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Impact of Climate Change on Biodiversity of Arctic Biome

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Abstract: Polar zones are identified as high species richness areas on our planet. In certain regions of the Arctic and Antarctic, air temperatures are observed to be increasing at rates over two times the global average; there are other direct human impacts on polar areas like contamination, over utilisation and advancement. Polar environments and the biodiversity they support are now reacting to this change and it is normal that much more significant effects will happen this century. Intensifying the threat to polar biodiversity is the certainty that numerous polar environments have restricted functional redundancy; in case of the disappearance of a solitary keystone species, they may possibly be exposed to descending impacts and complete biological system rebuilding. Fast environmental change influencing the polar areas will likewise have significant physical and biological outcomes for the remaining part of the planet since the ice-covered Arctic Ocean, the Antarctic landmass, and the globally notable Antarctic Circumpolar Current serves a critical job in controlling the Earth's environment and sea frameworks. This study concentrates on the contributing variables of environmental change, the impacts of environmental change on the Arctic biome, alongside the impacts of environmental change on the species of the Arctic biome. The outcomes are evident that biodiversity is being affected extremely by environmental change through its degradation of natural surroundings and adverse consequences on species inside.

Key words: Climate change; Biodiversity; Arctic.

Introduction

Changes occurring in the environment have turned into a debatable political and social issue in recent decades. Environmental changes are happening due to the rise in temperatures of our environment because of human activities. Environmental change occurs throughout an extensive stretch of time although the repercussions can be extreme and irreversible (Crowley, 2000). The quick anthropogenic environmental change that is being knowledgeable about the mid-twenty-first century is personally laced with the well-being and working of the biosphere. Environmental change is affecting biological systems through changes in mean conditions and in environment changeability, combined with other related changes like expanded ocean acidification and barometrical carbon dioxide fixations (Geyer et al., 2011). A few impacts of environmental change that have been noticed are loss of habitats, degradation of habitats, likely danger of species elimination, and effect on the aquatic ecosystem as well (Prakash, 2021; Arya, 2021). Envisaging climate change threatens the prey base of Arctic marine predators (Florko et al., 2021). Nowadays, rapid changes occurring in the environment have turned into a burning issue. This study aims to investigate the Arctic biome (Holland et al., 2012). The is because of the attributes of the biome and how they might be more vulnerable to environmental change than others. Due

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to the chilly environment and the species' dependence on the common habitat, the effects of environmental change might be more pervasive (Hoye et al., 2021).

Literature Review

Biodiversity is a major building block of the favours that ecosystems convey to human societies. Characteristically significant due to its commitment to the functioning of ecosystems, biodiversity is the variety of life at the genetic, species, and ecosystem levels of natural association – is difficult to recuperate whenever it is disintegrated (Anonymous Convention on Biological Diversity, Article-2, United Nations, 1992). With robust logical proof showing that human-instigated environmental change is happening, it is required to understand how species and sensitive biological systems may be impacted. There is almost no uncertainty among researchers that human-instigated GHGs emission has contributed fundamentally to environmental change. (Brown and Lomo lino, 1998; Holdridge, 1947). Several studies are performed in this regard. The variability of air temperature during the summer months and its impact on the number of vascular species in Arctic Canada (Rannie, 1986) has been evaluated. Plant community responses to simulated environmental change at a High Arctic polar semi-desert has been analysed (Webber et al., 2006). Population analysis of small mammals in cold regions has been evaluated (Yoccoz et al., 1999; Wookey, 2007). In the era of climate change, how the inter-connected food chain tactic can be considered for managing Arctic wildlife populations (Mellard et al., 2022) was studied thoroughly. The motivation behind this study is to assemble a superior comprehension of the impacts of environmental change on the polar biome's biodiversity, factors that add to environmental change, and what moves should be made to keep away from future adverse consequences on the biome's biodiversity. The question that this study attempts to answer is: What are the impacts of environmental change on the biodiversity of the Arctic biome?

Methods

To investigate this topic and examine the question thoroughly, these are the techniques utilised. The primary technique used to regulate the research was finding academic surveyed articles from various internet sites. The sort of insightful articles that were utilized were review papers on environmental change, the Arctic biome, and types of the Arctic biome, alongside impacts of environmental change on the Arctic biome. These articles were chosen considering the question and the themes covered were chosen to acquire a superior comprehension of the issue of environmental change and a top to bottom comprehension of the Arctic biome's biodiversity (counting the species possessing it and the scene of the biome).

