

# **Preliminary Literature-Search on the Effect of Dam Removal and Water-Level Change on Property- and other Economic Values: Study Citations and Author Abstracts (May 3, 2017)**

## **I. Property Values**

Bohlen, C. and L. Y. Lewis (2009). "Examining the Economic Impacts of Hydropower Dams on Property Values using GIS." Journal of Environmental Management **90**: S258-S269.

This paper examines dam removal and the measurement of the impacts of dams on local community property values. Valuable lessons may be found. In the United States, hundreds of small hydropower dams will come up for relicensing in the coming decade. Whether or not the licensees are renewed and what happens to the dams if the licenses expire is a subject of great debate. Dams are beginning to be removed for river restoration and fisheries restoration and these "end-of-life" decisions may offer lessons for countries proposing or currently building small (and large) hydropower dams. What can these restoration stories tell us? In this paper, we examine the effects of dams along the Penobscot River in Maine (USA) on residential property values. We compare the results to findings from a similar (but ex post dam removal) data set for properties along the Kennebec river in Maine, where the Edwards Dam was removed in 1999. The Penobscot River Restoration Project, an ambitious basin-wide restoration effort, includes plans to remove two dams and decommission a third along the Penobscot River. Dam removal has significant effects on the local environment, and it is reasonable to anticipate that environmental changes will themselves be reflected in changes in property values. Here we examine historical real estate transaction data to examine whether landowners pay a premium or penalty to live near the Penobscot River or near a hydropower generating dam. We find that waterfront landowners on the Penobscot or other water bodies in our study area pay approximately a 16% premium for the privilege of living on the water. Nevertheless, landowners pay LESS to live near the Penobscot River than they do to live further away, contrary to the expectation that bodies of water function as real estate amenities and boost local property values. Results with respect to the effect of proximity to hydropower generating plants are equivocal. Homeowners pay a small premium for houses close to hydropower dams in our region, but the statistical significance of that result depends on the specific model form used to estimate the effect. Consideration of the social and economic impacts of dam removal-based river restoration can complement studies of the ecological impacts of the practice. Such studies help us understand the extent to which human society's subjective perception of value of aquatic ecosystems relates to objective measures of ecosystem health. The paper also illustrates how geographic information systems (GIS) can help inform these analyses.

Cohen, J. P., et al. (2016) Proximity to a Water Supply Reservoir and Dams: Is there Spatial Heterogeneity in the Effects on Housing Prices? Social Science Research Network (SSRN) 29

An understanding of the spatial variation in the impacts of living near reservoirs, dams, and undevelopable land is important in explaining residential property values. While there is a body of literature on the effects of proximity to dams and reservoirs on housing prices, little known research attempts to determine if various individual houses are impacted differently depending on their locations and years of sale. We examine properties in Barkhamstead, Connecticut that sold between 2001 and 2015. We utilize non-parametric regression techniques to allow for the possibility that the major reservoirs, dams and undevelopable land areas, affect various house prices differently, depending on their locations and when they are sold. We find that for the most part, proximity to dams leads to lower housing sale prices, with the magnitudes of these effects varying across geographic space and over time. A difference-in-differences approach indicates that the willingness to pay for distance from the dams

decreased after the most recent housing crisis. In general, undevelopable land area is valued as an amenity in this rural town. The signs of the effects of proximity to the reservoir vary - some properties benefit from proximity while others experience lower sale prices when they are closer to the reservoir. We also control for other key housing characteristics and environmental variables, such as elevation, numbers of bedrooms and baths, age of properties, year of sale, square footage and acreage, and others. We generate maps of the signs and magnitudes of the coefficients for several of the key variables to illustrate the spatial heterogeneity.

Dickes, L. A. and E. L. Crouch (2015). "The Impact of Changing Lake Levels on Property Values." The Review of Regional Studies **45**(3): 221-235.

