

Impact of Pollution and Climate Change on Cold Water and Warm Water Fishes

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Abstract:

This study aims to shed light on the fact that pollution and climate changes has an adverse effect on both cold water and warm water fishes. It is a known fact the capability of a fish to adopt or accept the changes in environment is a species specific thing, if there comes a case of rapid change in temperature, there are almost some situation which will come out as an outcome i.e. it could result in extinction because of the thermal stress or it may go under the process of genetic changes within some limits based on the natural selection process. There is a possibility that alteration in the dominance of species will probably occur, for the reason that species are adaptive to certain range of thermal, spatial and temporal characteristics. This will happen because of the climate induced shifts. May be it will affect the route of dispersal.

Keywords: Climate Change, Extinction, Cold Water Fish, Warm Water Fish, Pollution.

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Introduction

Temperature of water regulates the food web of a river and its network, this process in itself is complex by nature, experts believe that thermal regime in rivers as well as stream ecosystems are profoundly significant to fishes and other water and marine organism this is for the reason that most of these organisms are ectotherms in nature hence their physiological processes is unswervingly controlled by temperatures of the ambient atmosphere. As an end result it is seen that the temperature of these water stream evidently governs the distribution and quantity and type of species along spatial and temporal scale, any change or modification in temperature put direct effect on marine life. Temperature is one factor that regulates or governs that which organism will thrive or which will reduce in size and number, as for each aquatic organism there is a thermal death point determined already, temperature mainly effects the cold blooded or poikilothermic species. Fishes are supposed to be poikilothermic in nature because not only its survival but also the growth and reproduction of these organism has acute temperature range, in order to survive each of these organism need to be favored by the suitable temperature. This is because temperature influence most of the activities of an organism such as enzymatic reactions, hormonal reactions, nervous control and digestion, if to suffice it won't be wrong stating that all of aspect of an organism's performance and behaviors are governed by temperature.

Both high and low level of temperature are fatal to an organism of different species, it also controls the distribution, abundance of population. If temperature is less than lethal point and it interacts with all other environmental factors it tend to favor reproduction and growth of the organism. One shall keep temperature into consideration when toxic substances are present in water as many toxic substances such as cyanides and zinc gets catalyzed by elevated water temperature hence start exhibiting increased level of toxicity.

Mostly the changes in water temperature occurs due to land activity and it in general drift upwards, but an exception comes in by discharge of cold bottom water, it comes out from artificial impoundments that are stratified, it somehow alter the flora and fauna for about more than a mile down streaming from a dam. Some other activities gives rise to the temperature of receiving waters and have following effects over it:

- If the temperature gets heightened it reduces the solubility of oxygen dissolved in water hence reducing the very availability of this essential gas.
- It has become evident that raised temperature increases the metabolism rate, rate of respiration and demand of oxygen by the fishes, and other aquatic life, it increases the respiration two time for temperature of 10° C. Hence the want of oxygen upsurges when the supply is low.
- With the rise in temperature solubility of toxic substances gets increased and gets intensified.
- High temperature gives rise to sewage fungus growth and have a negative effect on desirable fish life.

Factors Effecting Water Temperature

Since water temperature is a very important factor influencing fish communities, it is taken under study, among these factors it could be both natural and anthropogenic, and some of these natural and human factors respectively are given below:

- Elevation
- Channel gradient
- Orientation
- Surficial geology
- Groundwater input
- Air temperature

Human Factors:

- Rainproof surfaces
- Groundwater withdrawal
- Stream diversion
- Dam construction
- Discharges from point source.

Cold Water Fishes

According to Wisconsin Initiative on Climate Change Impacts temperature of water is one of the major factor that ultimately determines the habitat of a fish, mostly fishes are ectotherm in nature i.e. they exchange heat with the environment, and in general has the same temperature as surrounding environment. Temperature has major role of play in reactions at biochemical and physiological processes of a fish, from time to time fishes have acquired this difference of temperature regimes, in order to function efficiently. Each species of fish has its own thermal niche, and has certain upper and lower limit beyond which it is lethal for them to resist. It is this temperature and within this range of optimal temperature its body functions properly, and process of feeding, growth and reproduction take

place smoothly. Few major example of cold water fishes are:

- Koi
- Goldfish
- Salmonidae
- Cottidae
- Mottled sculpin
- Rainbow trout
- W.blacknose dace

The level of tolerance for temperature of cold water fishes usually lie at the lower or bottom level of the thermal scale, this holds a grave importance and plays a crucial role in the dispersal of these fishes in the uplands. Worthy growth performance of maximum number of cold water species lies between temperature ranges of 15°C to 25°C, it has the lower limits to 10.0°C an exception comes in the case of trout and snow trout, as they have lower limits of 5.0°C.

