Climate Change along the U.S. West Coast

How anadromous and marine fish may be affected

Predictions about the impacts of our changing climate on fish and habitat are based on models, with inherent, high levels of uncertainty. The best of the models have been peer reviewed and have tested their predictive abilities by using information from the past, e.g. from CO2 levels in ice cores, dating of sediments etc. to see if and how well the model would have predicted the actual environment that occurred, and adjusting accordingly (with the presumption that the current drivers of climate conditions will operate as they have in the past). Despite the uncertainty, there is ample information that changes in temperature, precipitation, fire regimes, sea level rise, and ocean acidification are coming and that these can put fish and their habitats at risk.

Salmon and Ocean Conditions

The University of Washington Climate Impact Group summarized the predictions about climate change on salmon and ocean conditions in the Pacific NW: Increased winter flooding and decreased summer and fall stream flows, and elevated warm season stream and estuary temperatures will clearly degrade in-stream and estuarine salmon habitat in the PNW. These changes will likely cause severe problems for the salmon stocks that are already stressed from already degraded freshwater and estuarine habitat. It is unclear how PNW coastal ocean conditions will respond to global warming. Warmer temperatures are likely to increase ocean stratification, yet possible increases in winds may counter that in ways that mitigate or even increase the wind-driven upwelling of nutrients that fuel a productive food web. The likelihood for many positive impacts on PNW salmon is low. Where winter temperatures are now cooler than optimal for juvenile salmon and/or incubating eggs, warming may improve stream productivity. However, such conditions are now limited to a very small number of inland, high elevation salmon bearing streams.

A National Academy of Science paper published by west coast scientists, noted widespread disruption of the food web from an event of delayed early-season upwelling and stronger late-season upwelling (an event which is consistent with predictions of how global warming may influence coastal upwelling regions). A 30 day delay in the spring transition in 2005 resulted in warm water, low nutrient levels, low primary productivity, and unprecedented low recruitment of rocky intertidal organisms (e.g. young mussels were 83% of normal).
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1805484/

Hypoxia conditions recently noted along Oregon's inner shelf (close to shore, in waters less than 50 m) due to upwelling of cold, dense, oxygen poor waters from the arctic that weren't mixed by strong upwelling and downwelling events, may also reflect changing ocean current and wind patterns, though it's not possible to tie these changes to climate change directly.

Sea-level Rise and Coastal Habitats

The National Wildlife Federation looked at a number of sea-level rise scenarios for the region: A significant sea level rise by 2100 of between 20-56 inches is predicted, with even a 2' moderate scenario bringing large loss of coastal and estuarine habitat. These habitats are vital to salmon, steelhead, sturgeon, Pacific herring, lingcod, Pacific tomcod, English sole, Starry Flounder, shellfish, Dungeness crabs and many other estuarine dependent species.

- Among the most vulnerable habitats is estuarine beach, which provides vital spawning areas for forage fish, including surf smelt and sand lance, which in turn provide food for birds, marine mammals, salmon, and other fish and wildlife. More than 2/3 of beaches in the Tacoma area are predicted to be lost by 2100.
- Estuarine beaches will undergo inundation and erosion, with up to a 65% loss.
- As much as 44% of tidal flat will disappear, 11% of inland swamp will be inundated with salt water, and 61% of tidal swamp will be lost.
- 13% inland fresh marsh and 25% of tidal fresh marsh will be lost.
- 52% of brackish marsh will convert to tidal flats, transitional marsh & saltmarsh.

Ocean Acidification

Ocean acidification is the term that has been coined to talk about decreasing pH levels of ocean water that has resulted from the ocean waters absorbing growing levels of carbon dioxide from the atmosphere. When atmospheric CO2 dissolves into ocean water, it forms carbonic acid that has a corrosive effect on aragonite – the calcium carbonate mineral that forms the shells of many marine creatures. Certain species of phytoplankton and zooplankton, which are critical to the marine food web, including the pteropod snails which are salmon prey and the larvae of Dungeness crab are susceptible. Coral reefs have already been affected in some places (14% decline of coral in the Great Barrier Reef). Species of open-ocean phytoplankton that have calcite shells are not as sensitive. Though the chemistry of the issue is understood, the biological implications are not. In some studies done by Woods Hole Oceanographic Institute, some crustacean shells got thicker while others thinner, with implications for the food web and predator, prey relationships.

In 2008, an international team of scientists surveying the waters of the continental shelf off the West Coast of North America from Canada to Mexico, discovered, for the first time, high levels of acidified ocean water within 20 miles of the shoreline. This corrosive, acidified water that is being “upwelled” seasonally from the deeper ocean was about 50 years old, when CO2 levels were at around 310 parts per million, already the highest level to that point that the earth had experienced in the last million years (from studies of gases trapped in ice cores). During the past 50 years, since the industrial revolution with the widespread burning of fossil fuels, atmospheric CO2 levels have increased to about 380 parts per million, suggesting that future acidity levels and impacts will only increase.

Sportsmen and women can help curtail continuing rises in CO2 levels by being an active voice for decisive U.S. action to reduce carbon emissions, find alternative fuel sources, and increase energy and water conservation incentives. At the local level, fishermen can participate in or donate resources to those working to expand protected habitat areas (marshes, riparian areas, wetlands, floodplains) and restore degraded areas, to increase the resiliency and complexity of natural systems.

Good sources of information for predictions of impacts and effects for the west coast of the United States include:

1. Climate Impact Group from the University of Washington focus on the Pacific NW (WA, OR, Montana, Idaho and Canada). http://cses.washington.edu/cig/

2. California Applications Program (CAP) & The California Climate Change Center (CCCC) http://meteora.ucsd.edu/cap/

3. Ocean Acidification NOAA's Pacific Marine Environmental Laboratory, http://www.pmel.noaa.gov/co2/OA/

4. The National Wildlife Federation's reports
http://www.nwf.org/sealevelrise/pdfs/PacificNWSeaLevelRise.pdf
http://www.nwf.org/globalwarming/pdfs/Investing_In_Americas_Natural_Resources.pdf

5. Oxford University: The basics of climate prediction: http://www.begbroke.ox.ac.uk/climate/interface.html

6. PISCO Partnership for the Interdisciplinary Study of Coastal Oceans http://www.piscoweb.org/research/science-by-discipline/coastal-oceanography/ocean-currents

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