A Review of Global Warming Effect on Aquatic Flora and Fauna

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ABSTRACT

Global warming presents a significant threat to aquatic ecosystems, impacting both flora and fauna in various ways. Experimental studies and predictions highlight the potential for substantial biodiversity losses, particularly in freshwater ecosystems spanning mountain streams, river basins, and lowland rivers. The combined effects of warming and contaminants can produce complex interactions, further complicating conservation efforts. This phenomenon extends to tropical wetlands, where the impacts on fisheries and aquatic biodiversity remain inadequately understood. Anthropogenic greenhouse gas emissions exacerbate these effects, contributing to ozone layer depletion and disrupting marine habitats. The interconnectedness of Earth's ecosystems amplifies the consequences, potentially leading to species extinction by the end of the century. Mitigation and adaptation strategies are essential, involving conservation, restoration, and reduction of non-climate stressors.

INTRODUCTION

Global warming significantly impacts aquatic flora and fauna, with experimental studies indicating that projected temperature increases can lead to significant biodiversity losses (Progênio *et al*., 2023). These impacts extend to freshwater ecosystems worldwide, including mountain streams, river basins, and lowland rivers (Carosi, 2022). Warming combined with contaminants can produce additive or non-additive interactive effects, influenced by factors such as taxa, exposure level, and duration (Dinh *et al*., 2022). Climate change also affects tropical wetlands, where impacts on fisheries, freshwater ecosystems, and aquatic biodiversity remain under-documented (Sharma, 2023). The release of greenhouse gases, from both natural and anthropogenic sources, contributes to ozone layer depletion, affecting fish species, coral reefs, and breeding habitats (Iyiola *et al*., 2022).

Effects on Aquatic Flora

Global warming significantly impacts aquatic flora, leading to crop yield reductions, and increased risks of heat waves and flooding, affecting food crops and heat-vulnerable plants (Progênio *et al*., 2023). It exacerbates the decline of submerged aquatic plant communities crucial for shallow aquatic ecosystems (Ansley *et al*., 2022). Rising water temperatures can trigger the mass development of species like *Ludwigia hexapetala*, altering the structure and composition of aquatic plant communities (Carosi, 2022). While warming within thermal tolerance ranges can boost plant growth, its effects on stoichiometry and palatability vary with environmental nutrient conditions (Gillard *et al*., 2021). Moreover, warming can heighten herbivory and grazing pressure on aquatic plants, compounded by eutrophication (Zhang, 2018). Overall, global warming's diverse impacts on aquatic flora have implications for ecosystem functioning and biodiversity conservation.

Effects on Aquatic Fauna

Global warming significantly impacts aquatic fauna. Experimental studies on freshwater communities revealed changes in density, alpha diversity, and beta diversity due to warming (Deutsch *et al*., 2002). Predictions suggest ocean warming will reduce marine animal species' body sizes, attributed to oxygen limitations (Ariza *et al*., 2022). Under high-emissions scenarios, global pelagic fauna faces a significant biomass loss, estimated at 3-22% in low and mid-latitudes (Dinh *et al*., 2022). Climate change alters the marine environment, leading to shifts in species range, growth reduction, sub-optimal behaviors, reduced immune competence, and increased disease virulence (Daniel *et al*., 2020). Riverine aquatic ecosystems suffer from habitat destruction, water level changes, and fish stock reduction due to climate change (Telat and Irfan, 2018).

Interconnected Impacts

Global warming and anthropogenic factors like pollution, transportation, and trade negatively impact aquatic populations and ecosystems, potentially leading to species extinction by 2080 or 2100 (Agrawal, 2011). The interconnectedness of Earth's ecosystems means temperature changes can trigger chain reactions, disrupting plant growth, reducing plant-eating animals, and affecting predator numbers (Deutsch *et al*., 2022). Predictions indicate ocean warming will shrink marine animal body sizes due to oxygen limitations (Murthy, 2022). The fisheries and aquaculture sector, vital for millions, already feel the effects of climate change. Adaptation and mitigation efforts must prioritize the human impacts on fisheries and aquaculture livelihoods (Progênio *et al*., 2023).

