

Social Science Research RFP Development Annotated Bibliography

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Annotated Bibliography: Hudson River Social Science Research

Introduction

This annotated bibliography was created as a preliminary step in developing an RFP for social science research on the Hudson River, its connected local waterways, and the social-ecological systems they support. The goal was to document what is known in social science literature about human interactions with river systems, including the Hudson River and its connected waterways. Human interactions encompass the bidirectional relationship between people and river systems, where people's actions affect rivers and how people are affected by these systems. An expansive review was conducted to identify innovative research in various geographies nationally and internationally for the potential to provide insights on related research related to the Hudson. The research directly related to the Hudson, covers the area starting with the New York-New Jersey estuary and farther north to the upper Hudson Valley.

For this review, social science is defined as "systematic investigation of the multi-faceted human experience encompassing thoughts, emotions, and actions of individuals or groups, and their relationships with the multiple social, economic, political, and environmental systems that exist in society." Disciplines of interest included anthropology, psychology, political science, economics, public health, and cultural studies.

The bibliography is organized into thematic sections that reflect the broad categories of publications included in this bibliography. Each thematic section is further organized with two sub-sections. The first sub-section focuses on social science research related to the Hudson and related waterways. The second sub-section selectively expands to social science research on rivers in the broader United States, focusing on peer-reviewed articles that addressed the established themes, to identify research areas that have been more extensively investigated in relation to other water bodies. Each thematic section ends with a brief paragraph synthesizing the research in that section to highlight the insights gained to inform the RFP.

Methodology

The literature search was conducted in an iterative process, initially focused on peer-reviewed publications (journal articles and book chapters) and then expanded to include relevant grey literature (e.g., reports, publications from government agencies, and dissertations). A number of search terms were initially used to uncover literature about social science rivers. Initial search terms were later expanded upon with more specific terms as the focus of the literature review narrowed. Note that a slash ("/") in the bullets below indicates that the search was conducted multiple times, alternating the words separated by the slash. We started with the following initial search terms that we organized into three broad categories as follows:

1. Systems taking care of the river or affecting it
 - Development/infrastructure rivers people/humans
 - Manage rivers people/humans
 - Policy rivers people/humans

2. Human experiences of engaging with the river
 - Knowledge/awareness rivers people/humans
 - Emotions river people/humans

- Actions/behavior river people/humans
- Public health rivers

3. Overarching topics

- Climate change rivers people/humans
- Human engagement rivers
- Inclusive practices/activities/approaches river
- Equitable practices river

After initial searches, terms were added to narrow the search, since the first collection of literature contained a broad array of over a hundred articles globally. In order, “Hudson”, “New York”, and “New Jersey” were added to impose geographic limits on the body of literature. Additional specific topic search terms were added to the above searches, where applicable, to uncover more related literature.

These additional terms include the following:

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|---------------------|-------------------|-------------------|
| • Social ecological | • Sociology | • Economics |
| • Impacts | • Perception | • Policy practice |
| • Systems | • Decision-making | • Attitudes |
| • Psychology | | |

In addition to Google Scholar searches, reference sections of some papers included in the bibliography were then reviewed to find other relevant research. The body of work from known researchers in social science fields was also directly searched to find more relevant research.

Future Plans

This document will serve as an internal resource for HRF staff and Board to supplement a one-pager outlining the research areas of focus. It may be shared on a case-by-case basis upon request from external partners who want to learn more about HRF’s internal process developing the social science RFP.

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1. Management and governance review (general)

The chapters and articles in this section focus on reviews of historical management and governance practices related to the Hudson River. One of these articles proposes that river management policy on the Hudson could be a useful guide to aid in restoration of the Huangpu River in Shanghai. Outside of the Hudson, we included one article that studied the characteristics of river basins and implications on management practices. Their takeaway that river basins featuring dams or levels of human development will need the most adaptation efforts to climate change, is also pertinent to the Hudson. Collectively, they underscore the need for research and management of the Hudson that incorporates human engagement with riverine systems as well as the multistakeholder processes necessary for effective management and science-based solutions.

Hudson River

Findlay, S. (2011). Environmental History of the Hudson River: Human Uses that Changed the Ecology, Ecology that Changed Human Uses. (Chapter 2: Linkages Between People and Ecosystems: How Did We Get from Separate to Equal?). State University of New York Press.

In this chapter, the author uses the ecosystem services framework to describe bi-directional relationships between humans and the Hudson River ecosystem. Positive and negative impacts by humans are acknowledged, including subtle and indirect impacts like combined storm and sanitary sewers. Combined sewers originally improved street sanitation by removing animal waste, but due to increased population size and more frequent extreme precipitation events, they now pose a risk, overwhelming wastewater treatment plants and contributing to the sanitation problem they once were meant to solve. The author argues that increased awareness of ecosystem services and how humans adapt to ecology can strengthen management and protection of crucial natural resources like those along the Hudson River. Book cited by 25.

Findlay, S. (2018). The bright side of linking science and management in large river ecosystems: The Hudson River case study. River Research and Applications, 35(5), 459-465.

<https://doi.org/10.1002/rra.3233>

In this article, the author posits that large river ecosystems (LRE) have certain complex challenges due to their size and diversity of ecological and economic motivations that also offer optimism and opportunity for science-based management. Using the Hudson River as an example, the author points out the massive diversity in geomorphology, politics, and interests over a relatively short length of waterway make for more challenging compromises amongst differing perspectives. At the same time, there is a higher likelihood that data availability for science-based management will be higher, due to the multiple stakeholders interested in collecting that data. The author highlights the value of connective networks that bring stakeholders together to identify problems and negotiate different perspectives and approaches to problem-solving. Article cited by 1.

Schuster, R., Sullivan, L.E., Kuehn, D.M., and Morais, D.D. (2011). Relationships among Resident Participation in Nature and Heritage Tourism Activities, Place Attachment, and Sustainability in three Hudson River Valley Communities. Journal of Park and Recreation Administration, 29(3), 55-69.