Findings

To first comprehend the effect of environmental change on the Arctic biome it's essential to initially comprehend the effect of environmental change in general. Environmental change is brought about by many factors some of which incorporate the emission of GHGs and anthropogenic action. The emanation of GHGs incorporates gases like carbon dioxide, methane, nitrous oxide, and different gases. These gases add to what exactly is known as the Greenhouse Effect. The greenhouse effect occurs when these GHGs are delivered into the atmosphere which then, makes the planet's temperature increase (Crowley, 2000). This has been a significant contributor to the issue of global warming and has been expanding because of the activity done by humans around the world. This activity is mainly anthropogenic, implying that it has been fundamentally brought about by human activities. "Anthropogenic environmental change is one of the primary supporters of the worldwide loss of biodiversity (as characterized in the Convention on Biological Diversity), and it has made accelerated rates of species' declinations, extinctions and changes to environments" (Geyer et al., 2011). From this part, it's clear that human activity is a supporter of environmental change and consequently prompts the deficiency of biodiversity globally. Some human actions that can be related to environmental change is the rising degrees of contamination and as expressed before the discharge of GHGs. Anthropogenic activities like burning of fossil fuels, expanding populations, deforestation, accelerate emission of GHGs; which in turn causes global warming. Result of global warming has detrimental impact on biodiversity. To acquire a superior understanding of environmental changes, the biodiversity of the Arctic biome is investigated alongside the species that occupy it. One species that is explored thoroughly is the polar bear. With the pattern of temperature rising, it has established changes in the Arctic climate that were absent previously. Extended vegetation, modified biological systems, decreased spring-summer snow cover, and declining level of ocean ice (Holland et al., 2012) are the issues that appear to

be emerging because of the modifications brought about by global warming. Although these are environmental issues explicit to this biome it doesn't mean they won't spread somewhere else overtime, which is what this excerpt clarifies. Through the adjustment of conditions of the Arctic biome, it is clear biodiversity is being affected. The biodiversity of a biome alongside a biome's environment is delicate. Assuming one thing changes in a biological system the impact can adversely influence the biome's biodiversity. One issue expressed before that shows this impact on biodiversity is the declining level of sea ice in cold environments. This issue is pervasive for the survival of the Polar Bear species who dwell in this icy climate. The polar bears need a specific amount of ocean ice for a living since they rely on it for mating, feeding, and getting across the Arctic landscape. The diminishing degree of ocean ice is influencing the everyday activities of the polar bears. A portion of the impacts of this decline in ocean ice is expressed – "Decreasing amount of ocean ice level and length have been related with shifts toward more land-based denning, proof of nutritional pressure, diminished body condition, survival, reproduction, and body size for polar bears" (Hunter et al., 2010). Polar bears are well adapted to the environment they live in, yet because of environmental change, they are shifiting their habitats and well-being. It is additionally noticed that a few polar bears are confronting exceptionally phenomenal circumstances. For example, one perception expressed that polar bear predation attempts are prompting awkward deaths due to the absence of ocean ice. A few polar bears have unintentionally suffocated while attempting to chase prey since there was no ocean ice for them to get back. This is an immediate impact of environmental change and the degradation of the climate the species lives in. Another example are the Arctic foxes. The Arctic is, the region around the North Pole a sea encompassed by land. In the far north, the Arctic is mostly covered by snow and ice, while the southernmost part is covered by boreal timberlands. In the middle, there is a wide region of the tundra. The Arctic is home to a variety of plants, animals, and individuals who survive in the absolute outrageous conditions on earth and that are interestingly adjusted to such conditions. Climate change, contamination, and development in the use of assets are factors that put an expanding squeeze on delicate Arctic populaces and environments. The Arctic Fox is one of the top land hunters of the Arctic area. It is believed to be one of the primary vertebrates to have colonised Sweden and Finland following the last ice age. As the Arctic warms, the tundra habitat may gradually be supplanted by boreal woodland from the South. The woodland territory is unacceptable for Arctic Foxes. Red Foxes are better predators and trackers than Arctic Foxes. Northward infringement of Red Foxes into the Arctic Fox's area has as of now been archived and is probably going to proceed as the tundra warms. Arctic Foxes prey generally on lemmings and voles. Milder and more limited winters are anticipated to cause decreases in the routine of these rodents' population cycles, and also diminish their general numbers. These variables are probably going to cause a decrease in Arctic Fox numbers and range size. Arctic Foxes feature the effects of environmental change on the manners in which that species communicate with one another, both through rivalry and by means of changes in hunter prey connections.