This study uses hedonic pricing models to examine the relationship between lake levels and property values for properties adjacent to Lake Thurmond. Lake Thurmond is located along the Savannah River Basin, bordering Georgia and South Carolina. Of the 1,030 properties from 2000-2009 for which data was reliable and available, 388 were lake front homes. The model of the effect of lake level on sales prices also includes home characteristics, home condition variables, lake attributes, and macroeconomic control variables. Results reveal a statistically significant change in sales price when the lake is closer to full pool. Results confirm that declining Lake Thurmond water levels have an impact on real estate values within some ranges below full pool. As climate variability places increasing pressure on communities, future research would benefit from further exploration into the relationship between economic activity and changing lake levels.

Kashian, R., et al. (2016). "Lake Drawdown Revisited: The Value of Two Inches of Water." Journal of Business & Economics Research (Online) **14**(1): 7-18.

This paper uses a hedonic price model to estimate the impact of water level on the value of real estate on Lake Koshkonong in Wisconsin. Hedonic techniques are employed to show that a reduction in the lake's water level has a significant effect on shoreline property values. The body of existing research demonstrates that changes in both the subjective and objective indicators of value are important for estimating the implicit value of water quality in hedonic analysis. This paper provides new evidence on the economic harm to lake communities created by the reduction of water levels.

Lansford, N. H. and L. L. Jones (1995). "Recreational and Aesthetic Value of Water Using Hedonic Price Analysis." Journal of Agricultural and Resource Economics **20**(2): 341-355.

Historically, water allocation focused on quantities demanded by consumptive uses. As quantity demand grows, efficient allocation among consumptive and nonconsumptive uses becomes more critical. This hedonic approach provides information regarding recreational and aesthetic (RA) value for a central Texas lake. The model indicates several statistically significant RA characteristics of housing; proximity is the most important. Waterfront properties command a premium, but marginal RA price falls rapidly with increasing distance. Marginal RA values are estimated for selected water levels and are found to have a lower marginal price per acre-foot than many agricultural uses.

Lewis, L. and C. E. Landry (2017). "River Restoration and Hedonic Property Value Analyses: Guidance for Effective Benefit Transfer." Water Resources and Economics (accepted manuscript).

Using home sales data for 10 years and four sites in Maine (USA), we estimate marginal willingness to pay (WTP) for river proximity and present a criterion-validity test of the use of benefit transfer. Given the degraded state of Maine's waterways (partly due to damming of rivers for commerce), we find positive, concave relationships between housing values and

river distance. We find statistically different estimates of marginal WTP across the four markets, but results from the same watershed are more similar. Also, we find mean WTP is diminishing with average river distance, which is consistent with the empirical functional form. Comparing original and benefit transfer estimates, we find errors range from 29% to over 1,000%, growing with spatial distance between the study and transfer sites. Lastly, we estimate a difference-in-difference model for the single market that has witnessed dam removal, and we apply the results to the other markets (that could undergo dam removal as well). While informative, our results suggest caution in the use of benefit transfer in applications of hedonic property price analysis.

Lewis, L. Y., et al. (2008). "Dams, Dam Removal, and River Restoration: A hedonic property value analysis." Contemporary Economic Policy **26**(2): 175-186.

This article presents the results of a hedonic property value analysis for multiple hydropower sites along the Kennebec River in Maine, including the former site of the Edwards Dam in Augusta, Maine. The effect of the removal of the Edwards Dam on the Kennebec River in Maine is examined through consumer's marginal willingness to pay to be close to or distant from the dam site. Data from both before and after the dam was removed are used to estimate changes in marginal prices. A similar data set is also used to look at the effects of the remaining upstream dams on property values. This article presents one of the first (to our knowledge) ex post analyses on the economic impact of dam removal on property values. As more privately owned dams in the United States come up for relicensing, evaluating the impacts with and without the dam will become increasingly important. This work can help inform those analyses.

Loomis, J. and M. Feldman (2003). "Estimating the Benefits of Maintaining Adequate Lake Levels to Homeowners using the Hedonic Property Method." Water Resources Research **39**(9): WES2-1.