<https://www.proquest.com/openview/527f33089006167e6cf094787c6fd18b/1.pdf?pq-origsite=gscholar&cbl=2037373>

This research study used quantifiable measures of Hudson Valley residents' sense of place as a first step to evaluate tourism development proposals. The study found that attachment to and identity with a place (largely based on cultural activities) was predictive of tourism support. The study suggests that there may be a tourism development saturation point, particularly in Cold Spring Village, where residents may perceive the current level of tourism to be sufficient. The study also found that tangible amenities were not a prominent concern for residents recommending their communities to potential visitors, suggesting that factors beyond physical infrastructure play a more significant role in residents' perceptions and recommendations. This study ultimately emphasizes the multifaceted engagement residents have with rivers, highlighting place identity, attachment, cultural activities, and collaboration and important factors in tourism development. Article cited by 22.

Wang, X., Wang, S., Peng, G., Katz, D.S.W., and Link, H. (2015). Ecological restoration for river ecosystems: comparing the Huangpu River in Shanghai and the Hudson River in New York. *Ecosystem Health and Sustainability*, 1(7), 1-14. <https://doi.org/10.1890/EHS15-0009.1>

This study compared the Hudson River with the Huangpu River in China to compare hydrological setting and management policy. Focusing on the conclusions regarding human engagement with rivers, the main takeaway from this paper was that unified management policies in the Hudson River, such as the Hudson Estuary Management Plan and collaboration amongst stakeholder groups, have helped benefit the Hudson River Valley with cleaner waters since the 1970s, and recommends similar management for the Huangpu River in China. Article cited by 7.

Beyond the Hudson

Palmer, M., Liermann, C.R., Nilsson, C., Florke, M., Alcamo, J., Lake, P.S., and Bond, N.R. (2008). Climate change and the world's river basins: Anticipating management options. <https://doi.org/10.1890/060148>

In this investigation, the researchers analyze projected climate change impacts on a river basin scale, identifying basins that are likely or almost certain to require action to combat these impacts. Proactive restoration, as opposed to reactive efforts, is recommended to minimize risk to humans and nature. Their analysis suggests that river basins impacted by dams or major human development will be more heavily impacted by flow change and water stress than undammed rivers. Article cited by 1016.

2. Beliefs, views, and perceptions of management

The next section includes research about beliefs, views, and perceptions of management related to riverine systems. Research specific to the Hudson is broad, including public understanding of public health advisories about fish and community discourse about restoration actions, both in support of and against specific projects. There is also one article about the perceptions of flood risk and need for preparatory actions like purchasing flood insurance. Beyond the Hudson River, similar research exists including additional stakeholders with economic interests (e.g., anglers, commercial fishers) focused on human relations with local fisheries management policies. This includes anthropological studies of cultural models of Chesapeake Bay watermen to inform blue crab fisheries in Maryland and traditional ecological knowledge guiding king salmon management by Indigenous fishers on the Yukon River.

See also:

- Section 1 (Management and governance): Schuster et al. (2011)

Hudson River

Bolnick, J., Roubin, S., Burr, M., and Byrne, S. (2023). Assessing awareness and compliance with fish consumption advisories on the upper Hudson River: Implications for risk management of the Hudson River Superfund site. *Environmental Pollution*, 344(1), 122125.

<https://doi.org/10.1016/j.envpol.2023.122125>

This investigation surveyed people who fish regularly between Hudson Falls and the Federal Dam in Troy, NY, a Superfund site which has a “Do Not Eat” advisory. The goal of the study was to gauge the effectiveness of these advisories and how much knowledge the fishing public had of them. Results indicated that those fishers with high awareness of the advisory tended to consume less fish, but awareness of the advisory was incomplete. The authors highlight that management strategies and communicating risk to the public should consider that fish consumption guidelines will not be followed perfectly, particularly when awareness of those advisories are low. They also recommend larger surveys of Hudson River fishers, so that consumption rates along the river can be considered in future cleanup efforts. No citations listed.

Connelly, N.A., Knuth, B.A., and Kay, D.L. (2002). Public Support for Ecosystem Restoration in the Hudson River Valley, USA. *Environmental Management*, 29, 467-476. <https://doi.org/10.1007/s00267-001-0033-Z>

For this investigation, researchers surveyed 3000 Hudson River Valley residents to gauge their support and willingness to pay for restoration of the local ecosystem near their homes. Support for general ecosystem goals was higher than support for specific restoration actions. This disconnect is relevant because residents may initially support the idea of restoration, while specific actions to reach restoration goals might be more controversial amongst residents, with some who support the restoration goals disagreeing with actions taken and the costs associated with those actions. Support for ecosystem protection actions were correlated with belief in the value of nature and past behavior engaging with environmental activism. The authors

recommend increased public outreach to foster support for restoration actions. Article cited 34 times.

Connelly, N.A. and Knuth, B.A. (2002). Using the Coorientation Model to Compare Community Leaders' and Local Residents' Views About Hudson River Ecosystem Restoration. *Society & Natural Resources*, 15(10), 933-948. <https://doi.org/10.1080/08941920290107666>

This study aimed to understand the degree of agreement, accuracy, and congruency between the views of three groups of community leaders comprising local non-profits, government agencies, businesses, academia, and citizen groups ((1) Environmental protectionists, (2) supporters of resource use and environmental protection, and (3) Moderate environmental protectionists) and local residents regarding ecosystem restoration of the Hudson River estuary. Community leaders were not found to be in complete agreement with residents, but two of the three community leader groups had views in common with them. Community leaders generally thought, inaccurately, that local residents placed less importance on environmental protection and more on economic development. In general community leaders perceived local residents' views to be incongruent with their own, even when their views were similar. Article cited 23 times.

McGlinn, L.A. (2002). Distance and dissolution: geographic patterns of support for and opposition to dredging the Hudson River. *Interdisciplinary Environmental Review*, 4(2), 36-51. <https://doi.org/10.1504/IER.2002.053893>

This study analyzed public opinion geographically regarding EPA's proposed dredging of the Hudson River Superfund site by reviewing the comments in a publicly available database containing all comments and commenter addresses. They found that support for the EPA's dredging was lower in locations near the Superfund site on the Upper Hudson, while it was more likely to be supported by commenters further south. Comments in favor of dredging were found to be more in-depth, while the comments opposed were more numerous, but brief or often a form letter submission. The authors highlight the importance of corporations and environmental organizations as channels of information regarding such issues. No citations listed.

