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Impacts of climate change on fish performance

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Abstract

Fishes play a complex and vital role as a source of protein and economic prosperity in developing countries which depend on traditional or commercial fishing. On the other hand, fishing is considered a source of income for most of the poor families which live in coastal areas. Although, there is a growing recognition that climate change leads to higher water temperatures and increased salinity, oxygen content, ocean acidification and impact on fishes in marine and freshwater ecosystems. These effects result in entering the non-native fish species to aquatic systems. Climate change also influences on native fishes by loss their habitats by their extreme competitive with non-native fishes which adapted with climate change. Moreover, transmission rates of parasites and pathogens between fishes are possible to rise with increasing salinity and temperature, which cause to the death of fish. However, the effect of climate change is continuing until the moment and more complex.

Keywords: Climate change, effect, marine, freshwater, fishes

1. Introduction

Fishing is one of the oldest human activities that has received great attention. Then, in the beginning of the 19th century, with the use of steam trawlers in England, fisheries manufacturing began. Then it was replaced by diesel engines after the First World War ^[1, 2]. Currently, fleets fish in all of the world's oceans and their number are estimated at 3.2 million fishing vessels ^[2]. Here lies the importance of fishing, so it will be vitally important to conserve marine resources from climate change more sustainably ^[3].

All aquatic ecosystems are being affected by climate changes, including natural systems. While, many changes which occur on water quality and thermal structure, rivers and warming of lakes affect on hydrological systems and also predators high in the food chain ^[4,5]. Climate change effects on fish in aquatic systems including marine waters and rivers, coastal estuarine habitats ^[6, 7].

According to the reports of ^[8-10] that climate changes on fish species in marine ecosystems have already been documented throughout the world. Climate change may lead to fishes extinctions in semi-enclosed seas and others aquatic regions. Also, can influence their fecundity, therefore decrease in egg number and size in many species ^[11,12] and probably affect on the abundance, distribution of fisheries catches, and consequently fishing operations and the effectiveness of fisheries management measures ^[13, 14].

2. Stress of climate changes on population dynamics

Current and future climate change could have a significant impact on fish stock ^[13,14,15]. The animal species are distributed in areas where the environmental conditions are favorable to their physiology, in particular through tolerance thresholds relative to the temperature. As a result of climate change, species can change their distribution to track climate change, provided that species' dispersal capabilities and resource availability allow for these shifts ^[16-18]. In recent decades, several studies have shown high distribution shifts in response to a rapid warming climate ^[19, 20]. These range changes have affected a wide range of taxonomic groups and geographic areas. It has also been shown that fish in the North Sea have changed their vertical distribution and are present at deeper depths than in the early 1980s ^[21].

Marine fisheries face a several threats include overfishing, pollution and anthropogenic. Nowadays, they are still face to face with climate change threats ^[22, 23].

Species respond individually to climatic disturbances, whether at the physiological or distributional level, it is clear that spatial and temporal associations between species of the same trophic level (competition) or adjacent trophic levels (predation) can be disturbed.

Each species of fish is able to tolerate a certain range of temperatures allowing the species to optimize its physiological, ecological and reproductive performances [24, 25].

Generally, warming of the water induces an increase in metabolic activity until the lethal temperature is reached [25]. This forces the fish to select habitats that are thermally favorable to them. Thermal tolerances therefore govern both local and biogeographic distributions of species [26-29] illustrated in (fig. 1).

In a previous study which tackled the assessment the influence of environmental factors on the fish distribution and

abundance in Argentina. The results showed that the fish composition and distribution was influenced by climate change in which the abundance of some fish species increased as water temperature increased during summer and autumn while others species recorded highest abundance with high rainfall [30].

In northern-latitude lakes global climate change led to warmer water temperatures which allowed non-native warm water fish to thrive in lakes. On the other hand, these thermal changes have created competing for food with native cold water fish species. Consequently, this may lead to loss of fishes [31, 32].