The hedonic property method was used to estimate residents' economic benefits from maintaining high and stable lake levels at Lake Almanor, California. Nearly a thousand property transactions over a 14-year period from 1987 to 2001 were analyzed. The linear hedonic property regression explained more than 60% of the variation in-house prices. Property prices were negatively and significantly related to the number of linear feet of exposed lake shoreline. Each additional one foot of exposed shoreline reduces the property price by \$108–\$119. A view of the lake added nearly \$31,000 to house prices, while lakefront properties sold for \$209,000 more than non-lake front properties.

Provencher, B., et al. (2008). "Does Small Dam Removal Affect Local Property Values? An Empirical Analysis." Contemporary Economic Policy **26**(2): 187-197.

This paper uses hedonic analysis to examine the impact of small dam removal on property values in south-central Wisconsin. Data on residential property sales were obtained for three categories of sites: those where a small dam remains intact, those where a small dam was removed, and those where a river or stream has been free-flowing for at least 20 yr. The primary conclusions that emerge from the data are that shoreline frontage along small impoundments confers no increase in residential property value compared to frontage along free-flowing streams and that nonfrontage residential property located in the vicinity of a free-flowing stream is more valuable than similar nonfrontage property in the vicinity of a small impoundment.

## II. Other Economic Values

Baker, C. D., et al. (2015). Economic & Community Benefits from Stream Barrier Removal Projects in Massachusetts. Cambridge, MA, Industrial Economics, Inc.  
*No abstract available.*

Borisova, T., et al. (2017). Is the Tide is Changing? Assessing Costs and Benefits of Dam Removal and River Restoration: A Case Study in Florida. 2017 Annual Meeting, February 4-7, 2017, Mobile, Alabama, Southern Agricultural Economics Association.

Nationwide, dam removal discussion is fueled by the increased interest in environmental restoration and high dam maintenance and retrofit costs (Stanley and Doyle 2003, Smith 2006). Unlike the debate in other states, for Florida's Kirkpatrick Dam impounding Ocklawaha River, environmental protection arguments are made by both the dam preservation supporters and their opponents. The supporters are interested in bass fishing in the impoundment, while the opponents argue for improving migratory fish passage and upstream river ecology by removing the dam. This study estimates of the value visitors derive from recreation and the economic contribution of river-based recreation to explore the economic arguments related to the recreational use of the impounded vs. natural stretches of the river and examine potential economic implications of the dam removal. We utilize a combination of site visitation data collected by government agencies and intercept visitor survey responses (n = 340). By examining the differences in the survey responses among the visitors engaged in different types of recreational activities, residing in different counties, visiting different recreational locations, and having different income status, we examine distributional issues associated with preserving and removal of the dam.

Born, S. M., et al. (1998). "Socioeconomic and Institutional Dimensions of Dam Removals: The Wisconsin Experience." Environmental Management **22**(3): 359-370.

There are tens of thousands of small dams in the United States; many of these aging structures are deteriorating. Governments and dam owners face decisions regarding repair or removal of these structures. Along with the many benefits society derives from dams and their impoundments, numerous recent ecological studies are revealing the extensive alteration and degradation of river ecosystems by dams. Dam removal—a principal restoration strategy—is an infrequent event. The major reasons for removal have been public safety and the high costs associated with repair; the goal of river ecosystem restoration now warrants greater attention. Substantial study is being given to the environmental aspects of dams and dam removals, but very little attention has been given to the socioeconomic and institutional dimensions associated with the removal of dams, although these factors play a significant role in the removal decision-making process. Based on a case study of dam removals in Wisconsin—where more than 30 of the state's 3600 small dams have been removed in the past few decades—legal, financial, and socioeconomic issues associated with dam removal are documented and assessed. Dam removal has been complex and contentious, with limited community based support for removal and loss of the impounded waters. In cases examined here, the estimated costs of repairing a dam averaged more than three times the cost of removal. The availability of governmental financing has been a key determinant in removal decisions. Watershed-scale ecological considerations are not major factors for most local interests. As watershed management and restoration increasingly include dam removal options as part of an integrated strategy, more attention will need to be focused on socioeconomic factors and stakeholder perspectives—variables that strongly influence the viability of this management alternative.

