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Impact of Climate Change on Aquatic Life: A general review

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ABSTRACT

Aquatic ecosystems are being significantly impacted by climate change, which has a crucial effect on aquatic life. Increased water temperatures are causing migratory patterns to be disrupted, breeding habits to change and species distributions to be altered. Invasive animals and diseases are spreading more easily due to warmer waters, endangering local populations even more. This can have cascading effects on entire food chains and ecosystems, leading to reduced fisheries and economic impacts on communities that depend on them. Climate change is altering the chemical composition of water bodies, leading to increased acidification and decreased oxygen levels, further stressing aquatic life. These changes have devastating and long-lasting consequences for the health of aquatic ecosystems and the many species that depend on them.

Keywords: Aquatic life, Climate change, Devastating effects

Introduction

Any change in the average daily weather pattern over a long period of time (usually decades or longer) brought on by either human activity or natural variability is referred to as climate change [1]. One of the main causes of environmental changes that have a significant negative impact on biodiversity and ecosystem capacity and functions is climate change [2]. In aquatic ecosystems, climate change may lead to increases in water temperature, acidity and deoxygenation. If compared to last three decades, the temperature of the water climbed two times faster. Ocean acidity has risen 30% since preindustrial times in contrast to dissolved oxygen levels have decreased by almost 2% since the mid-20th century. Additionally, as ocean temperatures increase heatwaves occur more frequently and last much longer. These changes impact species and biodiversity in aquatic environments, as well as productivity and food web structures [3]. Water and air temperatures fluctuate simultaneously, making aquatic life especially susceptible to the effects of climate change.

Impact of climate change on aquatic life

Freshwater systems

Freshwater ecosystems are especially susceptible to the effects of climate change. The trophic level, size and depth of the lake all influence how susceptible this system is to climate change. The drastic effects of climate change have caused changes in the distribution and shapes of the freshwater lake system. The dynamical shift in precipitation, evaporation and runoff has these features. Climate change encourages long-term increases in production of fish because it causes the rate at which invertebrate prey is produced to grow exponentially with temperature. The rates multiply two to four times for every 10°C rise in temperature [10]. One of the most important aspects of evaluating freshwater species' resistance to climate change is their ability to migrate.

Marine system

Climate change greatly affects marine fish production. The changing climate is causing many changes in the ocean, including increasing sea levels, melting polar ice, temperature rises, changes to the ocean current system and acidity of seawater. In the following decades, it is predicted that the temperature of the Indian Ocean would rise by 1-3°C [9]. Because of the increasing acidity of the ocean, marine organisms like oysters, shrimp, and corals would not be able to calcify and form their outer layer or shell. Consequently, the entire marine food web is impacted when gaps in the marine food chain occur.

Global marine biodiversity

Environmental factors have a significant impact on marine species richness [14]. Ocean warming may cause changes in marine species, especially in their latitudinal and depth ranges. The metabolisms of organisms change in warmer water. For instance, the need for oxygen may rise in warmer water. As observed with many fish species, it can force mobile species to migrate and alter their range of distribution, changing food webs and ecosystem dynamics. These changes could have more significant consequences, including invasions, localized extinction, and changes to their biogeographic pattern [15]. This can result in a notable shift in species richness, which is the primary origin of the disturbances to marine biodiversity and the environment.

Temperature

All aquatic life is poikilothermic. In the following decades, it is predicted that the temperature of the Indian Ocean would rise by 1-3°C [9]. As a result, they react quite quickly to temperature variations in their outside living space. When the outside temperature climbs above their threshold, these organisms will move to a place where their internal mechanism allows them to restore their internal balance. As a result, the water body's cooler zones will see a quick movement. It is possible that this migrating phenomenon may cut the tropics' catch potential by 40%. One of the main effects of climate change is that hiring practices are significantly impacted by rising temperatures [4]. Fish that live in water with higher temperatures will not grow as large or reach their maximum size since the increased temperature will speed up their metabolism [6]. Fish species extinction would be observed locally, particularly in freshwater and diadromous species. Coral bleaching brought on by the rising temperatures would have a catastrophic effect on reef fisheries [7].

Sea level rise

The habitats of over 70% of coastal species, including 30% of fish species and 50% of saltwater fish species, are predicted to be in danger due to sea level rise of up to one meter by 2100 [19]. Mangrove forests (20%), seagrass beds (70%), coral reefs (5%), and seagrass beds (70%) can all decline up to 80% as a result, leading to the loss of important spawning and nursery sites. Furthermore, because of ocean acidification—which becomes worse by sea level rise—marine species may see growth reductions of up to 40% and death increases of up to 20%. These effects could result in up to $1 trillion in economic losses by 2050 because of the loss of coastal protection, tourism, and fisheries, among other far-reaching effects.