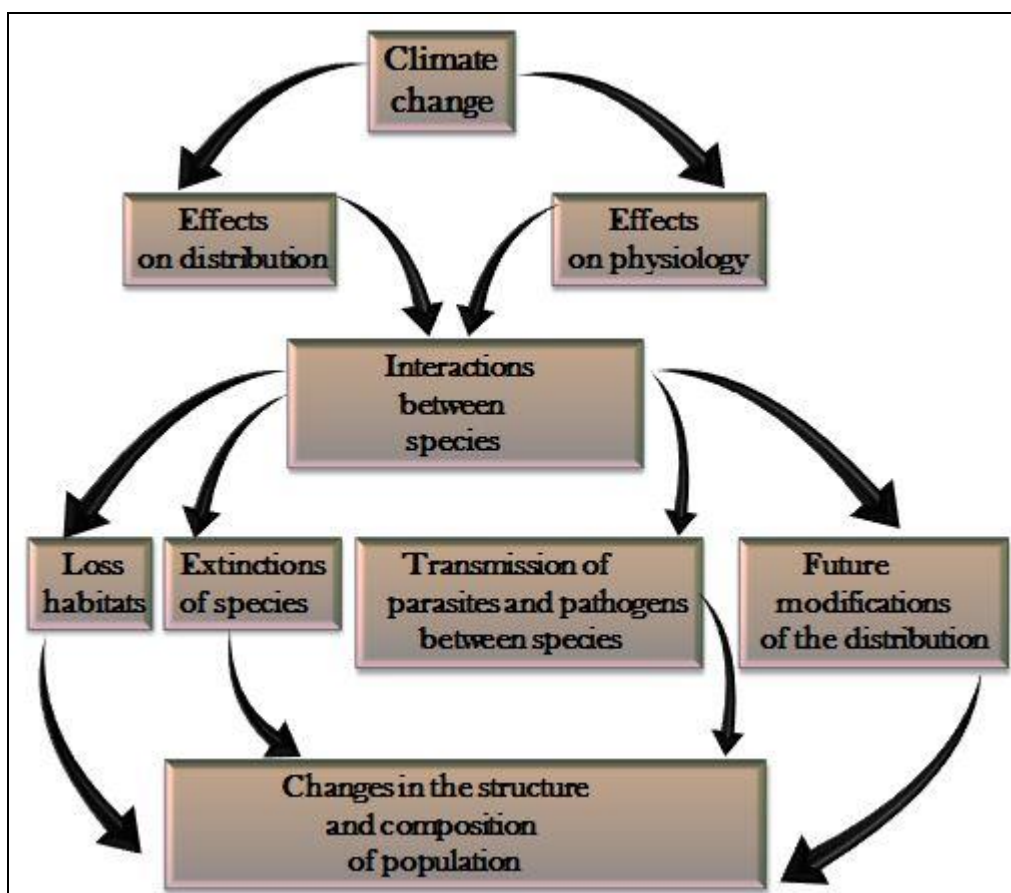


Fig 1: Potential effects of climate change on species distribution

3. Temperature impacts on fish performance

Fishes are ectothermic animals whose body heat comes from the outside environment. Their body is unable to produce heat and physiologically regulate their body temperature. Water temperature influences fish metabolism [33, 34]. Also, fish physiology is also affected by increase temperature which considered an abiotic factor [35]. They even lead to decrease fish body size. On the other hand, each degree of warming leads to decrease of fish body size around 6-22% according to [35, 36]. There are also several effects on fish result of increased temperature, even if the temperature was relatively simple [37]. Climate change impacts fish either directly or indirectly.

Direct impacts affect physiology and behaviour, altering growth, reproductive capacity, disease spread, mortality and distribution. Indirect impacts are related with changes in productivity and in the structure, migration and composition of the marine ecosystems on which fish depend [38-40] shown in (fig. 2).

Authors [41-43] in previously reports reported that temperature changes have profound effects on the performance of fish, including greatly spread of aquatic invasive species non-native, also transmission of parasites and pathogens between species [29].