Toomey, A.H., Campbell, L.K., Johnson, M., Strehlau, M., Strehlau-Howay, L., Manzolillo, B., Thomas, C., et al. (2021). Place-making, place-disruption, and place protection of urban blue spaces: perceptions of waterfront planning of a polluted urban waterbody. *The International Journal of Justice and Sustainability*, 26(8), 1008-1025. <https://doi.org/10.1080/13549839.2021.1952966>

This paper explores sense of place in Coney Island Creek in New York City. While heavily polluted, the creek was nonetheless providing recreation, sustenance, and social connections to its local residents and visitors. The authors find that some local stewards perceive proposed resiliency planning and development projects to affect their associated place meanings, concluding that local knowledge and values should be incorporated into decision-making and waterfront planning, especially in historically marginalized communities. Article cited by 14.

Zinda, J.A., Williams, L.B., Kay, D.L., Alexander, S.M. (2021). Flood Risk Perception and Responses among Urban Residents in the Northeastern United States. International Journal of Disaster Risk Reduction, 64, 102528. <https://doi.org/10.1016/j.ijdrr.2021.102528>

This study aimed to understand flood risk perception and response of residents in Troy, NY. The results suggest that although residents were aware of flood history in their town, salience of that risk was low and tended to have trust in local government response to hazard events. Financial and practical barriers to protective actions, such as obtaining flood insurance, may prevent better preparedness. The authors ultimately recommend responding not only to the physical aspects of risk, but also the social and psychological factors that shape residents' perceptions and decisions related to protective actions. Article cited by 26.

Beyond the Hudson

Cadavid, C.L. and Ando, A.W. (2013). Valuing preferences over stormwater management outcomes including improved hydrologic function. Water Resources Research, 49, 4114-4125. <https://doi.org/10.1002/wrcr.20317>

This study aimed to understand how people value environmental benefits of stormwater management by surveying households in Champaign-Urbana, Illinois. The researchers found that people value not only the practical benefits of flood reduction, but also water quality and habitat improvements that result from flood reduction. Willingness to pay for basement flood reduction was influenced by participants' experiences of significant flooding, suggesting that personal experiences shape priorities when it comes to stormwater management. The authors advise that widespread investment in low impact development stormwater solutions could address flooding while providing environmental benefits, both of which were broadly supported by participants in the study. Article cited by 95.

Field, C.R., Dayer, A.A., and Elphick, C.S. (2017). Landowner behavior can determine the success of conservation strategies for ecosystem migration under sea-level rise. PNAS, 114(34), 9134-9139. <https://doi.org/10.1073/pnas.1620319114>

In this study, the researchers surveyed coastal landowners about conservation strategies aimed at facilitating ecosystem migration for tidal marshes. They found that some popular strategies may not garner enough interest from coastal landowners to be effective, but identified some less common strategies that might have more support, but are unproven in practice and might be more expensive. Ultimately the study highlights the need for human dimensions to be considered in ecosystem migration efforts and for more research to be conducted on newer approaches to conservation. Article cited by 54.

Gordon, B. and Klotz, L. (2022). Community involvement in coastal infrastructure adaptation should balance necessary complexity and perceived effort. iScience, 25, 104852. <https://doi.org/10.1016/j.isci.2022.104852>

This study assessed a survey approach to public participation in coastal infrastructure development by offering a more complex questionnaire that highlighted multiple types of risk (intervention) and a simpler questionnaire that did not highlight these risk factors (control). This was done via a survey with members of the American public recruited through an online survey panel. Except for more easily visible coastal infrastructure like breakwaters, the more complex survey did not significantly differ in feedback from the simpler one, and cognitive load is increased. They conclude that more complex surveys and attempts at public participation may not provide richer information than a simpler one and may introduce more barriers to participation if the public perceives that it takes much more effort to understand and form an opinion about a given project. Article cited by 1.

Gray, K.M., LePrevost, C.E., and Cope, W.G. (2020). Anglers' Views on Using Signs to Communicate Fish Consumption Advisories. *Fisheries*, 45(10), 307-316. <https://doi.org/10.1002/fsh.10463>

This study surveyed 38 sport and subsistence anglers in North Carolina about their understanding of fish consumption advisory (FCA) signs, with one focus-group conducted in Spanish and three conducted in English. Many anglers expressed confusion over details like age recommendations, portion size recommendations, and mixed messaging about the health risks of fish from the waters as opposed to creel limits about how many fish can be legally taken. They recommended changes to the location and visual cues of the signage (e.g., putting them closer to the boat ramp and making the warning red), as well as multilingual signage. The authors broadly highlight the opportunities for wildlife management agencies to build on their communication with the public about their perceptions in order to enhance their management and public engagement strategies. Article cited by 4.

Marazzi, L., Loiselle, S., Anderson, L.G., Roccliffe, S., and Winton, D.J. (2020). Consumer-based actions to reduce plastic pollution in rivers: A multi-criteria decision analysis approach. *PLoS ONE*, 15(8), e0236410. <https://doi.org/10.1371/journal.pone.0236410>

This article focused on evaluating consumer-based actions based on their direct or indirect potential to reduce plastic pollution in European freshwater environments. A multi-criteria decision analysis was used to rank various actions on various criteria: feasibility, economic impact, environmental impact, other unintended environmental consequences, potential scale of change, and evidence of impact. They also analyzed the strengths, weaknesses, opportunities, and threats (SWOT) associated with the actions individuals can take to reduce their use of single-use plastics. The research highlighted the complex challenges for people and society to reduce plastic pollution in rivers. The findings indicated barriers consumers encounter in reducing plastic pollution through their choice to purchase, use, and manage plastic (e.g. costs, inconvenience, time constraints, lack of available facilities or customer support). Recommendations included creating new norms for sustainable consumer choices by developing private and public sector initiatives, creating well-enforced policies, and developing evidence-based media reporting. Article cited by 45.