During the year of 2010 review of water temperature was recognized as a factor of interest, by water quality standard review process. This was done to propose a change in the existing temperature standard, in order to attain this temperature of water and community of fishes both were under study.

Streams that has temperature which is intermediate of cold water and warm water are commonly referred to as cool water streams. This cool water stream usually has temperature that is suitable to both cold water and warm water, this is the reason because of which it has not a single clear species as a representative. Lyons et al. 2009 has divided cool water stream into two sub divisions such as: Cold transition and warm transition streams. Michigan department of Natural resources has defined cold transitional stream as a segment, which has drainage areas <80mi square and equally cold, this temperature which remains fairly cold occur when groundwater streams that are delivered into stream channel are found to be solid or substantial, but is not as strong as Cold streams. Cold-transitional streams time and again drain land with the help of extremely permeable geologies that develop into huge

Aquifers, but in here topographic relief remains moderate, these are quite common from one place to place around the Upper Peninsula where summertime air temperature remains almost cool, this can also take place in case where the incised larger wall of steep valley walls are drained by streams and it receives groundwater inputs from upslope aquifers.

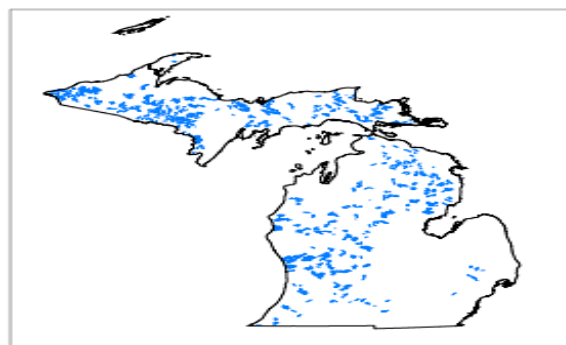


Fig 1: Shows Cold-transitional stream segments of Michigan City in geographical distribution; credit miwwat.org

Warm Water Fishes

According to Winger 1981, streams of warm water are those type of streams and river bodies which has warm temperature and usually gives support to diverse assemblage of fishes, this includes population of basses, catfishes and the sunfishes. Warm water streams can be distinguished from cold water streams on the basis of the fact that cold water streams lack Salmonidae population of fishes. The criteria that is used to classify a stream as a warm water one depends on individual and management agencies, one of the criteria that is followed is the presence or absence of trout, if there comes a case that trout is present down the stream, that stream is considered to be a cold water stream, and if at all these are absent the stream is classified as a warm water. Fishing in the stream of warm water is done throughout USA except Alaska (Funk 1970).

One of the simplest criteria to classify stream is by water temperature statistically, on the basis of it if an average summer water temperature remains 20°C or more than that it is considered as warm water stream. Not only this a cold water stream can change into warm water stream any time because of the disruptions of human activities, this condition remains eligible for the both i.e. whether or not human activities have hampered the stream or not. Lastly it won't be wrong to add that the concept of cold water stream or warm water stream depends on management goals. In addition to it Knighton said that geology, climate, land use and physiography of river has an important role in regulating the hydrologic and sediment regimes of warm water streams and at the end of the day regulates the local habitat of the fishes.

These kind of streams flow right through the forests, deserts and of course grasslands, the temperature here is controlled by the shade provided by plants

and others, scientifically speaking the land cover type basically have impact over the amount of stream shading which eventually puts on the effect over stream temperature. Some of the hot water streams rises in the gradients that are high, and become cold head water forming mountain stream. Whereas, when they flow downwards, it eventually becomes warm. Anyhow cases have been seen where many streams originate from lower-gradient prairies and coastal areas, and has warmer headwaters. The variation of temperature can be seen in warm water streams where the temperature varies from 0°C in month of winter to 40°C temperature during summer. (Matthew 1990)

Factors Effecting Warm Water Fishes

Composition of warm water stream fish's assemblage and population of fishes are influence by two factors:

- Abiotic factors
- Biotic factors

Modern day dissemination pattern adapted by fishes are greatly influenced by the various biogeographic procedures for example speciation, elimination, and extirpation. The physical and various biological factors act up together on large and small scales and eventually affect fishes of warm stream. According to Poff 1997, the process of assemblage of fishes that are of warm water stream is basically result of, that species passing through various series of changes. These changes include their nesting manner, and their consecutively finer habitat filters which handpicked species by their trait.

All together there are various factors that directly or indirectly puts on effect over the fish assemblage. Some of them are discussed below in the diagram, and their detail further continues.