Loomis, J. (2002). "Quantifying Recreation use Values from Removing dams and Restoring Free-Flowing Rivers: A Contingent Behavior Travel Cost Demand Model for the Lower Snake River." Water Resources Research **38**(6): 2-1-2-8.

A travel cost demand model that uses intended trips if dams are removed and the river restored is presented as a tool for evaluating the potential recreation benefits in this counterfactual but increasingly policy relevant analysis of dam removal. The model is applied to the Lower Snake River in Washington using data from mail surveys of households in the Pacific Northwest region. Five years after dam removal, about 1.5 million visitor days are estimated, with this number growing to 2.5 million annually during years 20–100. Using the travel cost method model estimate of the value of river recreation, if the four dams are removed and the 225 km river is restored, the annualized benefits at a 6.875% discount rate would be \$310 million. This gain in river recreation exceeds the loss of reservoir recreation but is about \$60 million less than the total costs of the dam removal alternative. The analysis suggests this extension of the standard travel cost method may be suitable for evaluating the gain in river recreation associated with restoration of river systems from dam removal or associated with dam relicensing conditions.

Loomis, J. (2011). Recreational Benefits of Removing Dams and Restoring Free-Flowing Rivers: An Example Micro-meta-analysis of the Contingent Visitation Benefits of Removing Dams. Modern Cost-benefit Analysis of Hydropower Conflicts. P.O. Johansson and B. Krström. Northampton, MA, Edward Elgar: 22-34.

*No abstract available.*

Loomis, J., et al. (2000). "Measuring the Total Economic Value of Restoring Ecosystem Services in an Impaired River Basin: Results from a Contingent Valuation Survey." Ecological Economics **33**(1): 103-117.

Five ecosystem services that could be restored along a 45-mile section of the Platte river were described to respondents using a building block approach developed by an interdisciplinary team. These ecosystem services were dilution of wastewater, natural purification of water, erosion control, habitat for fish and wildlife, and recreation. Households were asked a dichotomous choice willingness to pay question regarding purchasing the increase in ecosystem services through a higher water bill. Results from nearly 100 in-person interviews indicate that households would pay an average of \$21 per month or \$252 annually for the additional ecosystem services. Generalizing this to the households living along the river yields a value of \$19 million to \$70 million depending on whether those refusing to be interviewed have a zero value or not. Even the lower bound benefit estimates exceed the high estimate of water leasing costs (\$1.13 million) and conservation reserve program farmland easements costs (\$12.3 million) necessary to produce the increase in ecosystem services.

Loomis, J. B. (1996). "Measuring the Economic Benefits of Removing Dams and Restoring the Elwha River: Results of a Contingent Valuation Survey." Water Resources Research **32**(2): 441-447.

The contingent valuation method was used to obtain estimates of willingness to pay for removing the two dams on the Elwha River on the Olympic Peninsula in Washington State and restoring the ecosystem and the anadromous fishery. Using the dichotomous choice voter referendum format, the mean annual value per household is \$59 in Clallam County, \$73 for the rest of Washington, and \$68 for households in the rest of the United States. The aggregate benefits to residents of the State of Washington is \$138 million annually for 10 years and between \$3 and \$6 billion to all U.S. households. These estimates suggest that the general public would be willing to pay to remove old dams that block salmon migration.

McClenachan, L., et al. (2015). "Social Benefits of Restoring Historical Ecosystems and Fisheries: Alewives in Maine." Ecology and Society **20**(2): 31.