Paolisso, M. (2005). Blue Crabs and Controversy on the Chesapeake Bay: A Cultural Model for Understanding Watermen's Reasoning about Blue Crab Management. *Human Organization*, 61(3), 226-239. <https://doi.org/10.17730/humo.61.3.2dc5c4gxap2f6nvw>

This article uses a cognitive anthropology approach to enhance understanding of watermen's (commercial fishers in the Chesapeake Bay) knowledge, beliefs, and values in regard to blue crab and management of the blue crab fishery. The author then analyzes watermen's cultural and ecological knowledge to identify a cultural model of watermen's reasoning (that includes their beliefs, values, and personal experiences) about blue crab management. The author finds many watermen to be doubtful of the ability of science to account for changes in the crab fishery, respectful of the role of nature and/or God in provisioning crabs and frustrated or confused by government regulation that attempts to "manage nature" in a way that they don't believe is possible. Article cited by 168.

Walsey, V. and Brewer, J. (2018). Managed out of existence: over-regulation of Indigenous subsistence fishing of the Yukon River, *GeoJournal* 83,1169-1180. <https://doi.org/10.1007/s10708-018-9879-y>

This article explores conservation efforts by the state of Alaska as well as Indigenous fishers' engagement with governance and regulation. In the case of the king salmon fishery on the Yukon River in Alaska, sustainable indigenous relationship with the resource, such as that of the Gwich'in, has been overshadowed by policies that largely ignore culturally relevant traditional ecological knowledge (TEK) that grounds their fishing knowledge and practice. Interviews with Alaska Native fishers revealed fishers' perspective on regulation and the limitations to Indigenous Fishers Knowledge (IFK) from being actively implemented in management and policy. Fishers tended to be frustrated by many layers of bureaucracy involved in king salmon fishery management, lack of confidence in monitoring methods, and lack of clarity on the differences in fishing limits between the U.S. and Canada. Direct implementation of IFK in governance and ecosystem preservation is recommended by the authors. Article cited by 17.

3. Economic analyses

Economic literature here includes studies involving predictive models, scenario analyses, valuation, and cost-benefit analysis. Within the Hudson River, the research focused on incorporating individual motivations and society-level factors within models that predicted decision-making related to use of ecological services. These included a study that integrated ecological costs and benefits with economic considerations, to predict watershed planning scenarios. One article highlighted the economic value of environmental education at an urban park on the Hudson River while another report conducted the first economic valuation of clean water in the Hudson. Outside of the Hudson, we found literature about how people value ecological services provided by rivers, including the factors that affect residents' willingness to pay for improved water quality. There was also a paper studying the impacts of climate change on commercial shipping, for which we did not find a parallel for the peer-reviewed literature on the Hudson River.

Hudson River

Hong, B., Limburg, K.E., Hall, M.H., and Erickson, J.D. (2007). Scenario Analysis of Economy-Ecology Interactions in the Hudson River Basin. *Ecological Economics of Sustainable Watershed Management*, 7, 97-111. [https://doi.org/10.1016/S1569-3740\(07\)07005-8](https://doi.org/10.1016/S1569-3740(07)07005-8)

The research questions in this study addressed land use, exploring how economic activity affects new land demand, how land demand shapes land-use patterns, and then how land-use change affects watershed health. In answering these questions, the researchers utilized three sub-models (socio-economic, land-use, and ecosystem health) in an integrated assessment tool. By integrating socio-economic drivers into the methodology, the researchers drew connections between various economic scenarios in Dutchess County with the potential impacts on land-use and ecosystem health. The authors call for holistic assessment tools that handle the uncertainties inherent to ecological interactions with human society to support decision-making, including by incorporating multiple stakeholder positions to define opportunities for compromise and consensus. Article cited by 1.

Hutcheson, W., Hoagland, P., and Jin, D. (2018). Valuing environmental education as a cultural ecosystem service at Hudson River Park. *Ecosystem Services*, 31(C), 387-394. <https://doi.org/10.1016/j.ecoser.2018.03.005>

This study aims to summarize the cultural ecosystem services provided by the Hudson River through Hudson River Park's K-12 education programs. They used a travel cost model to determine a conservative estimate of the economic value of the benefits provided by these services to participants in the educational programs, noting that this analysis does not include all educational services offered by the Park, nor all the ecosystem services offered by the River. The educational programs were found to be particularly utilized by organizations in districts with high proportions of minority students or English language learners. While these programs are usually considered consumptive (users of environmental education are consuming but not producing anything new), the authors highlight the potential productive elements of environmental education (e.g., improved school performance, better decision-making, and a wider range of future career opportunities). In future studies, the authors suggest using economics methods to

evaluate education programs and are optimistic about the economic benefits and ecological improvements that could arise from more environmental education in urban estuaries. Article cited by 68.

Economic Analysis of the New York – New Jersey Harbor Estuary. (2023). ICF.

https://www.hudsonriver.org/wp-content/uploads/2023/09/EconomicAnalysis_NYNJHarborEstuary - 2023.09.25_FINAL.pdf

This article estimates the economic value of clean water for the NY-NJ Harbor Estuary by surveying households on their willingness to pay for water quality improvements under four scenarios, water safe for swimming, secondary recreation (e.g., paddling), enhanced aquatic life, and combined scenario that offered all these benefits. Based on their research, the authors estimated that water quality changes would lead to economic benefits to households amounting to 1.4 billion dollars annually or 21.7 billion dollars over a 20-year period, exemplifying the importance of water quality improvements to local residents.

Beyond the Hudson

Bergstrom, J.C. and Loomis, J.B. (2017). Economic valuation of river restoration: An analysis of the valuation literature and its uses in decision-making. *Economics*, 17, 9-19.

<https://doi.org/10.1016/j.wre.2016.12.001>

This study reviewed literature that conducted economic valuation of river restoration to summarize existing knowledge in this area, primarily in the U.S. and Europe. They also discuss how these river restoration values have been used in decision-making. It should be noted that none of the economic valuation studies listed included the Hudson River, nor any river in the states of New York or New Jersey, revealing a literature gap for the Hudson River region as of the paper's writing in 2016. In concluding, the authors point out that the limited number of papers available to review (38 total) precludes its reliable use in policy or management decisions, but as river restoration projects increase in number, new meta-analyses may provide more applicable knowledge for new restoration projects being considered. Nearly half of the studies reviewed were published in the three years prior to this meta-analysis (2012-2015), motivated by dam removal efforts, marking an increasing trend in economic valuation and the need for further research in this area. Article cited by 93.