Case Studies and Examples

Global warming significantly impacts aquatic flora and fauna. Experimental studies demonstrate losses in aquatic biodiversity due to warming in freshwater ecosystems (Carosi, 2022). Climate change affects various biotic components like fish, benthic macroinvertebrates, and zooplankton across global freshwater ecosystems (Dinh *et al*., 2022). Warming combined with contaminants can yield additive or non-additive effects, influenced by taxa, life stage, exposure level, and duration (Fernández *et al*., 2022). In marine environments, climate change alters species distribution and behavior, reduces growth and immune competence, and increases disease virulence due to higher water temperatures (Daniel *et al*., 2020). These cases underscore the necessity for comprehensive assessments and management strategies to conserve aquatic biodiversity in the face of global warming.

Human Implications

Climate change, stemming from both natural and anthropogenic sources like greenhouse gas emissions, contributes to the degradation of shallow aquatic ecosystems and the decline of submerged aquatic plant communities (Zhang, 2018). Elevated levels of greenhouse gases, particularly carbon dioxide, lead to its dissolution in seawater, affecting crucial oceanic ecosystems (Ebru *et al*., 2009). Furthermore, global climate change disrupts plant and animal distribution, alters habitat conditions, and impacts ecosystem productivity and diversity in aquatic ecosystems (Khan and Patel, 2021). To address these challenges, it is imperative to reduce carbon dioxide emissions, implement science-based management of aquatic resources, and curb the spread of exotic species (Minhas *et al*., 2022).

Mitigation and Adaptation Strategies

Mitigation and adaptation strategies for the effects of global warming on aquatic flora and fauna involve a combination of conservation and restoration approaches. These include protecting and restoring biodiversity, managing ecosystems, and reducing non-climate stressors. Shifting the conservation focus to regional networks and co-managing territory and resources can be effective (Sharma, 2023). Additionally, reducing non-climate stressors, selecting dynamic species, and expanding the protection of wild seascapes can improve biodiversity conservation (Minhas, 2022). In agriculture, techniques like in situ and ex-situ conservation, discouraging monoculture, and promoting landrace cropping enhances adaptability to climate change (Thrupthi and Devi prasad, 2023). Nature-based solutions such as carbon sequestration, disaster risk reduction, and creating green facilities in cities support biodiversity and ecosystem services (Mukherjee *et al*., 2023). Mitigation strategies also involve shifting to greener energy sources, wastewater treatment, and reducing reliance on chemical fertilizers (Iyiola *et al*., 2022). These efforts help mitigate climate change impacts on aquatic ecosystems, ensuring the sustainability of freshwater biodiversity and fisheries.

CONCLUSION

Global warming profoundly impacts aquatic ecosystems, leading to significant biodiversity loss in both flora and fauna. It affects freshwater ecosystems worldwide, exacerbating the decline of critical plant communities and altering the structure of aquatic habitats. Changes in temperature and environmental conditions disrupt the distribution, behavior, and health of aquatic fauna, with potential consequences for marine and freshwater biodiversity. The interconnectedness of Earth's ecosystems, coupled with anthropogenic factors like

pollution and habitat destruction, further exacerbates these impacts, potentially leading to species extinction by the end of the century. To address these challenges, comprehensive mitigation and adaptation strategies are imperative, including conservation efforts, reducing non-climate stressors, and promoting sustainable resource management practices. Effective action is essential to ensure the long-term sustainability of aquatic biodiversity and fisheries in the face of global warming.

REFERENCES

Agrawal, A. (2011). Effect of global warming on climate change, flora and fauna. Journal of Ecophysiology and Occupational Health, 11(3/4), 161.

Ansley, Koh., Yi, Ming, Quek., Kenneth, Yang, Teck, Lim. (2022). Simulating Effects of Global Warming Temperatures on Ipomoea Aquatica (Kangkong). APD trove journal, doi: 10.30943/trove/2022/28032022

Ariza, A., Lengaigne, M., Menkes, C., Lebourges-Dhaussy, A., Receveur, A., Gorgues, T., ... & Bertrand, A. (2022). Global decline of pelagic fauna in a warmer ocean. Nature Climate Change, 12(10), 928-934.