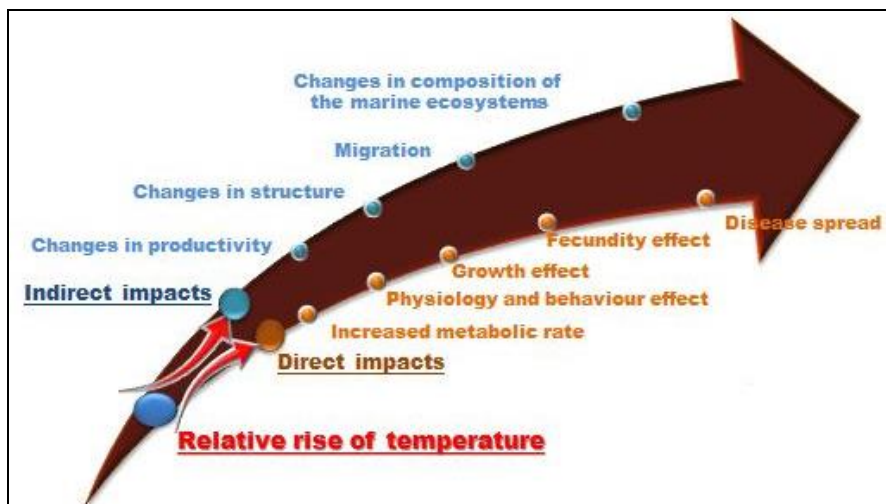


Fig 2: Temperature effect on fish performance

4. Climate change impacts of fish growth

Fig. 3 illustrates the understanding the changes in growth rate and size fish and hence their impacts on fish communities in wild and marine environments, it requires to know environmental factors which are affected by climate change [44].

Climate change influences on density of fish communities, through effects on ocean systems and hydrological [45]. Hence, density may effects on fish growth through relationships between predator and prey and increased competition according to [46-48] reported that the growth in length was influenced by temperature, where was the fastest growth at optimal temperatures and the slowest growth when temperatures were coldest or hottest and was negative relationship with density.

Climate change will have a profound impact on the non-spread of fish in aquatic ecosystems through temperature control. In addition, increased temperature may stress metabolic rates leading to reduced growth; it was evident on the Common carp fish [49].

In a previous study that was about the effects of water temperature on growth performance and fecundity of Atlantic cod in the North sea, the results showed that metabolic

processes for mitochondrial maintenance were high due to high water temperatures. Moreover, there has been an excessive decline in growth performance and fecundity [50].

In the recent study on native fishes in cool-water of lakes Huron and Michigan in North America, included two fishes species (*Perca flavescens* and *Coregonus clupeaformis*) the results showed influence of climate change on fish growth but indirectly where concluded that the prey availability and behavioral thermoregulation controlled by climate change are responsible for this effects in jointly with physical characteristics such as depth and trophic state of the ecosystem [51]. However, fish may choose thermal habitats which temperatures are favorable for growth, May have ability to behaviorally thermoregulate [24].

Studies results suggested that industrial wastes such as organic pollutants in marine environment have impact on fish life-history traits such as nursery habitat degradation, growth and survival. Hence, some scientists suspected that chemicals have contributed to the decline of some fish communities [52-56]. Notably, it is difficult to verify the relationship between chemical in natural environments and its effects on biota them due to the accumulation of multiple potential stresses [54, 57].

