Harnessing the hydrologic disturbance regime: sustaining multiple ecosystem services in large river floodplains

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River Restoration to Sustain Multiple Ecosystem Services

Large river floodplains are the most ecologically and economically productive lands in the region. Recent riparian research reveals a potential opportunity to use river restoration methods to simultaneously derive the following multiple services from floodplain rivers:

-- reduced river temperatures through cooling discharges of heated water

-- enhanced terrestrial and aquatic habitat

-- improved non-structural flood storage in large river floodplains

-- increased recreational opportunities.

The potential to reduce water temperature is an especially important avenue for investigation, due to the convergent mandates of the (1) federal Clean Water Act's Total Maximum Daily Load (TMDL) for elevated temperature as a water quality limiting factor and (2) federal Endangered Species Act concerns for the effects of elevated stream temperature on listed fish and other native riverine species.

This project will investigate innovative and cost-effective ways in which restoration may help meet requirements for managing fresh and treated wastewater while maximizing and sustaining the benefits of multiple ecosystem services to communities within the watershed.

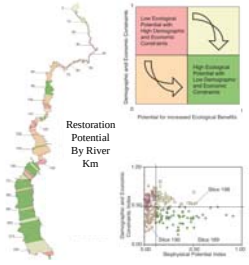
Water Quality Trading Policies Will Require Credible, Rigorous Criteria for Implementation

In January, 2003, EPA's Office of Water issued a policy encouraging water quality trading that ***"combines ecological services to achieve multiple environmental and economic benefits, such as wetland restoration or the implementation of management practices that improve water quality and habitat."***

Credible and quantitatively rigorous criteria will be required if such policies are to be implemented. This project will investigate if modeling and restoration decision-making techniques such as those described here might ultimately prove useful for implementing water quality trading policies. State resource agency officials are participating in this project from the outset in order to understand the advantages and limitations of this research with respect to its potential application to water regulatory policy.

This research will test the hypothesis that there are methods for treating heated effluent *and* restoring river functions that can achieve both objectives at lower cost. The river cooling potentially achieved through ecological restoration might make possible a trading system that could offset thermal discharges and create new ways to achieve compliance with temperature wasteload allocations. For example, entities that discharge heated effluent into the river from point sources could fund removal of river revetments and retirement of floodplain lands to allow the river to spread onto floodplain and increase hyporheic exchange. Revegetation of riparian areas or newly created islands could provide greater shade and an additional cooling effect. Costs to these entities to pay for restoration activities could potentially be less than cost to construct and operate engineered on-site temperature control technologies. This research will rigorously examine and test these hypotheses.

Visualization of Alternative Outcomes



The social and biophysical dynamics of the systems of river restoration are inherently complex in both space and time. Data visualization tools are essential to effectively establish and maintain lines of communication.

The figure at left illustrates a method for spatially representing the restoration potential river reaches for purposes of (1) increasing channel complexity, (2) increasing area of flood-plain forest, and (3) increasing non-structural flood storage. Simulation results describing surface and hyporheic cooling potential could be added to these restoration goals and similarly displayed.

In addition, this project proposes to use videographic animation of quality-assured data to: (1) depict future conditions under a range of citizen-defined alternative future land and water use scenarios and (2) help citizens and decision makers understand complex social and biophysical processes (animation not shown here).

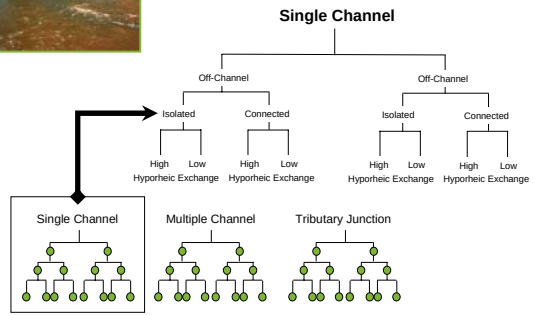
Models of Restoration Outcomes



Dye tracing illustrates hyporheic exchange processes within the river.

This approach will combine quantitative models of river temperature with a conceptual typology of river reaches and the their associated thermal dynamics for surface water and hyporheic flows. A schematic of river reach typologies is shown at right. This typology is hierarchically constructed to identify hydrogeomorphic patterns and associated thermal exchange processes. Existing quantitative models of stream temperature incorporate simple representations of hyporheic cooling processes. This research will refine these models with updated mixing models of hyporheic exchange and hydraulic conductivity. Results from the quantitative models will be compared with the thermal patterns observed in different reach typologies to assess the predictive power of the typological model. Field data will be used to test and refine both the numerical and typology models.

These river modeling methods are proposed for use to predict river thermal patterns that might result from alternative channel configurations, flow patterns, and floodplain vegetation. These models could then be used to assess the potential thermal cooling of alternative restoration plans identified through the policy and stakeholder process.



Stakeholder Processes to Inform Decision Making

Throughout this project, research results will be iteratively and collaboratively evaluated in public meetings with all clients. This will provide a transparent method to document technical results and stakeholder preferences.

Three categories of clients have been identified for this project:

(1) Policy makers: for example, mayors, urban planners, and policy officials within resource agencies

(2) Citizens interested in river and watershed restoration and management: for example, people who live in communities throughout the watershed

(3) Model users: for example, industry owners who discharge heated water to the river and resource agency personnel responsible for permitting discharges and enforcing standards

Each of these clients has needs for different kinds of information at different scales of analysis. Each will also likely have different preferences for alternative combinations of ecological and social outcomes. This project will test the hypothesis that restoration preferences of each group will evolve and change as they use model simulation results to visualize and understand the ecological and social implications of alternative river restoration scenarios. In addition, it is anticipated that the quality of information available and its presentation in a dynamic, visual format will be an important factor in facilitating stakeholder interaction.

An existing watershed restoration group has identified three key questions they believe are central to thermal restoration of the river. These questions are helping to guide the research as well as for involving stakeholders in the decision making process:

- What scientific evidence is needed to understand the mechanisms by which the water temperature reductions observed to date occur?
- Where are the riverine features that hold the most promise for such temperature reduction effects?
- What types of regulator and local citizen acceptance are necessary to bring about such change?

This research is funded by U.S. EPA–Science To Achieve Results (STAR) Program

Conserving ecosystem services through proactive decision making.