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The Impact of Climate Change on Wildlife and Biodiversity

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ABSTRACT: Climate change is most definitely a severe issue for planet earth today. Its impacts are being felt around the world, from rising sea levels and more frequent and severe weather events to shifts in ecosystems and biodiversity loss. Among the many groups of living beings affected by climate change, wildlife is particularly vulnerable. Changes in temperature, rainfall patterns, and other environmental factors are affecting the habitats, migration patterns, and populations of many species. As a result, wildlife is facing numerous threats, from habitat loss and fragmentation to species decline and extinction.

KEYWORDS-climate, change, wildlife, biodiversity, impact

I. INTRODUCTION

The loss of habitat is one of the most significant impacts of climate change on wildlife. As temperatures rise and rainfall patterns shift, many ecosystems are undergoing profound changes, leading to the loss of habitats for many species. For example, as temperatures increase, polar ice caps are melting, leading to a loss of habitat for animals such as polar bears, walrus, and seals.[1,2,3]

The loss of habitat can have significant consequences for wildlife populations. Many species rely on specific habitats for food, shelter, and reproduction, and changes in these habitats can disrupt these essential activities. For example, if a species loses its habitat due to climate change, it may be forced to migrate to a new area where it may not be able to find adequate food or shelter.

Furthermore, habitat loss can also lead to habitat fragmentation, which occurs when a habitat is divided into smaller and more isolated fragments. This can make it more difficult for species to find adequate food, mates, and shelter, as well as making them more vulnerable to predation and other threats. Habitat fragmentation can also lead to genetic isolation, reducing genetic diversity and potentially increasing the risk of inbreeding depression.[4,5,6]

In addition to the direct impacts on wildlife populations, the loss of habitat can also have wider implications for ecosystems and the services they provide to humans. Ecosystems are complex networks of species and processes that provide essential services such as pollination, nutrient cycling, and water purification.

Changes in Migration Patterns

Climate change is causing significant changes in the migration patterns of many species, from birds and butterflies to marine mammals and fish. Migration is a complex and highly coordinated process that is driven by a range of environmental cues, such as changes in temperature, day length, and food availability. However, with climate change altering these cues, many species are struggling to adapt to the new conditions.

One of the most significant changes in migration patterns is a shift in timing. As temperature is warm, many species are migrating earlier in the year, as the cues that trigger migration occur earlier than they used to be. For example, some bird species arrive at their breeding grounds up to two weeks earlier than they did 30 years ago.[7,8,9]

In addition to changes in timing, climate change is also affecting the routes that many species take during migration. For example, warmer temperatures in the Arctic are opening new shipping routes, which are disrupting the migration patterns of many marine mammals, such as bowhead whales and narwhals.

Changes in migration patterns can also have wider ecological implications, as they can affect the interactions between species and the functioning of ecosystems.[10,11,12]

The Decline of Species Populations

The decline of species populations is one of the most alarming impacts of climate change on wildlife. As temperatures rise and habitats are lost or fragmented, many species are struggling to adapt, leading to declines in their populations. This can have significant ecological and socio-economic consequences, as it can disrupt ecological processes and reduce the services that ecosystems provide to humans.

The decline of species populations is occurring across a wide range of taxa, from insects and birds to mammals and marine species. For example, the iconic polar bear is facing a significant population decline, as the loss of sea ice is reducing its access to food and breeding grounds. Similarly, marine species such as corals, sea turtles, and fish are facing significant declines in population, as warmer and more acidic waters are disrupting their ability to grow and reproduce.[13,14,15]

The decline of species populations can have significant ecological impacts, as it can disrupt the interactions between species and the functioning of ecosystems.

The decline of species populations can also have significant socio-economic impacts, as it can reduce the services that ecosystems provide to humans. For example, declines in pollinators can lead to reduced agricultural productivity and increased food prices.

Solutions

While the impacts of climate change on wildlife are significant and complex, several solutions can help mitigate these impacts and ensure that wildlife can adapt to the changing conditions. Here are some potential solutions:

- Reducing greenhouse gas emissions: One of the most effective ways to address the impacts of climate change on wildlife is to reduce greenhouse gas emissions. This can be achieved through a range of measures, such as transitioning to renewable energy sources, improving energy efficiency, and promoting sustainable transportation options.[16,17,18]
- Protecting habitats: Another key solution is to protect the habitats of wildlife, such as by establishing protected areas and promoting sustainable land use practices. This can help ensure that species have access to the resources and habitats they need to survive and thrive.
- Restoring degraded habitats: In addition to protecting existing habitats, it is also important to restore degraded habitats, such as by replanting forests or restoring wetlands. This can help increase the resilience of ecosystems and improve the ability of species to adapt to changing conditions.
- Supporting conservation efforts: Supporting conservation efforts, such as those focused on protecting endangered species, can also help mitigate the impacts of climate change on wildlife. This can involve providing financial and technical support to conservation organizations.
- Adapting to changing conditions: Finally, it is important to promote adaptation measures that can help species cope with the changing conditions. This can include measures such as restoring connectivity between fragmented habitats, promoting the use of drought-resistant crops in agriculture, and implementing conservation breeding programs for endangered species.