Restoration of coastal ecosystems provides opportunities to simultaneously restore historical fisheries and ancillary ecosystem and social benefits that were historically derived from functioning ecosystems. In Maine, dam removal and other ecosystem restoration efforts have positively impacted anadromous fish, with local populations of alewives (*Alosa pseudoharengus*) rapidly recovering to near historical population abundances in some locations. This research investigates the social benefits conferred by the restoration of habitat connectivity, fish populations, and local small-scale fisheries. Using municipal fisheries data and interviews with stakeholders in coastal Maine, it describes a suite of both direct and indirect benefits: a reversal of the "shifting baselines syndrome" and a motivation to manage fisheries sustainably, diversification of local economies and fisheries, community building and an increased sense of local pride, a demographic broadening of the conservation community, and enhanced ecosystem services and recreational opportunities. As well, it identifies a positive feedback between economic benefits and other social benefits, with revenue earned from alewife fisheries enhancing community engagement and providing motivation for further restoration. Placing ecological restoration efforts into this larger social context—rather than simply evaluating them based on immediate economic benefits—provides a broader framework to assess overall societal benefits derived from restoration efforts.

Mullens, J. B. and V. Wanstreet (2010). "Using Willingness-to-Pay Surveys when Assessing Dam Removal: A New Hampshire Case Study." The Geographical Bulletin **51**(2): 97.

As dams in the United States age and become obsolete and river restoration emerges as a new priority, dam removals have increased. Feasibility studies serve to detail the costs and benefits of such proposed dam removals; however, most do not consider intangibles such as the benefits derived from reconnecting seasonal fish habitat or improving the biological diversity within a river. In this research, a willingness-to-pay survey was used to assign a monetary value to intangible goods associated with the proposed removal of an historic dam on the Ashuelot River in southwestern New Hampshire. Within the town where the dam is located, we administered an intercept survey in order to document environmental, historic, and existence values associated with the dam. Results indicated that the environmental benefits of removing the dam, such as improving water quality and restoring fish populations, were highly valued by surrounding community members, while historic and existence values associated with keeping the dam were significantly lower. The results from this analysis provide further support for removal of this dam.

Reilly, K. H. and J. F. Adamowski (2017). "Stakeholders' Frames and Ecosystem Service Use in the Context of a Debate over Rebuilding or Removing a Dam in New Brunswick, Canada." Ecology and Society **22**(1): Article 17.

As many dams are starting to reach the end of their life spans, discussions about whether they should be retained or removed are becoming more common. Such debates are often controversial, but little is known about stakeholders' opinions about the issue. We use frame theory to describe how stakeholders perceive a decision on the future of the Mactaquac Dam in New Brunswick, Canada. Frames describe how people make sense of a situation by determining what is important and inside the frame, and what is outside the frame, based on their past experiences and knowledge. We explore whether the benefits that people realize from ecosystems (ecosystem services) influence their frames of dam removal. Based on interviews with 30 stakeholders, we found that participants who preferred to retain the dam aimed to prioritize the social and economic stability of the area, which relied on the ecosystem services provided by the dammed river. They emphasized the quality of the current ecosystem that has developed around the dam and preferred to avoid disturbing it. By contrast, those

who preferred to remove the dam framed the decision as an opportunity to restore the ecology and social and economic activities that were present before the dam was built. These frames were influenced by participants' use of ecosystem services—both focus on the ecosystem services they use, while minimizing the benefits of others. Exploring frames allowed us to uncover the assumptions and biases implicit in their views, and identify topics for education campaigns as well as possible areas of agreement between parties. We conclude that ecosystem services are a relevant source of frames of a decision on a dam's future.

Robbins, J. L. and L. Y. Lewis (2008). "Demolish it and They Will Come: Estimating the Economic Impacts of Restoring a Recreational Fishery." Journal of the American Water Resources Association **44**(6): 1488-1499.

This paper presents the results of an ex post survey of recreational anglers for the lower Kennebec River, post-Edwards Dam removal. To the best of our knowledge, this study represents one of the first ex post analyses of fisheries restoration from dam removal. We find significant benefits have accrued to anglers using the restored fishery. Specifically, anglers are spending more to visit the fishery, a direct indication of the increased value anglers place on the improved fishery. Anglers are also willing to pay for increased angling opportunities on the river. These findings have policy implications for other privately owned dams that are currently undergoing relicensing and/or dam removal considerations. Our findings may also hold implications for fisheries that have deteriorated due to historic dam construction.

