The Impact Of Extreme Weather Events On Fisheries

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Extreme weather events can have a large impact when it comes to the environment and the ability to sustain a healthy habitat, especially for native fishes around the world. Knowing that we need to work around the ever-changing weather is a hard challenge that some people see as impossible. Most of the events we researched are brought on by too much heat, too much or too little water, active tectonic plates, and increasing greenhouse gases in the atmosphere. Sometimes these events are a one-time problem and sometimes they become an ongoing series of downward spiraling events that create a massive problem at hand. Whether they can be stopped or slowed is up to us, as humans. We must learn to control what we give and take from a world so reactive to change and also test our flexibility to how well *we* can change with these extreme weather events.

Droughts are an event that can obviously devastate dry land, but they also tend to have a huge impact on the oceans, too. The devastating 2019 Alaskan summer drought brought bad air quality from forest fires, dying foliage from the heat, and record-setting water temperatures all around the state. Unfortunately, the salmon population did not adapt well to the sudden increase in water temperature and over 1,000 salmon carcasses were found on the shores of the Koyukuk River in central Alaska alone. According to the Alaska Department of Fish and Game, salmon prefer a water temperature of around 5 degrees Celsius while spawning (1). Prespawning mortality events were at an all-time high because the salmon were stressed out with the much higher water temperature which was a snowball effect causing abnormal oxygen levels in the water and diseases in the salmon (2). Droughts can affect the environment by drying up food sources like brush near the water, algae, and increasing the salinity with the lack of precipitation causing competition for food and shelter between species.

Droughts can have a large impact on oceans, but a constant rise in temperature from Global Warming causes a path of destruction throughout our seas. Sea levels will continue to rise as ice sheets and glaciers resume melting with abnormally fast warming temperatures throughout the world due primarily to accumulating greenhouse gases. With warming temperatures, there will also be a thermal expansion of sea water as it, too, warms. The sea level in the past century has already increased by 0.17 m, which is ten times faster than the considered 'normal' rate of sea-level rise in the past 3,000 years (IPCC, 2019). There is a predicted sea level rise of 0.18 m to 0.50 m to be observed in the next century. (IPCC, 2019). Like all global catastrophes, there will be grim consequences; especially when considering our fisheries across the globe. Areas to be the most affected are low-lying, tidally influenced shores and estuary areas that harbor and survive a large amount of fish who balance the ecosystem. (Glick, 2007) Saline intrusion is seen when rising sea levels cause an intense drainage of salt water into fresh water, not to be confused with typical brackish waters. (Glick, 2007) Altered oxygen levels, water clarity, and stratification are likely to be seen post-saline intrusion. (Glick, 2007) As sea waters rise, they will

consequently reduce estuaries that present a safe spawning area for forage fish, who in return make up a critical part of the marine ecosystem. Much of the surrounding ecosystem could experience massive die-off due to introduction of increased salinity and water levels. Tidal wetlands, specifically, will see a change in composition, likely resulting in premature death of juvenile Chinook and Chum Salmon due to lack of preferred safe habitat. (Glick, 2007)

Another large event that has an immediate effect on humans and marine and freshwater species are earthquakes, which can be defined as the sudden shaking of the Earth's tectonic plates by seismic waves causing the Earth's plates to 'slip' into and/or away from each other and releasing large amounts of energy (Bolt, 2020). Most earthquake events can be sorted into one of two categories, ground movement and tsunamis. Ground movements can cause damage to fish and other creatures' habitats by physically disrupting habitat foundation for the ocean floor, coral reefs, and other ground structures. They can also damage important human fisheries infrastructure that supports fish growth and sustainability of endangered species. The effects of earthquakes on fisheries is mostly reflected in the tsunamis that follow earthquakes.

Tsunamis, which are large and powerful waves caused by the moving of tectonic plates at the bottom of the ocean *(Dr. Hal Mofjeld, interviewed on February 25, 2005, NOAA Center for Tsunami Research).*The occurrence of impacts on fisheries in relation to ground movement caused by earthquakes is considerably smaller than the impact cases of tsunamis caused by earthquakes. The number of ground moving earthquakes from 1950 to 2010 in 270 of the Exclusive Economic Zones (EEZs) close to the coast was roughly 1520 with the number of cases with impact on fisheries being 10, 2 positive impacts and 8 negative. The number of tsunamis caused by earthquakes in the same time frame and EEZs was roughly 58 with the number of cases with impact on fisheries being 32, 31 of which were negative impacts (Belhabib, 2018). So, when examining the effects of earthquakes on fisheries, ground movements are less of the problem than tsunamis caused because of earthquakes.

Tsunamis cause tremendous damage for not only those on land but for the animals and plants underwater. Fisheries in particular face a huge concern of losing large amounts of fish due to the waves washing them up on the shore. (Climate Change)

There is another event that can harm the fisheries and fish. Volcanoes can cause major damage to the earth and the oceans. The damage can range from minor to catastrophic. Sulfur and mercury can be released into the ocean nutrients can also be released and this can be both good and bad. The extra nutrients can feed algae and cause algae blooms. There are major impacts to the ocean, but there are also human effects. The ash from the volcanoes can cause lung damage. In Alaska there are one hundred thirty volcanoes in the Aleutians and the Alaska peninsula. This is also a high traffic area for fishermen. If a fishing boat comes across a volcanic eruption there will be harm done to them and their boat. The ash is made up of tiny rocks and glass and can cause the engine to fail. The people also on the boat will have substantial lung damage. Depending on how close the volcano is there could also be flying projectiles and Tsunamis. Volcanoes can be very bad but they also do good to the earth, provide fertilizer and ultimately reshape the earth.

The following is a list of **concerns** formed by the weather events listed above:

1. Droughts causing small lakes or streams to dry up, hindering the fish from returning to their spawning grounds, in turn, lower abundance of fish due to not spawning.
2. Decreasing oxygen levels stress out organisms and can cause death.
3. Record setting temperatures killing nutrients like algae, or other forms of food causing competition between species.
4. Saline intrusion ruining nursery areas, particularly mangroves.
5. As oceans warm and rise, it will push fish around as ideal water temperatures move to different areas. Many species will continue to look for food deeper in the ocean creating competition for the species who are already at those depths.
6. Decline of salmon populations due to loss of estuaries (spawning areas) from rising sea levels.
7. Loss of coastal wetlands due to salinity and flooding which will kill off salmon populations (PNW)
8. Large waves destroy small habitats like tide pool areas or physically hurt the fish.
9. Loss of food sources from tsunamis that stir up nutrients and hurt coral.
10. Volcanoes when erupted can put harmful minerals and ash into the atmosphere and into the ocean.

Weather is not something that can be entirely determined by humans, but there obviously are some instances, like Global Warming, where we initiate and prolong extreme weather events. If we can begin to heal the wounds we've caused Earth to lessen our chances of experiencing extreme weather, we may be able to buy humans, and fish alike, more time. We can also be prepared, educated and flexible with these changes to increase our chances of overcoming the events. Our recommendations involve encouraging people to become more knowledgeable about the climate in their particular area. Knowing what type of weather benefits or hinders your local fisheries can help aid in the fight to keep wild fish thriving and serving as a plentiful natural resource for humans. For example, if you know there is a stream where salmon spawn, ensure that it stays clean and not polluted with trash, oils, or completely stripped of trees and shrubs that provide food and shelter to those who reside in the area. Humans and fish have a symbiotic relationship in the way that we have the knowledge to protect them and they have the ability to feed our generations to come if we fulfill our end of the deal.

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