Chen, W.Y., Li, X., and Hua, J. (2019). Environmental amenities of urban rivers and residential property values: A global meta-analysis. *Science of the Total Environment*, 693, 133628.

<https://doi.org/10.1016/j.scitotenv.2019.133628>

This review analyzed the existing literature for economic valuation of river ecosystems regarding residential property value. The meta-analysis found that of the three valuation scenarios analyzed, river view was associated with the highest increase in what residents were willing to pay, followed by river water quality, then river proximity. They also found a significant increase in willingness-to-pay for the environmental amenities of urban rivers after 2000, suggesting that public perception and appreciation of urban river amenities has increased over time. From a

utilitarian perspective, the authors argue that visual impacts could be a good priority for river restoration projects, and that river restoration should be prioritized in densely populated areas over places with low population densities, so more people can enjoy river views with a specific budget. Article cited by 45.

Choi, D.S. and Ready, R. (2021). Measuring benefits from spatially-explicit surface water quality improvements: The roles of distance, scope, scale, and size. *Resource and Energy Economics*, 63, 101108. <https://doi.org/10.1016/j.reseneeco.2019.07.002>

This study undertook a cost-benefit analysis of surface water quality improvement policies, specifically looking at three watersheds in Pennsylvania. By surveying households in the watershed, they find that value (assessed by willingness to pay) declines with distance in an approximately linear way, with weak indications that larger rivers are more valuable than smaller ones. Based on these findings, the authors suggest that it might be reasonable to assess and value small, location-specific water quality projects individually and then combine their values for practical purposes. Article cited by 16.

Millerd, F. (2005). The Economic Impact of Climate Change on Canadian Commercial Navigation on the Great Lakes. *Canadian Water Resources Journal*, 30(4), 269-280. <https://doi.org/10.4296/cwrj3004269>

This study estimates the economic impact of climate change on shipping costs using water level prediction data for the Great Lakes-St. Lawrence River under three different climate scenarios. Due to decreased capacity and increased number of trips due to low water, the authors predict a general increase in commercial shipping costs of 29 or 13 percent in 2050 for doubled atmospheric carbon dioxide levels and more moderate climate change, respectively. These results illustrate the impacts on major economic services provided by the river ecosystem, which will be altered by future climate change. Article cited by 63.

4. Relationships with ecological spaces and motivations to protect them

Studies in this category focused on individual and group-level connections and attachment to local ecological spaces and actions to take care of them. Related to the Hudson River, the literature explored social-emotional experiences from interactions with the river by focusing on either impact of flooding or volunteer and stewardship motivation. For the former, research explored how individuals adapt to and experience both chronic and acute flooding, highlighting the importance of local ecological knowledge. Stewardship studies aimed to understand why and how people engage with river restoration, looking at motivations such as place meaning, memories, and community connection related to the river. Beyond the Hudson, further research exists about the economic dependence of the river for a specific population, motivations to reduce plastic pollution in European waterways, and the health impacts of and social vulnerability to flooding, including disability, for which there is a noted gap in research.

See also:

- Section 2 (Beliefs, views, and perceptions of management): Toomey et al. (2021)

Hudson River

Campbell, L.K., Cheng, H., Svendsen, E., Kochnower, D., and Bunting-Howarth, K. (2021). Living with Water: Documenting Lived Experience and Social-Emotional Impacts of Chronic Flooding for Local Adaptation Planning. *Cities and the Environment*, 14(1), 4. <https://doi.org/10.15365/cate.2021.140104>

This study examines how chronic nuisance flooding (which can occur in absence of a major rainfall event) impacts residents and visitors. The authors interviewed 9 NYC Community Flood Watch participants to document living conditions, the impact of flood events, and outlook; using this co-production approach, the authors aim to better understand social-emotional impacts and personal adaptations to inform climate adaptation planning and communications to be more responsive and locally sensitive. The participants highlighted emotional distress as well as social and economic impacts like missing work, school, or appointments. Through interviews, the researchers identified hyper-local flooding hotspots and demonstrated the local ecological knowledge being developed and shared through networks of neighbors in communities dealing with sunny day flooding. This hyper-local knowledge and social-emotional impacts can provide useful insight into current and future challenges but has not been extensively studied. Article cited by 7.

Enqvist, J.P., Campbell, L.K., Stedman, R.C., and Svendsen, E.S. (2019). Place meanings on the urban waterfront: a typology of stewardships. *Sustainability Science*, 14, 589-605. <https://doi.org/10.1007/s11625-019-00660-5>

This article analyzes civic engagement among groups engaged with stewardship of waterfronts and water bodies in New York City, based on their perception of the place's purpose or meaning to them. Groups view the site in varied ways as a place of work, home, or use, and some groups vision a restoration of the site to its past state, while others want to maintain its current state, and others wish to transform the site into something new. Place meanings can help differentiate the types of stewardship and different roles that civic actors can take in environmental management. The authors outline different types of stewardship, including conservation,

restoration, placemaking (transforming a place into something new), activity-oriented, and professionalized stewardship (e.g., public agencies, private trusts, or paid non-profit staff). Article cited by 43.

Krasny, M.E., Crestol, S.R., Tidball, K.G., and Stedman, R.C. (2014). New York City's oyster gardeners: Memories and meanings as motivations for volunteer environmental stewardship. *Landscape and Urban Planning*, 132, 16-25. <https://doi.org/10.1016/j.landurbplan.2014.08.003>

This study explores how the act of environmental stewardship benefits volunteer oyster gardeners in New York City, who are motivated both by altruistic environmental concerns as well as social-ecological memories, symbolic meanings, and sense of place associated with local sites and key species. The authors suggest considering emotional connections to places and species as part of the services provided by environmental stewardship. By incorporating these functions into frameworks for understanding volunteer motivation, organizers of these volunteer efforts could enhance the benefits for the human and overall ecological community. Article cited by 107.

