Dams as a Model for Social-Ecological Systems Research at the Food-Energy-Water Nexus

Support for the Future of Dams Project is provided by the National Science Foundation's Research Infrastructure Improvement Award NSF # IIA 1539071.

Kevin Gardner[1], Catherine Ashcraft[2], Denise Burchsted[3], Scheri Fultineer[4], Arthur Gold[5], Caroline Gottschalk Druschke[5], Todd Guilfoos[6], David Hart[7], Jessica Jansujwicz[7], Sharon Klein[8], Anne Lightbody[1], Bridie McGreavy[9], Weiwei Mo[1], Colgate Searle[4], Sean Smith[7], Emi Uchida[6], Emily Vogler[4], Karen Wilson[10], and Joseph Zydlewski[11]

[1]Department of Civil and Environmental Engineering, University of New Hampshire, Durham, NH; [2]Department of Natural Resources and the Environment, University of New Hampshire, Durham, NH; [3]Department of Environmental Studies, Keene State College, Keene, NH; [4]Department of Landscape Architecture, Rhode Island School of Design, Providence, RI; [5]Department of Natural Resources Science, University of Rhode Island, South Kingstown, RI; [6]Department of Environmental and Natural Resources Economics University of Rhode Island, South Kingstown, RI; [7]Senator George J. Mitchell Center for Sustainability Solutions, University of Maine, Orono, ME; [8]School of Economics, University of Maine, Orono, ME; [9]Department of Communication and Journalism, University of Maine, Orono, ME; [10]Department of Environmental Science and Policy, University of Southern Maine, Portland, ME; [11]Department of Wildlife, Fisheries, and Conservation Biology, University of Maine, Orono, ME

Dams as a Model System

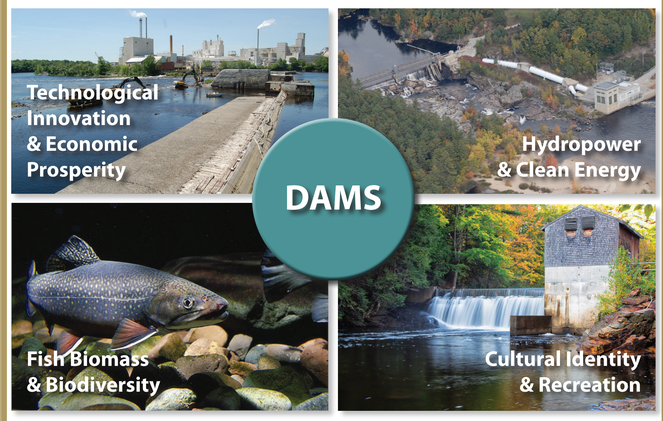

Figure 1. *Dams represent a literal and figurative nexus: a juxtaposition of infrastructure and freshwater ecosystems; an icon of technological innovation, economic prosperity, and cultural identity; a source of clean energy, opportunity for recreation, and threat to biodiversity.*

Research Questions

Improving the scientific basis for decision making requires an integration of two core systems:

Social-Ecological Systems (SES)

- Dams: A nexus between ecosystems and society
- Dams influence, and are affected by, many ecological, social, and economic processes
- Decisions about dams require an understanding of complex causal pathways that shape SES dynamics

Overarching SES Research Question

What are the tradeoffs, thresholds, and feedbacks among ecosystem services, across alternative dam management strategies at multiple scales?

Knowledge Systems (KS)

- Ways in which SES and other knowledge are developed and used in decision-making
- Integration of tradeoffs, thresholds, and uncertainties into decision-making
- Factors that promote the integration of SES knowledge and enable effective stakeholder participation and satisfaction with decisions

Overarching KS Research Question

How do preferences for dam decisions, as well as decision-making processes, affect decisions?

Valuation of Tradeoffs

Dam decisions need to be informed by an analysis of trade-offs

- Low GHG-emission, renewable energy
- Fish migration and Habitat
- Historical, aesthetic, cultural values, including native people and tribes & sustenance fishing
- Recreational values - boating, fishing, open space

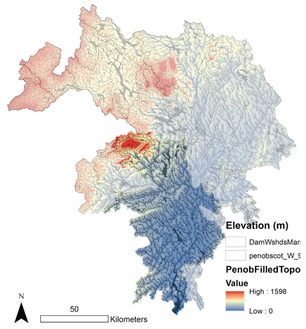

Figure 2. *The Penobscot River watershed has over 100 dams. The blue highlighted area shows the lower watershed; removal of all the dams in this part of the watershed would increase habitat and decrease hydropower production, as shown in Figure 3.*