Impact of Climate Change on Vegetational Cover of Arctic Biome

Biological processes in the Arctic are consistently hampered by temperature and permafrost. The soil from which the plants get their supplements for development is slim, and most plant species are hence restricted to the supplements accessible in this meagre layer of soil. An overall expansion in temperature in the Arctic because of global warming would build the disintegration of the enormous amounts of natural/organic materials that are frozen in arctic soil. Joined with the expanded concentration of carbon dioxide in the environment there would be an increment in the development of plant biomass because of expanded photosynthesis. Therefore, there would be an increment in the creation of arctic vegetation, and yet it is guessed that there would be a significant change in the blend of species in plant communities. Species that are uniquely adjusted to the cold environment will be suppressed by species with more extensive distribution, bringing about a general decrease in biodiversity. Such changes in the variety of species in plant communities could thus significantly affect the group of animals that live off or use the plants for different purposes. Most plant species living in the Arctic have adjusted to their natural surroundings, like propagation and growth, simply above or beneath 0°C. Genetic investigations show that when the last ice age ended, many plant species relocated from both Russia and Greenland. Cold plants are presented to incredibly low temperatures and experience an extremely short development season. To ensure reproduction, these plants must bloom and seeds should germinate as soon as possible before the beginning of ice in autumn.

Numerous species bloom buds during the previous year so they can begin blossoming when the conditions are right throughout the spring. In the hotter environment, the development season in the Arctic would be broadened. Spring would show up prior and pre-winter would begin later than now. This would significantly affect the phenological improvement of the plants. Phenology refers to the circumstance and duration of natural peculiarities. In the Arctic region, the length of the development season is a restricting variable for the spread of species. In the long run, phenological changes can contribute to changing the arrangement of plant communities. For animals that are dependent to follow the phenological advancement of plants, an adjustment of when plants bloom could be critical.

Discussion

By surveying different works on this issue, this study has distinguished elements of environmental change alongside the consequences for biodiversity in the Arctic Biome. The outcomes recount a convincing story of how anthropogenic action is making issues that hurt biodiversity in general. While inspecting a particular climate, it's obvious to see the adverse consequences as of now affecting everything. With the scene and conditions of the biome transforming it is having a reasonable adverse consequence on the species that dwell inside. These species are not used to the new conditions which are making them feed in an unexpected way, breed in an unexpected way, and change their practices. Assets are scarce for species they are adapted to, which is causing starvation, prompting a worry for expected elimination. The effect of environmental change is not only genuine and worrisome for the fate of biodiversity in the Arctic environment but for all other environments. The issue is turning out to be more far and wide and its impact will without a doubt be seen as increasingly greater over the long run.

Conclusion

Species are reacting to environmental change through changes in their morphology and behaviour, phenology, and geographic range shifts, and these progressions are intervened by plastic and evolutionary reactions. Responses by species and populations, joined with direct impacts of environmental change on biological systems, are bringing about broad changes in efficiencies, species associations, weakness to natural invasions, and other new properties. Simultaneously, these effects adjust the advantages and administrations that regular biological systems can give to society. Although not all effects are negative, even positive changes can require exorbitant cultural adjustments. Natural resource managers need proactive, adaptable strategies that consider verifiable and future viewpoints to limit costs over the long run. Numerous associations have began to investigate these methodologies; however, execution is not yet predominant or methodical across the globe. As individuals, we can play a fundamental part in preserving our biodiversity which will help in balancing the biological systems. For protection and restoration of environments, adaptation and mitigation mediations are required. In view of the study, it is clear that biodiversity overall inside the Arctic biome is adversely impacted. The states of the climate are changing and the species whose occupants are being affected. Species cannot behave in the natural way they were once doing like feeding, reproducing, and moving in their current surroundings. This is the situation at present occurring and over the long run, they will possibly deteriorate if preventive measures are not taken. Through the outflow of GHGs, it is clear that the reason is anthropogenic. With this said, it is vital that society investigates its activities and attempts to track down greater climate-friendly arrangements. Society should track down green choices to assist with diminishing emanations. Regardless of whether this is through observing cleaner transportation choices or enormous companies changing over to cleaner producers; steps should be taken to assist with safeguarding biodiversity. There is just one Earth and its biomes are delicate and should be regarded and safeguarded for our future generation. Environmental change is an immediate impact in light of the activities done by people, which is affecting the innocent species who should not be harmed by human activities.