Rothenberger, M., Armstrong, A., and Spitz, M. (2018). Social-ecological system responses to Hurricane Sandy in the Hudson-Raritan Estuary. *Ambio*, 47, 284-297. <https://doi.org/10.1007/s13280-017-0949-z>

This study explored conditions in the Hudson-Raritan estuary before and after Hurricane Sandy, including water quality metrics, which recovered faster; biological community changes, which persisted longer; and human interaction with the water, which saw anglers continuing to fish despite degradation of the ecosystem. While more focused on the biophysical impacts of Hurricane Sandy, this study also discusses how anglers viewed the ecosystem changes, expressing optimism about the estuary's capacity to provide fishable species and their own adaptive capacity to change methods. The authors express a concern that the combined effects of ecosystem change, and post-storm fishing pressures could contribute to feedbacks that further degrade the environment. Article cited by 7.

Beyond the Hudson

Bonthoux, S., Boulay, A., and Voisin, L. (2023). City dwellers' experiences and attitudes towards wild places based on an urban river. *Urban Ecosystems*. <https://doi.org/10.1007/s11252-023-01485-y>

This study analyzed human use of the Loire River in the French city of Blois. As urban cities grow and wilderness areas with little human intervention shrink, understanding how city-dwellers relate to the more "wild" elements of nature can be useful in designing spaces that enhance well-being and connection to nature for people that live in urban spaces. The methods used were both activity-mapping through observation of visitor behavior and questionnaires to directly survey visitors, followed by statistical analysis to elucidate themes in visitors' activities, attitudes, and experiences engaging with the Loire River. Management decisions that both preserved the river's near-wild state, enhancing habitat for flora and fauna, and promoted user access to the river through facilities like benches and bike paths, increased users' perceived appeasement and nature-connectedness. The authors suggest that managers consider the

effectiveness of near-wild spaces in urban areas in offering benefits to city-dwellers' well-being. No citations listed.

Hale, R.L., Cook, E.M., and Beltran, B.J. (2019). Cultural ecosystem services provided by rivers across diverse social-ecological landscapes: A social media analysis. *Ecological Indicators*, 107.

<https://doi.org/10.1016/j.ecolind.2019.105580>

This study used social media to quantify and map cultural ecosystem services (CES) offered by rivers in Idaho, focusing on CES categories, specific CES types, and the ecosystem characteristics that provision those CES. This study highlighted that public access to these landscapes through proximity or infrastructure is a requirement for CES, which is not necessarily the case for other ecosystem services, such as the provisioning of food or fiber. Social media was found to be an effective and efficient methodology for measuring CES on a regional scale and is recommended, in combination with landscape and socio-cultural data, to understand how CES are provisioned and anticipate future changes. For example, large rivers and cliff land cover were associated with more CES provisioning, perhaps because of increased accessibility to these areas or due to their striking visuals in contrast to developed land or dense forest which can impede landscape views. Connecting CES to the biophysical, social, and built environments can help build knowledge of how to enhance these landscapes effectively, and the study was able to weakly, but significantly, associate specific CES with landscape features. Article cited by 70.

Kosanic, A., Petzold, J., Martin-Lopez, B., and Razanajatovo, M. (2022). An inclusive future: disabled populations in the context of climate and environmental change. *Current Opinion in Environmental Sustainability*, 55, 101159. <https://doi.org/10.1016/j.cosust.2022.101159>

This study focused on the disproportionate impact of climate and environmental change on disabled populations and lack of research on these impacts, proposing future research that includes disability and other marginalized identities in future adaptation to these changes. They particularly highlight the Sustainable Development Goals (SDGs) and Agenda 2030, advocating for engaging disability experts in the strategy and policies to reach these goals. By including more research on disabled communities, policy is more likely to be inclusive of other marginalized identities with which disability often intersects and will contribute to the overall SDGs (e.g., addressing healthcare needs for disabled people could also impact poverty and education goals). Article cited by 51.

Lane, K., Charles-Guzman, K., Wheeler, K., Abid, Z., Graber, N., and Matte, T. (2013). Health Effects of Coastal Storms and Flooding in Urban Areas: A Review and Vulnerability Assessment. *Journal of Environmental and Public Health*, 913064. <http://dx.doi.org/10.1155/2013/913064>

This study reviewed studies of health impacts from storm events, focusing on impacts in urban coastal areas. The authors considered health impacts broadly, including secondary hazards, mental health effects, and risks during clean-up and recovery activities. They also characterized vulnerability to storm impacts by factors like age, pre-existing physical and mental health conditions, and low income. For priorities in future planning, the authors recommend

minimizing infrastructure vulnerabilities, enhancing resilience of important systems like power delivery, buildings, transportation, and health care. They also emphasized the importance of interdisciplinary approaches and community engagement in developing climate resilient cities. Article cited by 255.

5. Inclusive stakeholder engagement

Inclusive engagement encompasses the research that emphasizes broader participation in river management and research by actors beyond the public and private sector actors that have commonly been included in decision-making, including community scientists and local residents whose knowledge has often been overlooked. On the Hudson River, we included an article about partnerships and coalition-building in three urban waterways in New York City as well as an article that critiqued the design and implementation of a survey about water governance to understand the ways in which race and class have been barriers to participation in water governance. Outside of the Hudson River, there is more research including indigenous knowledge and local ecological knowledge into the management of rivers. These articles offered some indicators of the characteristics of partnerships to enable groups to more actively historically marginalized to shape research, conservation, and management efforts.

See also:

- Section 4 (Relationships with ecological spaces): Campbell et al. (2021), Krasny et al. (2014)
- Section 6 (Climate resilience): Dilling, et al. (2023)

Campbell, L.K. (2006). Civil society strategies on urban waterways: stewardship, contention, and coalition building. Thesis, MIT, Dept. of Urban Studies and Planning.

<http://hdl.handle.net/1721.1/37658>

This master's thesis investigates strategic approaches to protection of urban waterways by civil society actors on the Bronx River, Newtown Creek, and Gowanus Canal. The author hypothesizes, based on these case studies, that civil society actors (operating outside of the public and private sectors) are generally early advocates for river restoration, followed by the public and then private sectors. Cooperation among these groups varied among the three waterways studied, and the author concludes that, while specific strategies could not be classified as "better" or "worse" than others, including elements of collaboration, advocacy, and independent stewardship allowed organizations to be flexible in problem-solving and decision-making about their waterway restoration actions. Article cited by 9.