Valuation of trade-offs using economic methods: Use and non-use value

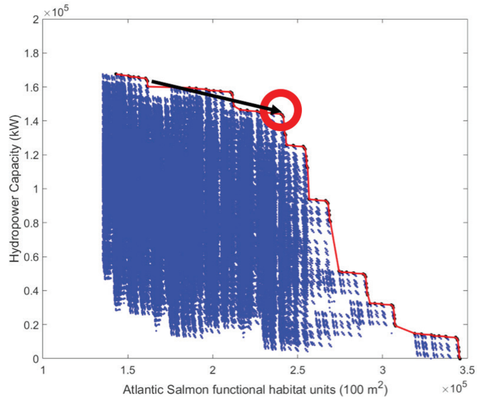

Figure 3. *Analysis of trade-offs between hydropower production and salmon habitat in the Penobscot River watershed. Each blue dot represents one of ~10^{35} possible scenarios for dam removals. Red line indicates most efficient choices. Circle shows system change if all dams in the lower watershed are removed. (Prepared by Sam Roy)*

Coordinated decision making across a system of dams can potentially yield better outcomes

- Maximize energy production and fish passage across a watershed or larger system of dams
- Can dams be managed using concepts of environmental trading systems?

Participatory modeling generates knowledge of dynamic SES and can improve decision processes

- Use of science in decision-making
- Role of stakeholders generating, interacting with systems knowledge (how does this influence scientific understanding and decision-making?)

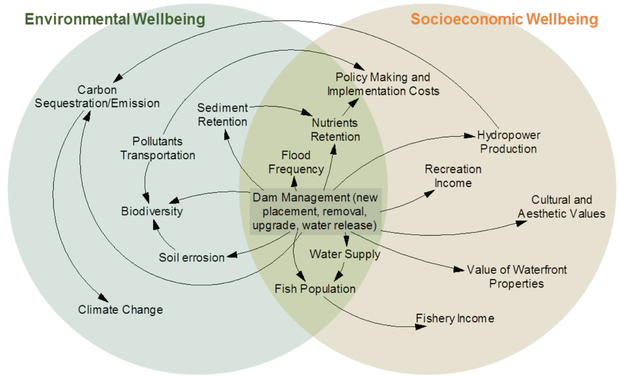

Figure 4. *Analyzing dam trade-offs and SES dynamics: New England as a model system. (Prepared by Weiwei Mo and Cuihong Song)*

Systems, Methods, Team Expertise, and Collaborations

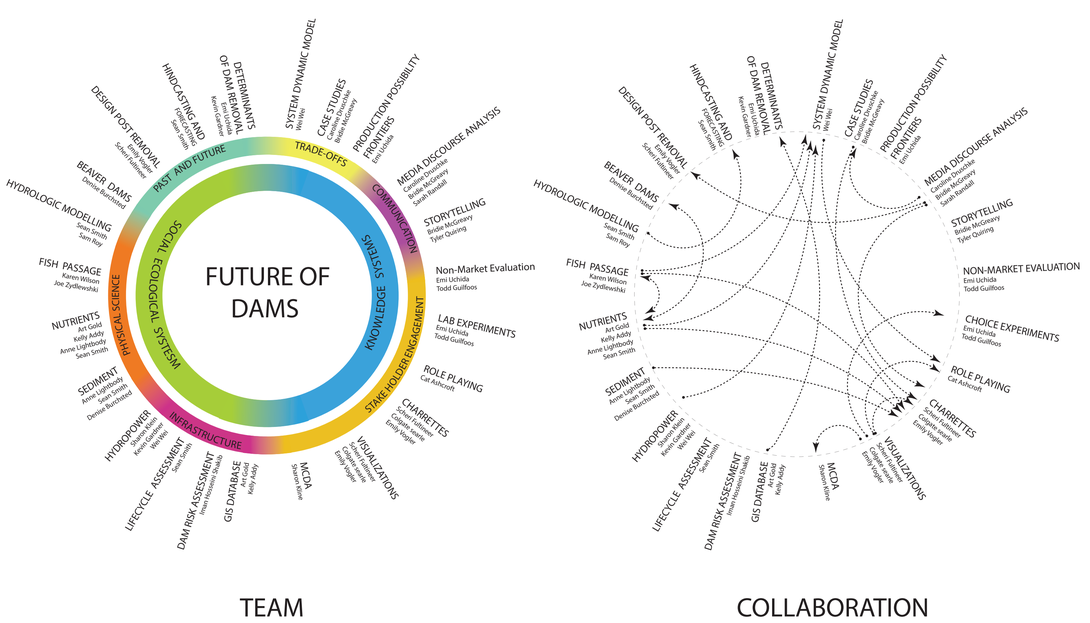

Figure 5. *The Future of Dams team considers two primary systems: Social-Ecological Systems and Knowledge Systems. Each of these includes a number of disciplinary domains and a variety of research approaches and methodologies. (Prepared by Emily Vogler)*

Proposed Outcomes

1. Provide analytical support tools for decision making associated with dams
2. Cultivate effective and inclusive science communication with stakeholders and decision makers
3. Describe ecological, social and economic tradeoffs associated with barriers, power generation, mitigation actions and their removal
4. Characterize the structure and efficacy of the regulatory framework used to make dam related decisions
5. Illustrate biological, ecological and physical processes imposed by impoundments and their removal
6. Generate relationships and trust between and among project researchers