References

ACIA, 2005. The Arctic climate impact assessment, Cambridge: Cambridge University Press.

Aanes, R., Sæther, B.-E., Smith, F.M., Cooper, E.J., Wookey, P.A. and Øritsland, N.A., 2002. The Arctic oscillation predicts effects of climate change in two trophic levels in a High-Arctic ecosystem. *Ecology Letters*, **5:** 445-453.

Arya, S., 2021. Freshwater biodiversity and conservation challenges: A review. *Int. Journal of Biological Innovations*, **3(1):** 74-78. https://doi.org/ 10.46505/IJBI.2021.3106\

Crowley, T., 2000. Causes of Climate Change over the past 1000 Years. *Science*, **289(5477):** 270-277.

Florko, K.R.N., et al., 2021. Predicting how climate change threatens the prey base of Arctic marine predators. *Ecology Letters*, **24(12):** 2563-2575.

Geyer, J., Kiefer I., Kreft, S., Chavaz, V., Salafsky, N., Jeltsch, F. and Ibisch, P., 2011. Classification of climate-change-induced stresses on biological diversity. *Conservation Biology*, **25(4):** 708-715.

Holland, M.M., Jahn, A., Bailey, D.A. and Blazey, B.A., 2012. Twenty-first-century arctic climate change in CCSM4. *Journal of Climate*, **25(8):** 2696–2710.

Høye, T.T., et al., 2021. Nonlinear trends in abundance and diversity and complex responses to climate change in Arctic arthropods. *Proceedings of the National Academy of Sciences*, **118(2):** e2002557117..

Hunter, C., Caswell, H., Runge, M., Regehr, E., Amstrup, S. and Stirling, I., 2010. Climate change threatens polar bear populations: A stochastic demographic analysis. *Ecology*, **91(10):** 2883-2897.

IPCC, 2007. "The physical science basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change; summary for policy makers." Geneva, Switzerland: WMO, UNEP.

Mellard, J.P., et al., 2022. Food web approach for managing Arctic wildlife populations in an era of rapid environmental change. *Climate Research*, **86:** 163-178.

Post, E., Forchhammer, M.C., Bret-Harte, M.S., Callaghan, T.V., Christensen, T.R., Elberling, B. and Fox, A.D., 2009. Ecological dynamics across the Arctic associated with recent climate change. *Science*, **325:** 1355-1358.

Prakash, S. and Srivastava, S., 2021. Impact of climate change on aquatic ecosystem and its biodiversity: An overview. *International Journal of Biological Innovations*, **1(2):** 60-65.

Rannie, W.F., 1986. Summer air-temperature and number of vascular species in Arctic Canada. *Arctic*, **39:** 133-137.

SWIPA, 2011. Snow, water, ice, permafrost in the Arctic (SWIPA). http://amap.no/swipa/

Turner, J.R. Bindschadler, P., Convey, G., di Prisco, E., Fahrbach, J., Gutt, D., Hodgson, P., Mayewski and Summerhayes, C. (eds.), 2009. "Antarctic climate change and the environment." Cambridge, UK: Scientific Committee on Antarctic Research.

Webber, P.J. and Wookey, P.A., 2006. Plant community responses to experimental warming across the tundra biome. *Proceedings of the National Academy of Sciences (PNAS)*, **103:** 1342-1346.

Wookey, P.A., 2007. Climate change and biodiversity in the Arctic—Nordic perspectives." *Polar Research*, **26(2):** 96-103.

Yoccoz, N.G. and Imms, R.A., 1999. Demography of small mammals in cold regions: the importance of environmental variability. *In:* A. Hofgaard et al. (eds.): Animal responses to global change in the North. *Ecological Bulletin*, **47:** 137-144.