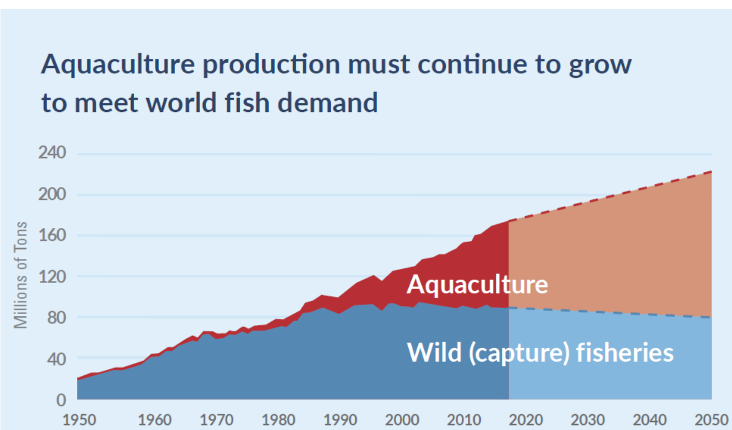
Climate Impacts on Wild Fish

Declining Supply, Increasing Demand

Climate change is already altering marine and coastal ecosystems with significant implications for wild capture fisheries and marine economies. The combined effects of warming temperatures, low oxygen, acidification, prey and predator migration, and sea level rise threaten to reshuffle ecosystems and disrupt established fisheries.

U.S. capture fisheries are well managed, but commercial landings have not increased substantially in 30 years and there's little room for additional sustainable wild harvest. Anticipated impacts on wild fish populations make it less likely that wild stocks will be able to withstand additional harvest pressure. Seafood demand in the U.S. has grown steadily, driven by increases in both population and per capita seafood consumption and it is expected to increase by roughly 30 million tons in the next decade.

Marine aquaculture can provide the seafood we need while helping to relieve some of the pressure on marine resources and providing greater food security.



Ocean Warming

Since the middle of last century, climate change has been warming the oceans as they absorb the heat trapped by greenhouse gas emissions. To beat the heat, fish and shellfish populations are moving toward cooler and deeper waters. As ocean temperatures continue to climb, the catch potential in most areas of the U.S. is expected to decline. Some fish are predicted to have little remaining habitat in the U.S. Species that are unable to shift will face declining environmental conditions, and that will be reflected in less resilient populations.

Warm water holds less dissolved oxygen than cool water while simultaneously driving up animal metabolic rates. As temperature increases, not only is demand for oxygen increasing, fish and shellfish have to work harder for what little oxygen is available. Changes in water temperature can have pronounced effects on muscle and cardiovascular function, metabolism, growth, and reproduction. Energy that would normally be used to forage for food, avoid predators, or invest in reproduction is used up in the effort to just stay alive. Warming waters can lead to fewer offspring and increasing mortality in some older fish.

Warming can also modify predator-prey relationships and the availability of prey. Zooplankton, small invertebrates at the bottom of the ocean food web, bloom early when temperatures rise. If they do, they may not be available when juvenile fish need them most. As smaller prey species relocate to find cooler temperatures, predator species may follow, leading to major changes in an ecosystem.

Over the last decade, the Gulf of Maine, the basin that stretches from Cape Cod to Nova Scotia, has warmed faster than nearly every other tract of ocean on earth, as climate change joined forces with a natural oceanographic pattern to increase sea surface temperatures by 3.6 F from 2004 to 2013. Atlantic Cod has been commercially fished in the Gulf of Maine for 400 years. Atlantic Cod could lose 90% of its suitable habitat in the U.S. and move to cooler waters off Canada. The stock is in poor condition, landings have declined since their peak in the 1980s, and quotas have been reduced to help the stock rebound. The warm water is sending them to deeper, colder waters, exposing them to new predators as well as putting them beyond the reach of commercial fishermen.

Harmful Algal Blooms (HABs)

Harmful algal blooms are occurring in more coastal areas and with increased frequency since the 1980s in response to warming waters and increased rainfall. Excess nutrients from farms and lawns run off into waterways, feeding algae blooms and taking up most or all of the available oxygen. Dissolved oxygen crashes alone can cause massive fish kills, but some HABs also produce toxins that can accumulate in fish and shellfish tissues. When eaten by humans, HAB-contaminated seafood can can cause illness or even death. HABs can also alter food web dynamics through impacts such as physiological stress and increased susceptibility to disease, and feeding impairment by avoidance of toxic prey, which in turn can alter the energy flow within an ecosystem.


On the U.S. West Coast (CA, OR, WA), a toxic bloom of Pseudo-nitzschia shut down the Dungeness crab and razor clam fisheries in 2015. The commercial Dungeness crab fishery lost $97.5 million in landings compared to the previous year.

Acidification

Around half of all carbon dioxide produced by humans since the Industrial Revolution has dissolved into the world's oceans, lowering the ocean's pH, making it more acidic. The world's oceans could become 150% more acidic by the end of the century and could have a considerable influence on marine life, including fisheries that supply the primary source of protein for more than 1 billion people worldwide.

As seawater absorbs carbon dioxide, it becomes increasingly corrosive. The shells and skeletons of many ocean organisms are made of calcium carbonate. Increased acidity slows the growth of calcium carbonate structures, and under severe conditions, can dissolve structures faster than they form. Calcified species such as urchins, oysters, and scallops, as well as fish like salmon that rely on these calcifiers for food are at risk from changing ocean chemistry. Coral, made of thin layers of calcium carbonate, is highly sensitive to ocean acidification and warming, putting this valuable marine fish habitat at risk.

Loss of Estuary Habitats

Loss of habitat from sea level rise will lead to declines in the vast majority of commercially and recreationally harvested marine finfish and shellfish that are dependent on estuaries and coastal systems for some stage of their life cycle. Estuaries serve as nurseries for fish and invertebrates, providing the rich food sources they need to grow while offering some protection from predators. More than 50% of all important commercial and recreational fish and shellfish in the U.S. depend on estuaries and nearshore coastal waters for key parts of their life history. More than 50% of coastal wetlands could be lost due to the combined effects of sea level rise and coastal development, such as the construction of seawalls, by the end of the century.

As sea levels rise, coastal salt marshes retreat landward, but when their retreat path is blocked by coastal areas hardened by shoreline structures, such as seawalls or rock revetments, we lose wetlands in what is known as "the coastal squeeze." One study found nearly 90% of brackish, high-marsh wetlands in the Chesapeake Bay would be lost under a 3-foot sea level rise scenario.

While not immune to the impacts of climate change, aquaculture offers unique opportunities for adapting to and mitigating its effects. Species can be selected or selectively bred for farming that are optimal for local growing conditions and resilient to increases in temperature and other changing environmental conditions. Through aquaculture hatchery and nursery practices, young shellfish, finfish, and seaweeds are nurtured through their most vulnerable juvenile life stages before being planted onto farms for grow-out. These practices can include buffering of acidic intake seawater into hatcheries or use of innovative technologies such as probiotics to boost survival of young shellfish. Siting aquaculture systems in locations with optimal conditions, as well as the ability to position systems throughout the water column, allows them to resist marine heatwaves that force wild fish to migrate and that would harm less mobile species.

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