Ocean deoxygenation

The decrease in oxygen in saltwater is a result of ocean warming. It occurs because of warmer waters having less dissolved oxygen. This happens together with greater stratification, altered ventilation, and increased oxygen consumption by various organisms. Hypoxic or anoxic conditions can spread due to deoxygenation, particularly when coupled with increased nutrient content from intensive farming runoff or increasing precipitation. Under these circumstances, many species will become extinct, particularly sessile (non-mobile) aquatic animals. Since the 1950s, the quantity of hypoxic coastal areas has increased fourfold. The oxygen level of the world's oceans is expected to drop by 3-4% by the year 2100 [16].

Food web

Climate change is still influencing food webs; under high-emission scenarios, phytoplankton is expected to decline by 45% by 2100, or 2.5% from the previous decade [22]. It is projected that zooplankton declined by 3.5% over the past ten years, with warmer-water species being favored by changes in the composition of the communities [23]. Fish populations in the North Atlantic are predicted to decline by 25–35% by 2050, with a 5-7% decline in the last ten years, based on high-emission conditions [24]. Marine mammals are also affected; their distribution and behavior have changed in response to fluctuating prey supply, and some populations have fallen by 12-22% every decade [25]. These changes have a major effect on the resilience and general health of marine ecosystems.

Primary productivity

The availability of nutrients in the water body is determined by temperature and light levels, which in turn impacts primary productivity. Because of the uncertainty of the climate, less precipitation would result in less runoff from the land, starving mangroves and wetlands and harming the local fisheries. In certain other locations, heightened precipitation from extreme weather events, such as flooding, caused a sharp rise in the water body's nitrogen level, leading to eutrophication and the washout of fertilizer, which resulted in the introduction of dangerous algal blooms, or red tides, into the water bodies.

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Lower latitudes are the site to most small-scale fisheries, which are particularly affected by climate change and experience a decline in the primary productivity of fisheries sector [8].

Coral reef

There is currently a serious threat to coral reefs. Rising temperatures and increased acidity are the main causes. As acidity increases, the pH of the water decreases, resulting in a reduction of aragonite saturation, which could retard coral calcification [11]. In the long run, the acidity of the world's oceans poses a major threat to coral reefs. Aragonite saturation happens in deep cold-water corals at depths of 90 to 150 meters [12]. The impacts of acidification are evident in these corals found in deep cold water. Reef fish biodiversity suffers when coral becomes less abundant due to adverse consequences of climate change. Coastal fisheries are negatively impacted by bleaching events and climate change [13, 26]. When coral reefs are damaged, long-term consequences happen for the species that depend on them for habitat and nutrition.

Crustaceans

Sea water becomes more acidic due to a decrease in pH brought on by a rise in CO_2, one of the factors contributing to climate change. Aragonite, a typical type of calcium carbonate that dissolves in acidic seawater, makes up the exterior skeletons of crustaceans. The entire marine environment may shift if these tiny crustaceans, which are at the base of the food chain, become extinct [17]. The disappearance of sea ice is another detrimental effect that climate change has had on crustaceans. Since last 3 decades, the average number of small crustaceans has dropped by 80%. A loss of small crustaceans, which provides food for a variety of marine mammals and other organisms, might lead to the disintegration of the South Ocean's food chain [18].

Fisheries

Ocean warming is altering the distribution and abundance of fish and shellfish populations. The warming of the North Sea has led to a 30% decline in cod stocks since the 1980s. Changes in temperature and day length are affecting the reproduction and growth cycles of species. A study found that a 1°C increase in temperature can lead to a 10-20% decline in fish growth rates [17]. Ocean acidification and sea-level rise are destroying critical habitats like coral reefs and mangroves. It's estimated that 30% of coral reefs have already been destroyed, and another 30% are at high risk of destruction [18]. Thermal stress is increasing the susceptibility of species to diseases and parasites. It is found that a 2°C increase in temperature can lead to a 50% increase in disease prevalence in fish populations [19].

Conclusion

The fundamental components of both freshwater and marine ecosystems are in danger due to the clear disastrous consequences of climate change in aquatic life. Rising temperatures, ocean acidification, and altered precipitation patterns have disrupted key biological equilibrium, putting many species at risk of extinction. Warmer waters alter fish distributions, breeding habits, and migration patterns, while habitat degradation and coral bleaching are causing damage on essential spawning and nursery sites. Climate change is increasing the risk to vulnerable populations by facilitating the spread of invasive species, diseases, and pollutants. Urgent action is needed to lessen these effects, protect vital habitats, and preserve the integrity of aquatic ecosystems to prevent catastrophic devastation to the planet's vital aquatic life support systems.

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