Finewood, M.H., Sneegas, G., Friedenber, C., and Guevarez, L. (2021). A Critical Reflexive Audit of Qualitative Water Governance Research in the Lower Hudson Valley, New York. Water Alternatives, 14(3), 755-772. <https://www.water-alternatives.org/index.php/alldoc/articles/vol14/issue-3-2/643-a14-3-6/file>

This paper is an evaluation of the authors' research plan to survey stakeholders about water governance in the Lower Hudson Valley, NY. After noting the disconnect between regional diversity and racial and income diversity in survey participation, the researchers conducted additional interviews and reviewed existing scholarship on watershed governance, participation, intersectionality, and critical race theory to identify themes in the barrier to more diverse participation. Class, interpersonal racism, systemic racism, and lack of representation were all highlighted during interviews as barriers to participation. The authors recommend further research audits to identify biases and privileges in research design and methodology,

highlighting the role of the researcher in producing knowledge about the river and water management that accurately encompasses the diverse interactions with it. No citations listed.

Beyond the Hudson

Field-Juma, A. and Roberts-Lawler, N. (2021). Using Partnerships and Community Science to Protect Wild and Scenic Rivers in the Eastern United States. *Sustainability*, 13(4), 2102.

<https://doi.org/10.3390/su13042102>

The researchers here ask how community science and community partners can help create lasting protections for rivers. In the case of two eastern U.S. rivers in New Jersey and Massachusetts, partnerships were federally designated in the areas with a patchwork of private and public land ownership, and needed to engage municipal, state, federal and local non-profit actors to implement river conservation plans. There were many benefits to engaging a range of stakeholders and maintaining long-term engagement by local groups who are committed to stewarding the river with data and knowledge production. For example, dam removals brought Shad back to the NJ river, and community water quality monitoring helped garner federal attention to wastewater treatment runoff concerns in the MA river. Benefits extended to the community scientist volunteers themselves; participants cited contributing to scientific knowledge, helping their community, and meeting others who care about the river/environment as the top three benefits they experienced. Article cited by 7.

Hammersley, M.A., Scott, C., and Gimblett, R. (2018). Evolving conceptions of the role of large dams in social-ecological resilience. *Ecology and Society*, 23(1), 40. <https://www.jstor.org/stable/26799069>

This article uses concepts from the adaptive cycle framework and cultural ecosystem services, particularly for Native Nations, to focus on the movement to decommission dams and how riparian communities engage in that process. In the specific case the researchers focus on in Washington State, “stakeholder-based collaborative governance incorporated knowledge coproduction and regulatory maneuvering to successfully overcome obstacles inherent in both dam decommissioning and subsequent restoration.” The article concludes by discussing how dam removal projects can exemplify progressive water management strategies when they actively embed governance with marginalized stakeholders to incorporate their perspectives and ultimately strengthen the socio-ecological system (SES) that relies on the river. Article cited by 18.

Herman-Mercer, N., Andre, A., Buschman, V., Blaskey, D., Brooks, C., Cheng, Y. Combs, E., et al. (2023). The Arctic Rivers Project: Using an Equitable Co-Production Framework for Integrating Meaningful Community Engagement and Science to Understand Climate Impacts. *Community Science*, 2(4), e2022CSJ000024. <https://doi.org/10.1029/2022CSJ000024>

This article presents efforts by the Arctic Rivers Project to conduct community-engaged research to increase collective understanding of the historical and potential future impacts of climate change on rivers, fish, and Indigenous communities. The researchers find that co-producing knowledge with Indigenous communities and building relationships with community members

to guide research in their local area can result in a more equitable process as well as more productive results that are useful to decision-making and management. Their approach to co-produce knowledge covered all aspects of the research process. Starting with developing the proposal by collaboratively to identifying the gap to address, the guidelines included establishing an indigenous advisory council with charters, establishing protocols for working together, developing data ownership guidelines, equalizing power dynamics, and growing cultural awareness. Article cited by 1.

6. Climate resilience

Climate resilience research on the Hudson River includes historic lessons of ecological and social resilience, conceptualizing community resilience, and disaster risk management from adverse climate events, including its compounding impacts for socio-economically vulnerable groups. Outside of the Hudson River, we included studies that focus more on the future of climate adaptation, including potential demographic changes in response to climate migration away from the coast and potential data sharing innovations for local adaptation. A review of literature on disabled populations in the context of climate and environmental change was also included to highlight the opportunities to further investigate the vulnerabilities of disabled populations to future change and adaptation efforts on the Hudson River.

Hudson River

O’Neil, J.M., Taillie, D., Walsh, B., Dennison, W.C, Bone, E.K., Reid, D.J., Newton, R., et al. (2016). New York Harbor: Resilience in the face of four centuries of development. *Regional Studies in Marine Science*, 8(2), 274-286. <https://doi.org/10.1016/j.rsma.2016.06.004>

The article is a review which highlights the importance of not only ecological resilience but also “social resilience,” which is not specifically defined but includes the response to major social crises such as terrorist attacks, for future development to be sustained in New York Harbor. Despite a long history of environmental degradation, organizations that support science, education, and environmental restoration provide social resilience; they use Billion Oyster Project (BOP) and the program Curriculum and Community Enterprise for Restoration Science (CCERS) housed within it as a case study. This educational program that engages community groups in restoration was found to bolster social resilience as well as ecological resilience and restoration. Cited 8 times, including one policy citation in 2021. Article cited by 13.

Rosenzweig, C. and Solecki, W. (2014). Hurricane Sandy and adaptation pathways in New York: Lessons from a first-responder city. *Global Environmental Change*, 28, 395-408. <https://doi.org/10.1016/j.gloenvcha.2014.05.003>

In this paper, the authors aimed to understand how New York City officials are approaching climate change, using the ongoing Hurricane Sandy response as a case study. The paper finds that Sandy led government officials in NYC to include climate change risk in their rebuilding efforts. The authors emphasize the importance of flexible adaptation pathways, inclusion of the entire metropolitan region in planning, and co-generating knowledge about climate risk by both stakeholders and scientists. They acknowledge cultural and other barriers to implementation, like a culture of “toughness” that contrasts programs like NYS’s NY Smart Home Buyout program. Article cited by 294.

