Innovative Management Options To Prevent Loss of Ecosystem Services Provided by Chinook Salmon in California: Overcoming the Effects of Climate Change

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In this research project, investigators are using an integrated water resources management model (WEAP21) to simulate potential changes in flow and temperature in the salmon spawning reaches of Butte Creek, California, in response to climate change. The resulting data are being used to drive a fish population model (SALMOD) that simulates response to changing environmental conditions, including threshold effects on survival. Literature reviews, field surveys, and an expert panel are being used to develop a conceptual model of the impacts of changes in the salmon marine-derived nutrient subsidy to terrestrial wildlife.

The basic objective of the research is to determine the flow and temperature thresholds that lead to long-term losses or reductions in spring-run Chinook salmon in Butte Creek. **Hypothesis 1:** Climate induced changes in flow and temperatures in Butte Creek will lead to critical reductions in the available habitat of spring-run Chinook salmon. **Hypothesis 2:** The loss/reduction of Chinook salmon will reduce the diversity and abundance of birds and mammals in the riparian corridor. The final objective is to evaluate management options to ameliorate these impacts.

The approach to assessing non-linear and threshold responses to gradual climate change on spring-run Chinook and the dependent terrestrial ecosystem services will be both analytical and expert-panel based. The primary, linked analytical models are WEAP21—an integrated watershed hydrology, water and irrigation management, and water quality model, and SALMOD—a population dynamics model that predicts the growth, survival, and movement (habitat choice) of salmon in freshwater systems from spawning to the egg, juvenile, and smolt life stages, based on water quantity and quality conditions. Model results, along with the knowledge base of the study team, will provide information for expert panels in Years 2 and 3 of the project. These experts will help assist in the evaluation of potential impacts of climate change and management policies to address these impacts.

Expected results include greater insight into the sustainability of spring-run Chinook salmon and their role in defining the terrestrial biodiversity of the riparian corridor. Bringing climate change to bear on the issues will determine environmental thresholds that also will be decision-making thresholds. The investigators will provide various stakeholder and management groups with a set of tools and new information to help determine: (1) if salmon are in increased danger from climate change; (2) if there are strategies to save the fish and fish-dependent wildlife species from climate change effects; and (3) when and how these strategies can be implemented. The analytical process and expert panel opinion will lead to: (1) possible water management strategies to counter climate change impacts on stream ecosystems and the services they provide; and (2) an improved understanding of the potential tradeoffs between services provided by water diversion versus services provided by water left in the stream.

Analytical tools developed will be made available to the research and water management communities. Dr. Lisa Thompson (Co-PI), who has an appointment in the University of California Cooperative Extension (UCCE), will extend academic information about California inland fisheries to stakeholders such as private landowners and government officials. David Purkey has worked with the U.S. EPA Office of Research and Development to extend the WEAP21 modeling framework to incorporate climate change, and it was used in the recent California Governors Report on Climate Change (http://www.climatechange.ca.gov/). Thus, the results of this work will be relevant for water management decision makers far beyond the Butte Creek basin.

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