

Aquatic Ecosystems and Wildlife

Background

Marine and freshwater aquatic ecosystems are at particular risk from the effects of climate change due to their exceptional sensitivity to heat, drought, and extreme weather. Accelerated erosion, sea level rise, salt water intrusion into freshwater systems, ocean acidification, algae blooms, stronger storms, and warmer river, lake and ocean temperatures are likely to disturb sensitive marine and freshwater ecosystems that are already stressed from development and other human impacts. In order to protect these ecosystems from projected impacts of climate change, climate adaptation needs to be considered within aquatic conservation planning.

Impacts and Solutions

Increases in river and stream temperature: As air temperature increases, so does the temperature of streams and rivers. These temperature increases will have a negative impact on the riverine wildlife that relies on cold-water regimes for food and breeding. Many species of fish are already stressed from existing temperature changes such as Brook Trout that rely on water below 65°F to survive (U.S. Fish and Wildlife Service, 2011).

Solutions: Wildlife managers have been utilizing nature-based actions to reduce the exposure of cold-water species to increasing water temperatures by restoring riparian tree canopies to provide shade over open water. Increasing the tree canopy shade creates a cooler microclimate for wildlife to survive. Another solution to increasing temperatures is creating cold-water refuges in streams and rivers that allow for aquatic wildlife to take shelter during high water temperature events. These refuges are typically dug out side channels embedded in rivers and streams that allow for fish to move into deeper, colder water during an extreme heat event.

Yet another solution to too-warm river and stream water that has been implemented in some states is the strategic release of colder water from reservoirs to help mitigate water temperature downstream (Yates, et al., 2008). Cold water releases help mix deeper, cooler reservoir water with the more shallow stream water to lower the overall temperature of the river or stream.

State and Local Examples: Washington State is incorporating climate adaptive measures such as stream shading to mitigate increasing temperatures (Washington State Department of Ecology, 2012). The state's Department of Ecology has already been successful in increasing the survival rate of many of the state's cold-water fish during extreme weather events. Oregon has also been studying the impact of using cold-water refuges, or deeper dug out side channels in rivers and streams, as a way to prevent harm from warmer water temperatures to the state's Bull Trout population, and further using this information to prioritize conservation efforts (Dunham, 2014).

The technique of using targeted cold-water releases from reservoirs has been used in states such as Tennessee to prevent cold-water fish from being overheated. These cold-water releases have helped mitigate the impact of extreme heat events within the effected rivers and streams (Tennessee Valley Authority, 2014).

Loss of habitat and ecosystem conductivity in marine environments: Altered sea levels, rising sea surface temperatures, changes to local ocean salinity, and ocean acidification will alter and reduce the available habitat for marine and coastal species. These climate-induced changes can lead to impacts such as coral bleaching, threatened shellfish populations, harm to marine mammals such as dolphins and whales, and impacts to the entire food chain.

Solutions: Some harm caused by climate change in the oceans can be mitigated by implementing climate adaptive conservation programs such as restoring reefs and other habitats at various depths to provide refuge for mobile species during extreme weather or localized ocean-heating events. Working to create large scale, well-connected systems of conserved areas will allow for species to migrate and retreat as needed when wildlife's normal habitat is out of sync with current water temperature and level regimes. For non-mobile species such as coral, reducing existing pressures from human activities such as pollution and vessel impacts can help species' survival.

State and Local Examples: Florida has been working to create and restore reefs along various depths that allow for wildlife to move to more protected areas during storm or high temperature events that would otherwise threaten species (Coastal Watershed Institute, 2014). Other states such as California have been working to improve ecosystem conductivity for animals that move between ocean water and freshwater environments during their lifecycle by removing barriers to migration such as levees and dams (California Natural Resources Agency, 2010).

Increased hypoxia events due to toxic algae blooms: As the frequency and severity of extreme precipitation events increases in inland areas, the amount of agricultural runoff that enters waterways will also increase. Agricultural pollution is known to cause harmful and toxic alga blooms, or "Red Tide" events that put people and ecosystems at risk. Even if the type of alga is not toxic, the blooms can reduce the available dissolved oxygen from the water, creating dead zones where marine life either dies, or if mobile, leaves the area. Habitats that would normally be teeming with life become essentially biological deserts (National Oceanic and Atmospheric Administration, 2014).

