Providing Safe Haven for Sensitive Aquatic Species in a Changing Climate

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FISH CULTURE IN A CHANGING CLIMATE

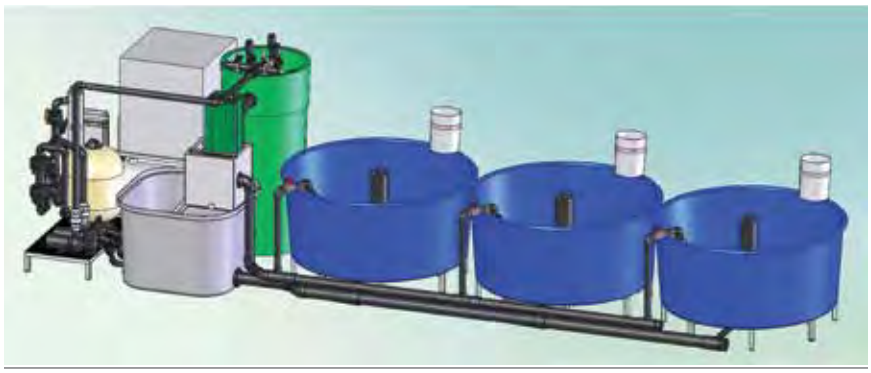
Fish culture will be affected by climate change, but many aspects of the fish husbandry environment can be controlled through the use of modern technology and engineering. The ability to control the culture environment provides the option to engineer around climate change as it occurs and additionally allows fish culture to be used as a tool to address issues of climate change and associated impacts on native or wild fishes. Aquaculture for coldwater fish species, such as salmon and trout, will likely require modern technologies to supply conditions suitable for fish husbandry in a changing climate. Recirculating aquaculture systems (RAS) have proven effective for production hatcheries and also as an emergency tool to address issues of climate change and mitigate impacts on native or wild fishes. Such work was recently demonstrated by the California Department of Fish and Wildlife (CDFW) to provide drought safe haven for wild fishes that were otherwise jeopardized by unprecedented drought. Other recovery efforts have been planned or implemented recently in Texas, North Carolina, New Mexico, and other locations to protect imperiled fish and mussel populations by bringing populations into culture facilities. These and other efforts worldwide demonstrate innovative approaches to address potential or realized impacts of climate change. These fish culture techniques should be considered part of the available toolbox for all fisheries professionals as they face impacts of climate change.

CASE STUDY: McCLOUD RIVER REDBAND TROUT

McCloud River Redband Trout *Oncorhynchus mykiss stonei* is one of several sensitive and unique fish species in California that required fish rescue during recent extreme drought to prevent excess fish loss and alleviate population-level effects. McCloud River Redband Trout streams (tributaries of the upper McCloud River) were monitored from late 2013 through mid-2015 for drought-related impacts. Stream monitoring during this period indicated drought effects during two separate seasonal periods—winter and summer. The winter period consisted of reduced stream flows and episodic events of cooler than normal air temperatures, freezing solid significant portions of Redband Trout habitat. Summer period impacts included reduced streamflows sooner and more extensively than long-term averages. These conditions suggested that genetically distinct subpopulations of McCloud River Redband Trout were at risk due to degrading habitat not likely to improve before impacts were realized. Fortunately, minimal Redband mortality was documented before fish rescues were implemented by CDFW. For McCloud River Redband Trout, rescue options included (in order of preference) instream movement, movement to another inner basin stream with genetically distinct McCloud River Redband Trout, and/or holding in a self-contained RAS at a hatchery.

McCloud River Redband Trout *Oncorhynchus mykiss stonei.* Photo credit: California Department of Fish and Wildlife.

Anticipating potential drought impacts on sensitive wild fish populations, CDFW customized, procured, installed, and employed self-contained RAS in expedited time at select CDFW hatcheries. In close proximity to the McCloud River, the CDFW's Mt. Shasta Hatchery was selected for providing drought-safe haven for rescued Redband Trout until conditions improved in natal streams. Before RAS were in operation, several logistical and infrastructural hurdles had to be addressed. These included accommodating RAS and electrical needs in a 100-year-old hatchery building, assembly of RAS components, and populating bioreactors with nitrifying bacterial species. By July 2014, RAS were ready to accommodate fish and by September biologists had provided drought safe haven to over 1,000 McCloud River Redband Trout.



Recirculating aquaculture systems used as drought safe haven by the California Department of Fish and Wildlife.

In addition to releasing fish back to the wild, CDFW is considering options for subsets of Redband Trout including a conservation program utilizing genetic analysis performed by the University of California at Davis. The CDFW staff rescued and provided drought safe haven for other coldwater fish species including the southern Oregon/northern California Coast Coho Salmon *Oncorhynchus kisutch* evolutionarily significant unit and the California Central Valley steelhead *O. mykiss* distinct population segment. Fish from those efforts were released to the wild as conditions did improve.

Extreme and changing climate and the related effects to aquatic habitats are anticipated products of global warming. As with the McCloud River Redband Trout example, modern fish husbandry offers an aide in the conservation of sensitive aquatic species in peril from climate change. The Fish Culture Section is poised to assist with this growing issue by disseminating information on successful projects, such as the McCloud River Redband Trout holding project; by helping to identify expertise for fisheries managers who need it; and by encouraging continued discussion of issues and solutions related to climate change. AFS

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