Characterizing Uncertainty in the Impact of Global Climate Change on Large River Fishes: Missouri River Sturgeon Example.

Principal Investigator: Mark Wildhaber, Columbia Environmental Research Center

Recent decades have brought substantive changes in land use and climate across the earth, prompting a need to think of population and community ecology not as a static entity, but as a dynamic process. In studying the effects of climate change, there is increasing reliance on models that relate climate variables to outputs and impacts on biological systems. The main limitation of such models is the exceedingly difficult task of quantifying sources of uncertainty given the highly nonlinear nature of interactions between climate variables and community level processes. For example, models for large river fish populations are dependent on habitat conditions linked to hydrological variability of the river itself, which is linked to variation in weather variables, which are ultimately linked to potential climate variations. There is uncertainty in each linkage, and also individual process models and parameters upon which the models rely.

In collaboration with the University of Missouri and Iowa State University, this project will advance efforts to understand and accommodate uncertainty by applying to Missouri River sturgeon population dynamics the tools of multi-scale climate models and hierarchical Bayesian modeling frameworks, linking models for system components together by formal rules of probability. While a complete climate prediction may be intractable at this time -- for instance, the climate projections may not incorporate land use changes and solar fluctuations into the boundary conditions – we propose a framework to quantify known uncertainty that is also flexible enough to adapt to advances in climate predictions. A key advantage of the hierarchical approach is that it incorporates various sources of observations and includes established scientific knowledge, and uncertainties associated with each. This work is critical for monitoring effects of climate change since lakes and streams have been identified as sentinels of environmental change. The proposed hierarchical modeling approach should help to account for these uncertainties, in particular variability of relevant climate conditions across temporal and spatial scales, so forecasts of community or population response to a given climate change scenario include realistic measures of uncertainty. The approach will combine available data from numerous agencies (e.g., U.S. Geological Survey, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, and U.S. Fish and Wildlife Service) and models (e.g., North

American Regional Climate Change Program and sturgeon population, movement, and bioenergetics model) across a variety of scales. This work will provide the framework for

describing the potential consequences of global climate changes on large riverine ecosystems, alerting decision-makers to the most likely consequences, and producing a new suite of indicators of large riverine ecosystem change and health   The project will also provide explicit means for scaling results up or down multiple hierarchical levels and associated uncertainty. The goal is to evaluate the potential distributional changes in an ecological system, given distributional changes implied by a series of linked climate and system models under various emissions/use scenarios for evaluation of management options for coping with global change consequences and a powerful tool for assessing uncertainty of those evaluations.