Tedesco, M., Foster, S., Baptista, A., and Zuzak, C. A Multi-Hazard Climate, Displacement and Socio-Vulnerability Score for New York City. *Sustainability*, 16(1), 42. <https://doi.org/10.3390/su16010042>

In this study, the researchers developed a metric called the Climate Displacement and Socio-Vulnerability (CDSV) score for New York City, considering climate hazards holistically, along with displacement and social vulnerability. They identified hotspots of vulnerability, finding that Black

and Latin/Hispanic populations in the South Bronx, South Brooklyn, and Queens are disproportionately exposed to hazards, particularly heatwaves. They also found a statistically significant relationship between CDSV score and the prevalence of asthma and diabetes, particularly in the case of heatwaves. Given the interconnectedness of climate justice, social inequity, and health, the authors emphasize the need for policymakers and organizations to address climate change as social justice and health issues, taking urgent action to incorporate other hazards and more expansive socio-vulnerability data to gain a fuller understanding of climate displacement and vulnerability. No citations listed.

Beyond the Hudson

Dilling, L, Daly, M.E., Travis, W.R., Ray, A.J., and Wilhelmi, O.V. (2023). *Global Environmental Change*, 79, 102649. <https://doi.org/10.1016/j.gloenvcha.2023.102649>

In this study, the authors identify two types of adaptation: incremental (small changes) and transformative (fundamental shifts), then study how adaptive capacity might support these adaptation types, particularly transformative adaptation that requires deep changes in how people value water. The study sites were three city water systems that recently experienced drought: Austin Water (Austin, Texas); Southern Nevada Water Authority (Las Vegas, Nevada), and Tampa Bay Water (Tampa Bay, Florida). They gathered data through semi-structured interviews. Based on the cases studied, findings show that crisis response can lay the groundwork for more lasting transformative adaptation by building adaptive capacity by collaboration and communication among water managers, decision-makers, and the public. Article cited by 11.

Hauer, M.E., Jacobs, S.A., and Kulp, S.A. (2024). *Climate migration amplifies demographic change and population aging. Sustainability Science*, 121(3), e2206192119. <https://doi.org/10.1073/pnas.2206192119>

This study takes a deeper look at climate migration, examining the demographic impacts on origin and destination communities, where climate migrants are leaving and arriving, respectively. Accelerated aging of origin communities is a particular concern, and an important consideration in climate adaptation; for example, first floor elevations to build flood resiliency might be maladaptive for an aging population facing mobility issues. Results of this study also show that demographic amplification will potentially be much larger than previously reported in the literature and could be underestimated. Article cited by 4.

Kosanic, A., Petzold, J., Martin-Lopez, B., and Razanajatovo, M. (2022). *An inclusive future: disabled populations in the context of climate and environmental change. Current Opinion in Environmental Sustainability*, 55, 101159. <https://doi.org/10.1016/j.cosust.2022.101159>

This article reviews the literature on how climate and environmental change affects disabled populations, acknowledging intersectionality with other marginalized groups, finding that disabled populations are not widely considered as an essential stakeholder group in the existing scientific literature on climate and environmental change. At the same time, there has been

progress in sustainability policy such as the UN Agenda 2030 for Sustainable Development, which includes disability as one of the attributes of people who are likely to be disproportionately impacted by climate change. The authors also highlight the Sendai Framework for Disaster Risk Reduction 2015-2030, outlines three steps for inclusive and effective disaster risk management: “a) data collection on emerging trends regarding disabled populations; b) engagement and promotion of people with disabilities in research; and c) incorporation of existing knowledge of different disabled groups (including science-based and Indigenous and local knowledge) into risk management”. The authors emphasize that international sustainability research should actively engage disabled communities as relevant stakeholders, including scientists, other experts, and members of the public with disabilities, in order to develop inclusive strategies for climate change adaptation. Article cited by 51.

Nichols, C.R., Wright, L.D., Bainbridge, S.J., Cosby, A., Henaff, A., Loftis, J.D., Cocquempot, L., et al. (2019). Collaborative Science to Enhance Coastal Resilience and Adaptation. *Frontiers in Marine Science*, 6, 404. <https://doi.org/10.3389/fmars.2019.00404>

This article reviews the current state of data-driven coastal resilience projects, providing a summary of potential initiatives, challenges, and overarching themes. Diverse partnerships and an emphasis on virtual collaboration across broader geographies could make people more resilient to coastal changes, and the authors emphasize the importance of local-scale knowledge, since global solutions are not applicable in all local scenarios. A virtual forum for increased collaboration could allow for more data to be collected, shared, and utilized in an emergency response scenario. They also suggest that the virtual consortium collaboratively advance coastal resilience and adaptation by prioritizing developing of new tools and technology to deliver useful emergency preparedness information; studying people’s use of emergency response data and information; and studying outcomes for people incorporating social science research. Challenges include organizing data-sharing, facilitating effective collaboration and supporting places with less resources but a high-risk coastline. Article cited by 36.

Smith, J.G., DuBois, B., and Krasny, M.E. (2015). Framing for resilience through social learning: impacts of environmental stewardship on youth in post-disturbance communities. *Sustainability Science*, 11(3), 441-453. <https://doi.org/10.1007/s11625-015-0348-y>

In this study, the researchers study three examples (one in New York, two in Colorado) of civic ecology education (CEE) for youth in the aftermath of a natural disaster, focusing on (1) the degree to which CEE programs foster social learning and (2) the types of cognitive shifts that occur among CEE program participants. They define social learning as “a process of individual and collective frame alignment situated in communicative action.” A notable change in participants’ thinking was a shift from focusing on the impacts of disturbance before the program to solutions and actions they could take in response to the disturbance after the program. The social learning attributes associated with resilient communities were elevated after the CEE program, suggesting that these active and cooperative stewardship activities could be beneficial for overall community resilience. Article cited by 48.