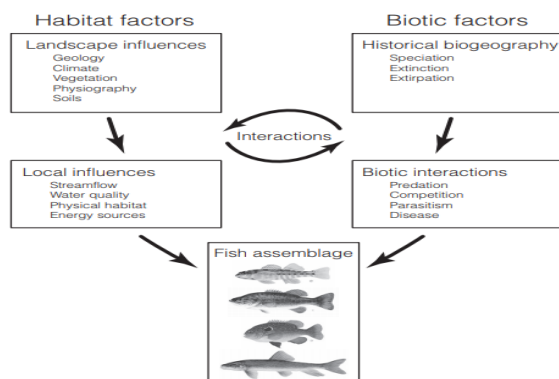


Fig 2: Diagram representing various abiotic and biotic factors effecting fish assemblage; Pic credit: Daniel.C

Abiotic Factor:

Habitat factors also known as abiotic factor may vary from small scale to large scale, i.e. it could be small-scale local influence or it can be large scale landscape influence. This abiotic factors are hierarchically nested right from the microhabitats to channel units, stream reaches, segments of valley and water sheds. Influence of landscapes are result of climate and geology that put effect over soils and vegetation process contained by a geomorphic domain. Another very important local habitat factor that influence the warm water stream fish assemblage is flow of stream, water quality is another parameter that can affect or put influence over the assemblage structure of fishes or over the population of an individual fish in warm water. This water quality may include biological aspect, and characteristics that are chemical and physical in nature, these characteristics of a water body are used in relation to water uses. (Armantrout 1998)

Biotic Factor

Assemblage by definition mean fishes of many species coming together to interact with one another, these interactions are at times beneficial, but sometimes it can be considered to be detrimental(Hildrew 1996). Ecology of fishes proceeds in the same manner as human ecology, it is dependent on the concept of “survival of the fittest”, and predation reduces or even eliminates a species and its selective force, it becomes a primary biological determinant of assemblage of local fish structure. Top predators in numerous streams of warm water are:

- Black bass
- Catfishes
- Sunfishes (Snieszko 1974)

Additional biotic factors for example disease and parasitism, negatively effects the health of warm water fishes, this phenomenon takes place particularly in streams of water where pollution of sewage or pesticide and rise in temperature are the one of the many cause to create stress in fishes. Another factor that comes into play is hybridization. The fact that abiotic factors i.e. variability in flow of stream, plays a vital role in fish assemblage was supported by Horwitz 1978, in his work “Temporal variability patterns and the distributional patterns of stream fishes”.

Effect of Pollution and Climate Changes on Fishes

Woods mentioned in his work and came of an opinion after informing that river Thames has been a main source of salmon fishes, but while moving towards the end of the eighteenth century it was noted that there had been dramatically decline in the number of fishes and a huge area was found to have become devoid of these fishes altogether.

This theory was supported by Moyle, in one of his work he wrote that the population of fishes are the most vulnerable one as the aquatic environment becomes the receiver of eventually every form of pollution and human waste.

In the year 1996 International Union for conservation of Nature published a red list giving out the data that showed almost seven hundred and thirty four species as being threatened and ninety two of them were found to be extinct worldwide, where water pollution was found to be one of the reasons, that contributed in decline of fishes population. (Clark, 1992). Not only pollution but climate changes also has and a negative effect on the aquatic ecosystem, Isaak 2011 concluded in a study that a huge number of scientific work shows and predict that considerable amount of disruption which happens to aquatic ecosystems from climate change, and the recent trend of rise in temperature of streams and river with simultaneous combination of increase in thermal constraints on some of the population is being suggestive of the same.

Dauwalter had worked on warm water streams, and has written that since the revolution of industries, concentration of carbon dioxide have increased rapidly which has eventually given rise to a problem bigger than anything, it is the increase of air temperature at global level, since stream temperature have concurrent reaction with the gradual increase of air temperature, it means the

clear implication of the same would be seen on fishes. Although it is known that rise in stream temperature has a direct implication on fishes that are temperature sensitive, there are certain other changes that will take place in warm water streams that will accompany certain climate warming. Following are the expected changes:

- Increase location for habitat of warm water fishes, because of the increase in temperature of cold water streams.
- Distribution shift of thermally suitable habitat of fishes which is narrow tolerance for temperature.
- Temperature rise create alteration in flow pattern of stream because of precipitation regimes.
- Expansion would be seen in habitat of nonnative fishes, invertebrates and diseases.
- Alteration would be seen in assemblage of invertebrate because of damage of species that has life history in need of specific environment cues.

Conclusion

The relation between fisheries and the ecosystem goes deeper than it seems, it also is more significant than those that is present in common agriculture. The rise in temperature of ocean and sudden increase in acidity makes it almost impossible for the marine organism such as shrimps, oysters and corals to perform the process of classification in order to form the shells. Not only this, change in temperature is giving rise to alteration of marine food web, which would eventually someday result in crack in the food chain. Because of this circulation, production, and species composition of global fish production is in being affected. Not only has this pollution had a life threatening effect on reproduction system of fishes.



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