Smith, M. G. (2010). "Dam Removal: A Taxonomy with Implications for Economic Analysis." Journal of Contemporary Water Research and Education **134**(1): 7.

*No abstract available.*

Trout Unlimited (2001). Small Dam Removal: A Review of Potential Economic Benefits. Arlington, VA, Trout Unlimited.

*No abstract available.*

Warren, D. and F. J. Hitzhusen (2007). The Economics of Low-head Dam Removal: A Case Study on the Salmon River in Fort Covington, New York. Economic Valuation of River Systems. F. J. Hitzhusen. Northampton, MA, Edward Elgar: 67-85.

*No abstract available.*

Whitelaw, E. and E. Macmullan (2002). "A Framework for Estimating the Costs and Benefits of Dam Removal." BioScience **52**(8): 724-730.

Sound cost-benefit analyses of removing dams account for subsidies and externalities, for both the short and long run, and place the estimated costs and benefits in the appropriate economic context.

### III. Ex-Ante Project Impacts (General; No Dam-Related Studies)

Kiel, K. A. and K. T. McClain (1996). "House Price Recovery and Stigma after a Failed Siting." Applied Economics **28**(11): 1351-1358.

The costs of siting a locally undesirable facility include those borne by developers, local government, and those homeowners whose houses decline in value. When a siting fails, developer and government costs are still incurred, in addition to the costs of community opposition. However, the impact of a failed siting on residential real estate prices has not been assessed. In this study, house prices in a market surrounding a failed incinerator are examined. While proposing an incinerator did negatively impact house values, prices rebounded after the facility was cancelled. Residents did not attach any stigma to the site.

Neelawala, P., et al. (2015). "The Impact of Project Announcements on Property Values: An Empirical Analysis." Australasian Journal of Environmental Management **22**(3): 1-15.

The study examines the property value impacts of an announcement of a project which has potential environmental impacts as distinct from other studies that address costs associated with under-construction and the operating impacts of developments. The hypothesis is that the announcement of a proposed project with potential environmental impact creates uncertainty in the property market of the affected area, and this impact is greater on properties closer to the project than those farther from it. The results of the study confirm the hypothesis and indicate that the marginal willingness to pay for properties within a 5 km distance declined by AU\$17,020 per km proximity to the proposed heavy vehicle route, after the proposed route was announced. The results support the need for more holistic measurement of cost-benefit analysis of projects and provide a basis for improved consideration by policy makers of the rights of affected parties.

Torre, A., et al. (2015). "The Ex-Ante Impact of Conflict over Infrastructure Settings on Residential Property Values: The Case of Paris's Suburban Zones " Urban Studies **52**(13): 2404-2424.

The presence of nearby public facilities has an impact on real-estate values; for this reason, the market may reasonably anticipate that public infrastructure projects will affect house prices. But undesirable and semi-desirable facility location choices may be contested by nearby residents, as they are a source of negative externalities or expectations. In Paris's suburban zones, opposition to these infrastructures is frequent, and the official announcement of a project does not automatically mean it will be implemented. Through three case studies, we explore the way in which the expectation mechanism is affected by legal conflicts driven by nearby residents. We suppose that expectations depend on the probability that a given project will be realized. The variation is captured by a hedonic model. As conflicts amplify or reduce the certainty of the new facility's arrival, market perceptions of the infrastructure vary.

Yiu, C. Y. and S. K. Wong (2005). "The Effects of Expected Transport Improvements on Housing Prices" Urban Studies **42** (1): 113-125.

Improvements in transport were commonly found to have a positive effect on the price of housing. As the construction of infrastructure often lasts for years, it is plausible to assume that investors will take expected improvements into consideration when pricing and trading neighbourhood properties. However, there have been few investigations of such effects. This paper is an empirical study of whether premiums were paid for the expected benefits offered by a new tunnel before its completion. The results showed that there were positive price expectation effects well before the completion of the tunnel. The expectation effects allow the government to finance infrastructure projects by selling land in the affected districts in advance.