In conclusion, the impacts of climate change on wildlife are profound and far-reaching. The loss of habitat, changes in migration patterns, and the decline of species populations are just a few of the many ways in which climate change is affecting wildlife around the world. These impacts have significant ecological and socio-economic consequences, including disruptions to ecosystem services and negative impacts on human livelihoods.[19,20,21]

However, despite the severity of these impacts, some solutions can help mitigate them and ensure that wildlife can adapt to changing conditions. By reducing greenhouse gas emissions, protecting and restoring habitats, supporting conservation efforts, and promoting adaptation measures, we can help ensure that wildlife can continue to thrive in a changing world.

Ultimately, addressing the impacts of climate change on wildlife is not just an environmental imperative, but also a moral one. Utilization of resources also gives us a responsibility towards the planet to make it better for other beings as well. By taking action to address climate change and protect the habitats and populations of wildlife, we can help ensure that this responsibility is fulfilled and that we leave a healthy and sustainable planet for generations to come.

II. DISCUSSION

Climate change affects both terrestrial^[1] and aquatic biomes^[2] causing significant effects on ecosystem functions and biodiversity^[3]. Climate change is affecting several key ecological processes and patterns that will have cascading impacts on wildlife and habitat^[4]. For example, sea-level rise, changes in the timing and duration of growing seasons, and changes in primary production are mainly driven by changes to global environmental variables (e.g., temperature and atmospheric CO₂). Climate-induced changes in the environment ultimately impact wildlife population abundance and distributions.^[22,23,24]

Global climate change will affect ecosystem functions and cycles such as nutrient, hydraulic, and carbon cycles, changing aspects of environmental conditions such as temperature, soil moisture, and precipitation^{[7][8]}. Wildlife species are adapted to their environments and changes to the environment and habitat conditions will mediate effects, either directly or indirectly, on species survival, fecundity and ultimately population persistence^{[9][10][11]}. The ability to adapt to changing habitat conditions as a result of climate change will differ across individual species and between populations. Some wildlife species may be more vulnerable to climate change than other species. Vulnerability is often linked to particular life-history traits (e.g., specialized habitat needs or limited dispersal abilities, see Pacifici et al. 2015^[12] for a review on species vulnerability to climate change) or genetic composition. For example, grassland birds may be more vulnerable to changing climate than forest birds as forests can buffer change more so than grasslands^[13]. Projected changes in the climate will generally have adverse effects of wildlife populations^[14], though there are some species coping with climate change or benefitting from environmental change. For example, American kestrels (*Falco sparverius*) have shifted their breeding phenology to earlier in the year and may now raise two broods of young within a breeding season^[15].

The Influence of Climate Change on Wildlife and Habitats

Climate change effects on wildlife include increases in disease and changes to pathogen distributions, patterns, and outbreaks in wildlife^{[16][17][18]}; changes in range distributions and shifts in latitudinal and elevational gradients; changes in phenology or the timing of life cycle events that may create phenological mismatches^[19]; and extinction or population reduction^[5]. The effects of climate change across a species' range will most likely not be homogenous, meaning it can vary substantially, especially if a species' range spans across different continents as exhibited by many migratory birds. Other changes in habitat include shifting vegetation (i.e., tree-lines are shifting to higher elevations), changes in nutrients in plants, earlier snowmelt and run-off, increase in invasive species, warming of streams and rivers, reduction or degradation of habitat (i.e., glacial melt), and an increase in large wildfires^[20] and droughts^[21].

Although climate change effects on wildlife often are linked to species-specific traits, there are general impacts associated with taxonomic groups^[4]. For fish it can affect reproduction^[6], growth, and recruitment^[22]. Cold-water fish such as inland North American species are highly affected with the warming of streams and rivers^[22]. Amphibians are highly sensitive to their environment and changes in temperature and moisture can affect development, range, abundance, and phenology^{[23][4][24]}. In reptiles, climate change effects can alter thermoregulation patterns, affect female reproduction and in some species, change sex ratios with increasing temperature^[4]. Furthermore, for many bird species the timing of migration and other phenological events are affected by climate change^[25]. Range shifts, growth size, and survival are linked to climate change for mammals^[4]. Arctic marine mammals are closely linked to sea ice dynamics and a changing climate will affect these dynamics^[26]. Therefore, it is increasingly important for conservation and management plans to consider the effects of climate change on wildlife and habitat for the geographic location^[27].