Solutions: Along with taking actions to reduce agricultural runoff into wetland and marine ecosystems, the creation of refuge areas can serve to mitigate the harm of an alga bloom event. Reducing agricultural runoff can include actions such as planting riparian buffers to filter runoff before it reaches river and stream systems, and innovative weed management techniques. *For more information about reducing agricultural runoff, please see the Agriculture and Farming section.*

State Examples: State and local governments have been working with farmers to reduce the amount of non-point source pollution from the agriculture sector. One example of this can be seen in Maryland, where farmers are required by law to follow Nutrient Management Plans. A Nutrient Management Plan specifies how much fertilizer, manure or other nutrient sources may be safely applied to crops to achieve yields and prevent excess nutrients from impacting waterways. Nutrient management plans generally are required for all agricultural land used to produce plants, food, feed, fiber, animals or other agricultural products (Maryland Department of Agriculture, 2012).

Loss of wetlands due to rising sea levels and increasing air temperatures: As air and water temperatures increase and sea levels rise, certain wetland species will need to retreat inland to avoid inundation with salty or brackish water. Some species of wetland vegetation cannot survive if submerged in sea-water for an extended period of time. This will alter the structural diversity of foundation species such as intertidal marsh plants that are vital to the survival of ecosystems (U.S. Environmental Protection Agency, 2009).

Solutions: Potential adaptation solutions include allowing coastal marshlands and wetlands to migrate further inland as sea levels rise by using policy tools such as rolling easements, setback requirements, and buyback programs (Needelman, Crooks, Shumway, Titus, Takacs, & Hawkes, 2012). The benefit of these strategies is that they preserve habitats for vulnerable species, and act as a buffer to protect inland ecosystems as well as communities. Another solution is to limit the use of coastal armoring that creates hard barriers preventing wetland retreat.

State and Local Examples: In Buzzards Bay, Massachusetts, adaptive shoreline conservation programs are dealing with shifting shorelines to preserve vital habitats of the state's aquatic plants and wildlife (Buzzards Bay National Estuary Program, 1991). Massachusetts has also taken action to reduce the amount of coastal armoring in areas with active dunes to allow for the habitats to retreat slowly inland as sea levels rise (O'Connell, 2010).

Intense rain events damaging rivers and streams and wildlife: During extreme precipitation events, the increased quantity and speed of a river can be harmful to fish and other wildlife within the river system. While many species are accustomed to bouncing back after a flood event, the effects of flooding combined with existing stressors, and the addition of other climate impacts may prove too much for some riverine species.

Solutions: Some impacts of climate change on riverine wildlife can be mitigated by restoring the natural capacity of rivers to buffer extreme weather events. This can be done through land acquisition programs that protect or increase natural areas bordering rivers, levee setbacks to free floodplains of development that can become river debris during a flood, and programs to restore riparian buffers. Fish can be protected from severe flooding events by re-establishing side channels within rivers that act as buffers and shelters against strong currents and flowing debris and provide refuge until after the event has passed.

State and Local Examples: The Everett Marshland Tidal Wetland Restoration Project in Washington State has restored historic wetlands and tidal basins, and helped improve the fresh- and saltwater wetlands' resiliency to extreme weather events (Puget Sound Nearshore Ecosystem Restoration Project). Restored riparian vegetation acts not only as shelter for fish during flood events, but also increases the roughness (friction) of the waterways to help slow floodwater.

Increased harmful sediment in spawning areas: During extreme precipitation events, silt and other pollutants are washed into the streambed and can damage the spawning areas used by many species such as Brook Trout and Bull Trout (Muck, 2010). The sediments clog clean gravel areas that the fish need to spawn, and prevent existing eggs from fully developing. This harms not only the survival rate of trout and other gravel-spawning species, but also reduces the available food sources for species that feed on trout eggs such as aquatic salamanders and waterfowl.

