of causing various diseases, including the results of neurological disorders, and further research is necessary to investigate the parasite’s effect on the recovery of population.

Located approximately 400 kilometers north of the Arctic Circle, Norilsk is a part of Russia's northernmost region, known as Xinjiang, which is abundant in copper, nickel, and a variety of other minerals. It serves as one of the primary hubs for the country's non-ferrous metals industry (Tin, Liggett and Maher, 2012). With the growing focus on the development of energy in the Arctic region, Norilsk has transformed into a globally renowned metallurgical nerve center, giving rise to the world's largest nickel smelting company, Norilsk Nickel. On May 29, 2020, a storage tank at a thermal power plant owned by Norilsk Nickel experienced a catastrophic failure, leading to the leakage of over 20,000 tons of diesel fuel. The incident transformed the neighboring Amberya River into a crimson mess, contaminating an area of approximately 350 square kilometers. Subsequently, the company attempted to suppress news of the accident, allowing the leaked diesel to flow an additional 12 kilometers along the Amberanya River into Lake Piasino, and eventually into the Arctic Ocean. According to the Russian environmental monitoring service, approximately 15,000 tons of diesel oil entered the water body, while 6,000 tons contaminated the soil, resulting in various organisms being contaminated by heavy metals. The damage to the Arctic's ecological environment is immense. Therefore, it is crucial for individuals to actively endorse sustainable development in the Arctic. The distinctive of region on natural environment is essential to the planet's ecology. Any environmental pollution disaster will inevitably have unforeseen consequences. The Norilsk spill serves as a stark reminder to the international community of the necessity to responsibly develop and utilize the resources of the Arctic region.

2.2 The Damage Caused by the Oil Spill

Situated about 400 kilometers north of the Arctic Circle, Norilsk is a constituent of Russia's farthest northern region, Xinjiang, which is abundant in copper, nickel, and various other mineral resources. It serves as one of Russia's principal bases for the non-ferrous metal industries (Tin, Liggett and Maher, 2012). With the increasing attention being paid to energy development in the Arctic region, Norilsk has metamorphosed into a globally acclaimed metallurgical nerve center, giving rise to the world's largest nickel smelting company, Norilsk Nickel. On May 29, 2020, a storage tank at a thermal power plant owned by Norilsk Nickel catastrophically failed, leading to the spillage of over 20,000 tons of diesel fuel. This incident turned the adjacent Ambernaya River into a gory red mess, contaminating an area of approximately 350 square kilometers. Subsequently, the company's attempts to suppress the news of the accident caused the leaked diesel oil to flow an additional 12 kilometers, following the Ambernaya River into Lake Piasino, and eventually reaching the Arctic Ocean. According to Russia's environmental monitoring department, approximately 15,000 tons of diesel oil entered the water body, and 6,000 tons tainted the soil, leading to heavy metal pollution across various organisms. The devastation wreaked upon the Arctic's ecological environment is unfathomable. Therefore, it is of paramount importance for people to actively endorse sustainable development in the Arctic region, which distinctive natural habitats is vital to Earth's ecology. Any environmental pollution disaster will unravel unanticipated consequences. The Norilsk oil tank leak serves as a harrowing reminder for the international community to responsibly develop and utilize the resources of the Arctic region.

2.3 Ozone Layer Destruction

The recently published study in Nature Communications, dated June 23rd, suggests that climate change has induced substantial alterations in atmospheric conditions within the Arctic, exacerbating the seasonal depletion of the Arctic ozone layer. Should greenhouse gas emissions continue at elevated levels, the situation is anticipated to worsen further in the coming decades. By the turn of the century, substantial harm can be expected. Research finding reveal a significant escalation in the local maximum of polar stratospheric clouds (PFPLM) over the past 50 years. Given that the surface of the polar stratospheric cloud is capable of adsorbing chlorine-containing materials and activating the chlorine within them, it plays a vital part while the production of the ozone hole: the larger the PFPLM, the more easily the ozone layer is destroyed. The expansion of the PFPLM's size is attributed to the increasingly protracted polar vortex over the Arctic. The researchers discovered that over the past half-century, the Arctic polar vortex has expanded by 3.5-4.8 days per decade. The low temperatures within the polar vortex are crucial for the formation of polar stratospheric clouds. By utilizing weather model simulations, the researchers determined that the escalating duration of the polar vortex in the Arctic is a consequence of the alterations in the climate system brought about by the increasing greenhouse gases in the atmosphere. The accumulating greenhouse gases are enhancing radiative forces, which results in more energy from solar radiation being retained at the surface (Laidre et al., 2018). Consequently, the stratosphere above the Arctic is cooling down. Furthermore, changes in sea surface temperatures in the North Pacific, under the influence of changing climate patterns, contribute to these developments.

3 CONCLUSION

Human activities, such as oil exploration, polar tourism, and sea traffic, have significantly impacted the ecological environment of the polar regions. Indirectly or directly, these activities contribute to a significant decline in species, modifications in the global ecological environment, and severe damage to species diversity. Consequently, it becomes imperative to formulate targeted strategies to safeguard the polar environment and preserve the population of polar organisms. To ensure that polar organisms will not confront migration challenges, it is crucial to take immediate action.

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