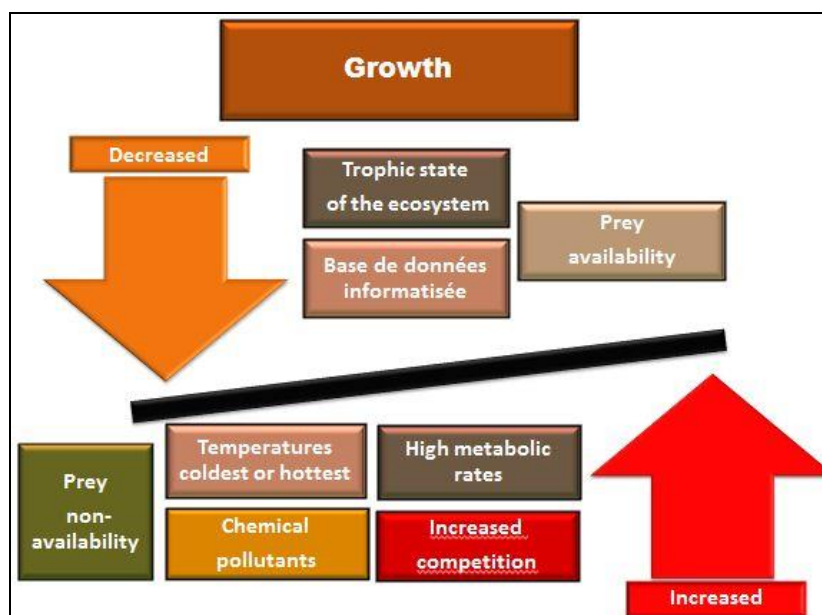


Fig 3: Climate change impact on fish growth

5. Climate change influence on tidal fishes

Coastal areas near the tidal entrances are utilized for navigation and fishing. On the other hand, fishes are a major part of the marine ecosystem and use tidal zones as passage corridors for migration and feeding [58-60].

Furthermore, tidal zones are influenced by climate change in several areas in the world. While, the salinity fluctuating due heavy rainfall or evaporation, and there is a strong likelihood that the salinity affects on host-parasite system [61-63].

[62] predicted that the Impact of climate change on tidal zone may reduce fish catchment due to the aberrant pattern of climate change. Also, may can disrupt the trophic balance of aquatic organisms according to [64].

6. Influence of salinity on fish

Salinity is an important topic for discussion because there are several impacts on aquatic communities [65]. Furthermore, it may lead to the spread of parasites and pathogenic and their effects are clear on host [66-68].

The life cycle of fish is extremely complex throughout their life, where the need to move between fresh and salt water. Thus, it requires them to adapt with different saline environments, leading to stress on fish physiology [69].

When fish assemblages are exposed to various salinity increases in natural environments, results of some studies showed that there are differences in fish communities were detected among years from different decades in terms of density and biomass. Notably, practically the effects on the structure and function of fish assemblages has been appeared [66, 67, 70].

The period of fish nursery is most important during life cycle and completely depends on environment conditions [71]. As a result, change in fish communities have been reported in the warmer and more saline waters in estuaries due to climate changes. Hence, this requires several adjustments in metabolism, ion regulation and osmoregulation [72-75]. Result of author [75] showed that abundances of juvenile fish species significantly increased. Thus, the changes in salinity of water jointly with temperature have an effect on the presence or absence of the juvenile fish, also fish larvae are highly sensitive to environmental variations according to [72].

In a previous investigation on effect of salinity on the transmission of trematode parasite, authors [61]) reported that the transmission of parasites is influenced by environmental conditions under the stress of climate change, also the exposure to different salinity for many weeks assisted to transmission of *Maritrema novaezealandensis* from its first intermediate snail host to a second intermediate amphipod host, which is considered preferred nutrition for fish. Notably, parasites influence host individuals [61, 76-80]. Overall, salinity is considered the key regulator of the transmission dynamics of parasites, and their influence depends on varying salinity and parasites favorable to the host according to [61].

Considering the importance of the salinity effect, the study result of [81] suggested that there is likely influence of salinity on some species fish reproductive.

7. Climate change impacts on parasitism and spread of diseases between species

Combined effects of climate changes causes to stresses of fish ecosystem. As a result, this may reduce fish resistance or tolerance to infection. On the other hand, this may assist parasites to interact with natural and spread in hosts, influence on their behaviour, productivity and reproduction [79, 80, 82-90].

Moreover, this threatens the survival of species by reducing of abundance, permanently or temporarily [29, 68, 88].

Notably, the ability of parasites to adapt to various environments and hosts provides them the ability to survive [29, 68, 88, 90].

Regardless of these, they may not interact with various parasites and not be affected under the same environmental conditions [90].

8. Conclusion

In this paper, we have reviewed the previous literatures which studied possible impacts of climate change on fish performance and their growth.

However, aquatic organisms are affected by global warming and increase salinity related to climatic changes. On the other hand, the results of the studies have suggested that there is an evidence that fish performance is influenced by climates conditions but it is difficult to know all of their consequences, but they can be predicted.

Due to direct or indirect effects of climate change, oceans, seas, tidal zones, estuaries and lakes lack self-protection to face these threats. Therefore, harmful anthropogenic stresses should be reduced, which have serious social and economic ramifications.

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