III. RESULTS

Biological diversity — or biodiversity — is the variety of life on Earth, in all its forms, from genes and bacteria to entire ecosystems such as forests or coral reefs. The biodiversity we see today is the result of 4.5 billion years of evolution, increasingly influenced by humans.[25,26]

Biodiversity forms the web of life that we depend on for so many things – food, water, medicine, a stable climate, economic growth, among others. Over half of global GDP is dependent on nature. More than 1 billion people rely on forests for their livelihoods. And land and the ocean absorb more than half of all carbon emissions.

But nature is in crisis. Up to one million species are threatened with extinction, many within decades. Irreplaceable ecosystems like parts of the Amazon rainforest are turning from carbon sinks into carbon sources due to deforestation. And 85 per cent of wetlands, such as salt marshes and mangrove swamps which absorb large amounts of carbon, have disappeared.

The main driver of biodiversity loss remains humans' use of land – primarily for food production. Human activity has already altered over 70 per cent of all ice-free land. When land is converted for agriculture, some animal and plant species may lose their habitat and face extinction.

But climate change is playing an increasingly important role in the decline of biodiversity. Climate change has altered marine, terrestrial, and freshwater ecosystems around the world. It has caused the loss of local species, increased diseases, and driven mass mortality of plants and animals, resulting in the first climate-driven extinctions.

On land, higher temperatures have forced animals and plants to move to higher elevations or higher latitudes, many moving towards the Earth's poles, with far-reaching consequences for ecosystems. The risk of species extinction increases with every degree of warming.

In the ocean, rising temperatures increase the risk of irreversible loss of marine and coastal ecosystems. Live coral reefs, for instance, have nearly halved in the past 150 years, and further warming threatens to destroy almost all remaining reefs.

Overall, climate change affects the health of ecosystems, influencing shifts in the distribution of plants, viruses, animals, and even human settlements. This can create increased opportunities for animals to spread diseases and for viruses to spill over to humans. Human health can also be affected by reduced ecosystem services, such as the loss of food, medicine and livelihoods provided by nature.

When human activities produce greenhouse gases, around half of the emissions remain in the atmosphere, while the other half is absorbed by the land and ocean. These ecosystems – and the biodiversity they contain – are natural carbon sinks, providing so-called nature-based solutions to climate change.

Protecting, managing, and restoring forests, for example, offers roughly two-thirds of the total mitigation potential of all nature-based solutions. Despite massive and ongoing losses, forests still cover more than 30 per cent of the planet's land.

Peatlands – wetlands such as marshes and swamps – cover only 3 per cent of the world's land, but they store twice as much carbon as all the forests. Preserving and restoring peatlands means keeping them wet so the carbon doesn't oxidize and float off into the atmosphere.

Ocean habitats such as seagrasses and mangroves can also sequester carbon dioxide from the atmosphere at rates up to four times higher than terrestrial forests can. Their ability to capture and store carbon make mangroves highly valuable in the fight against climate change.

Conserving and restoring natural spaces, both on land and in the water, is essential for limiting carbon emissions and adapting to an already changing climate. About one-third of the greenhouse gas emissions reductions needed in the next decade could be achieved by improving nature's ability to absorb emissions.

Climate change and biodiversity loss (as well as pollution) are part of an interlinked triple planetary crisis the world is facing today. They need to be tackled together if we are to advance the Sustainable Development Goals and secure a viable future on this planet.[27]

IV. CONCLUSION

Governments deal with climate change and biodiversity through two different international agreements – the UN Framework Convention on Climate Change (UNFCCC) and the UN Convention on Biological Diversity (CBD), both established at the 1992 Rio Earth Summit.

Similar to the historic Paris Agreement made in 2015 under the UNFCCC, parties to the Biodiversity Convention in December 2022 adopted an agreement for nature, known as the Kunming-Montreal Global Biodiversity Framework, which succeeds the Aichi Biodiversity Targets adopted in 2010.

The framework includes wide-ranging steps to tackle the causes of biodiversity loss worldwide, including climate change and pollution.

“An ambitious and effective post-2020 global biodiversity framework, with clear targets and benchmarks, can put nature and people back on track,” the UN Secretary-General said, adding that, “this framework should work in synergy with the Paris Agreement on climate change and other multilateral agreements on forests, desertification and oceans.”

In December 2022, governments met in Montreal, Canada to agree on the new framework to secure an ambitious and transformative global plan to set humanity on a path to living in harmony with nature.

“Delivering on the framework will contribute to the climate agenda, while full delivery of the Paris Agreement is needed to allow the framework to succeed,” said Inger Andersen, the head of the UN Environment Programme. “We can’t work in isolation if we are to end the triple planetary crises.”[27]

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