Carosi, A. (2022). Effects of Climate Change on Freshwater Biodiversity. Water, 14(23), 3953.

Daniel, Assan., Felix, Kofi, Agbeko, Kuebutornye., Umar, Farouk, Mustapha., Huapu, Chen., Guangli, Li. (2020). Effects of Climate Change on Marine Organisms. American Journal of Climate Change, doi: 10.4236/AJCC.2020.93013

Deutsch, C., Penn, J. L., Verberk, W. C., Inomura, K., Endress, M. G., & Payne, J. L. (2022). Impact of warming on aquatic body sizes explained by metabolic scaling from microbes to macrofauna. Proceedings of the National Academy of Sciences, 119(28), e2201345119.

Dinh, K. V., Konestabo, H. S., Borgå, K., Hylland, K., Macaulay, S. J., Jackson, M. C., ... & Stoks, R. (2022). Interactive effects of warming and pollutants on marine and freshwater invertebrates. Current Pollution Reports, 8(4), 341-359.

Ebru, Özdemir., Ahmet, Altindağ. (2009). The impact of global warming on aquatic life. doi:10.1501/CSAUM_ 0000000002

Fernández, I., T Mozanzadeh, M., Hao, Y., & Gisbert, E. (2022). Physiological Impacts of Global Warming in Aquatic Organisms. Frontiers in physiology, 13, 914912.

Gillard, M. B., Caudal, J. P., Deleu, C., & Thiébaut, G. (2021). Heterogeneous Impact of Water Warming on Exotic and Native Submerged and Emergent Plants in Outdoor Mesocosms. Plants, 10(7), 1324.

Iyiola, A. O., Asiedu, B., Oyewole, E. O., & Akinrinade, A. J. (2022). Impacts of Climate Change on Aquatic Biodiversity in Africa. In Biodiversity in Africa: Potentials, Threats and Conservation (pp. 369-394). Singapore: Springer Nature Singapore.

Khan, R., & Patel, V. (2021). The Influence of global climate change on freshwater ecosystem. In Water Conservation in the Era of Global Climate Change (pp. 347-366). Elsevier.

Minhas, A. P., Puri, S., & Sobti, R. C. (2022). Resilience Strategies for Biodiversity Conservation. In Biodiversity (pp. 15-22). CRC Press.

Mukherjee, S., Rizvi, S. S., Biswas, G., Paswan, A. K., Vaiphei, S. P., Warsi, T., & Mitran, T. (2023). Aquatic Eco-systems Under Influence of Climate Change and Anthropogenic Activities: Potential Threats and Its Mitigation Strategies. Hydrogeochemistry of Aquatic Ecosystems, 307-331.

Murthy, H. S. (2022). Impact of Climate Change and Global Warming on Aquaculture and Fisheries: An Insight. In Impact of Climate Change on Hydrological Cycle, Ecosystem, Fisheries and Food Security (pp. 163-170). CRC Press.

Progênio, M., Antiqueira, P. A., Oliveira, F. R., Meira, B. R., Lansac-Tôha, F. M., Rodrigues, L. C., ... & Velho, L. F. (2023). Effects of warming on the structure of aquatic communities in tropical bromeliad microecosystems. Ecology and Evolution, 13(2), e9824.

Sharma, S. K. (2023). Impact of Global Warming on Changing Pattern of Biodiversity and Fish Production in Inland Open Waters. In Outlook of Climate Change and Fish Nutrition (pp. 49-61). Singapore: Springer Nature Singapore.

Telat, Y., & Irfan, A. (2018). EFFECTS OF GLOBAL WARMING AND ANTHROPOGENIC FACTORS ON AQUATIC LIFE. In Арктические берега: путь к устойчивости (pp. 157-160).

Thrupthi, G. N., & Devi Prasad, A. G. (2023). Threats on Aquatic Ecosystem-Mitigation and Conservation Strategies. J Aquac Fisheries, 7(52), 2-6.

Zhang, P. (2018). Trophic interactions in warming waters: aquatic plant-consumer interactions under climate change (Doctoral dissertation, Netherlands Institute of Ecology).