Solutions: Some of the harm caused by increased sediment loads can be mitigated by improving and maintaining diverse and abundant spawning habitats containing clean gravel beds in areas with suitable temperatures and flows (Palm, Brännäs, Lepori, Nilsson, & Stridsman, 2007). By preserving and maintaining multiple clean spawning areas, the impact of extreme weather will be diffused over the entire population, and the chances that a single event will cause serious harm will be reduced. In addition, streamside riparian restoration can slow sediment flow.

State and Local Examples: The California Department of Fish and Game has had great success with restoration programs that target trout spawning areas. One such example is the Tuolumne River, where a restoration program increased the amount of coarse gravel in parts of the river historically used for spawning over the course of four years. The program was successful in increasing and improving Chinook salmon spawning habitat in the river (Stockton Fish and Wildlife Office, 2010). The program also sought to improve diffused spawning habitats so in the

event that one habitat was compromised due to a storm washing large amounts of silt into the area, other spawning areas were available.

Tools and Resources

Climate Change Vulnerability Assessment for Shorebird Habitat (CC-VASH): The Climate Change Vulnerability Assessment for Shorebird Habitat is an innovative, Excel-based assessment and decision making tool that was developed in 2010 by the Manomet Center for Conservation Sciences' Shorebird Recovery Project in partnership with the U.S. Fish and Wildlife Service Northeast Region's Division of Refuges. This tool allows the user to create a vulnerability assessment for their area, as well as to design conservation programming. [\[Link\]](#)

Coral Reef Watch Satellite Monitoring: NOAA's Coral Reef Watch Program's satellite data provides current reef environmental conditions, and is to quickly identify areas at risk for coral bleaching. This tool can be used to provide visual representation of vulnerable coral reef habitats. [\[Link\]](#)

Essential Fish Habitat Mapper: by the NOAA Digital Coast Service Center. The Essential Fish Habitat Mapper is an online tool that displays essential fish habitat, and habitat areas of particular concern, established under provisions in the Magnuson-Stevens Fishery Conservation and Management Act. The tool also points out areas where steps have been taken to minimize the impact that fisheries have on essential fish habitat, including anchoring restrictions, required fishing gear modifications, and bans on certain types of gear. Users can query information from multiple fishery management plans at once to view habitat maps and lists of species for a specific location. [\[Link\]](#)

FishXing: This tool, pronounced "fish crossing", was created by the US Forest Service to assist engineers, hydrologists, and fish biologists in the evaluation and design of culverts for fish passage. This tool can be used to map out areas where aquatic habitat conductivity programs could be implemented. It is free and available for download. Version 3 of FishXing is in its final beta form. [\[Link\]](#)

NOAA Habitat Priority Planner: The Habitat Priority Planner was designed with the local planner, coastal conservation group, and coastal manager in mind. The Primer is a spatial decision support tool that helps users prioritize important areas in the landscape or seascape for conservation or restoration. This tool generates a range of scenarios and options, as well as pertinent reports, maps, and data tables. [\[Link\]](#)

Reef Resilience Toolkit: by the Nature Conservancy. This tool The Reef Resilience Toolkit provides the latest information, guidance, and resources to help managers address the impacts of climate change and local threats to coral reefs. [\[Link\]](#)

Sea Level Affecting Marshes Model (SLAMM): Created by Warren Pinnacle Consulting, Inc., this tool simulates the dominant processes involved in wetland conversions and shoreline modifications during long-term sea level rise. Map distributions of wetlands are predicted under conditions of accelerated sea level rise, and results are summarized in tabular and graphical form. [\[Link\]](#)

Synthesis of adaptation options for coastal areas: by the NOAA Climate Ready Estuaries Program. This report summarizes the adaptive options for coastal areas, linking climate impacts with adaptive goals, benefits, constraints, and adaptive examples. [\[Link\]](#)

WWF Adaptation to Climate Change Toolkit: Coasts. The Adaptation to Climate Change Toolkit: Coasts is a series of tools and resources aimed at anyone with an interest in climate change adaptation for marine turtle habitats, including coastal managers, conservation practitioners, scientists and educators. [\[Link\]](#)