

Literature Review – List of Abstracts

Adamowicz et al. 1994. [Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities.](#)

A stated preference model and a revealed preference model for recreational site choice are examined and compared. Both models are based on random utility theory and the data are obtained from the same individuals. The stated preference model is based on the respondent's choice from hypothetical choice sets. Attributes in the stated preference model are based on the ranges of the actual levels of attributes in the revealed preference choice set and are presented to respondents using a fractional factorial statistical design. The results show that while independently estimated models appear to reflect different underlying preferences, joint estimation of the model parameters, including estimation of the relative scale parameter, provides evidence that the underlying preferences are in fact similar. Furthermore, combining the revealed and stated preference information yields other benefits in estimation.

Allan et al. 2015. [Using cultural ecosystem services to inform restoration priorities in the Laurentian Great Lakes](#)

Ecological restoration programs often attempt to maintain or enhance ecosystem services (ES), but fine-scale maps of multiple ES are rarely available to support prioritization among potential projects. Here we use agency reports, citizen science, and social media as data sources to quantify the spatial distribution of five recreational elements of cultural ES (CES) – sport fishing, recreational boating, birding, beach use, and park visitation – across North America's Laurentian Great Lakes, where current restoration investments exceed US\$1.5 billion. These recreational CES are widely yet unevenly distributed, and spatial correlations among all except park visitation indicate that many locations support multiple CES benefits. Collectively, these five service metrics correlate with tourism gross domestic product, indicating that local economies benefit from ecosystem conditions that support CES. However, locations of high recreational CES delivery are often severely affected by environmental stressors, suggesting that either ecosystem condition or human enjoyment of these recreational CES is resilient even to substantial levels of stress. Our analyses show that spatial assessments of recreational CES are an informative complement to ecosystem stress assessments for guiding large-scale restoration efforts.

Allan, J.D. and et al. 2017. [Ecosystem services of Lake Erie: spatial distribution and concordance of multiple services](#)

The Laurentian Great Lakes provide a wide range of ecosystem services (ES) whose spatial distribution and extent are largely unquantified, thus limiting our understanding of ES co-occurrence, magnitude of ES supply, and the incorporation of ES into environmental planning. We mapped the spatial distribution of twelve ES in the Lake Erie Basin, including three supporting, three provisioning and six recreational/cultural services at three scales of analysis: sub-basins, counties and natural or urban focal areas. Whether ES are quantified by number of service sites or service delivery, the concordance of services varied among locations. Some ES were found to be spatially correlated, likely due to common function, such as sport fishing, boat launches and marinas, and other ES were co-located according to shared 'human habitat' in or near urban centers, as seen with municipal parks and municipal water supply. Most ES were spatially uncorrelated, and significant associations were almost exclusively

positive. Total service delivery varied significantly among locations at both the county and focal area scales, indicating that areas of both high and low overall service delivery were common. Managers may benefit from awareness of the extent of ES delivery for different services in their area of interest, including co-benefit opportunities to improve delivery of multiple services.

Aronson et al. 2010. [Are Socioeconomic Benefits of Restoration Adequately Quantified? A Meta-analysis of Recent Papers \(2000–2008\) in Restoration Ecology and 12 Other Scientific Journals](#)

Many ecosystems have been transformed, or degraded by human use, and restoration offers an opportunity to recover services and benefits, not to mention intrinsic values. We assessed whether restoration scientists and practitioners use their projects to demonstrate the benefits restoration can provide in their peer-reviewed publications. We evaluated a sample of the academic literature to determine whether links are made explicit between ecological restoration, society, and public policy related to natural capital. We analyzed 1,582 peer-reviewed papers dealing with ecological restoration published between 1 January 2000 and 30 September 2008 in 13 leading scientific journals. As selection criterion, we considered papers that contained either “restoration” or “rehabilitation” in their title, abstract, or keywords. Furthermore, as one-third of the papers were published in *Restoration Ecology*, we used that journal as a reference for comparison with all the other journals. We readily acknowledge that aquatic ecosystems are under-represented, and that the largely inaccessible gray literature was ignored. Within these constraints, we found clear evidence that restoration practitioners are failing to signal links between ecological restoration, society, and policy, and are underselling the evidence of benefits of restoration as a worthwhile investment for society. We discuss this assertion and illustrate it with samples of our findings—with regards to (1) the geographical and institutional affiliations of authors; (2) the choice of ecosystems studied, methods employed, monitoring schemes applied, and the spatial scale of studies; and (3) weak links to payments for ecosystem service setups, agriculture, and ramifications for public policy.

Bergstrom and Loomis. 2017. [Economic valuation of river restoration: An analysis of the valuation literature and its uses in decision-making](#)

This paper provides an analysis of existing non-market valuations of river restoration primarily in the United States and Europe. The goals of the river restoration in terms of ecosystem services are identified, as are the valuation methods used. More than two-thirds of the 38 river restorations reviewed sought to restore and protect fish populations, including in many cases threatened or endangered species. River restorations were also frequently undertaken to improve wildlife habitat, and water quality for boating. In terms of the use of non-market valuations in decision making, six of 38 restorations reviewed involved benefit-cost analyses or environmental assessments or equivalent decision documents. While both revealed preference and stated preference methods were used for valuing river restorations, the majority of restoration valuations (27 out of 38, about 70%) utilized stated preference methods such as the contingent valuation method (CVM) and choice experiments (CE). Annual willingness-to-pay per household estimated from the stated preference methods appear logically and positively related to the miles of river restored demonstrating weak scope.

Berkes and Pockock. 1987. [Quota Management and "People Problems": A Case History of Canadian Lake Erie Fisheries](#)

A new management plan was drawn up for Ontario's commercial fisheries in 1982 after 2 years of negotiations between the Ontario Ministry of Natural Resources and the Ontario Council of Commercial Fisheries, which represents the fishing industry. Implementation of the plan began in 1984 with individual harvest quotas for Lake Erie. Government-industry agreement on the principle of quotas was relatively easy to achieve, but the allocation of individual quotas was more problematic, partly because of errors made in rushing decisions rather than going through the due political process to arrive at a compromise. A workable plan, with some dissent remaining, was nevertheless achieved in 2-3 years, following the initial socioeconomic dislocations, through a process of negotiation, adaptation, joint decision making (comanagement), and cooperation in enforcing regulations. Political and social considerations (equity) were relatively more important to fishermen than were economic efficiency objectives. The case study suggests a number of elements of a pragmatic resource planning protocol: Baseline biological and statistical data have to be accompanied by suitable socioeconomic and cultural information on fishermen; new regulations need to take into account any existing self-regulation; proposed reductions in fishing effort need to be reconciled with equity concerns of the fishermen and with broader sociopolitical goals such as employment; and specific objectives of any new management plan should be framed so that they can serve as criteria for program evaluation.

Bingham et al. 2015. [Economic Benefits of Reducing Harmful Algal Blooms in Lake Erie](#)

Excerpt from Executive Summary: This project strives to identify the economic benefits of reductions in future HABs and does so by evaluating the benefits of avoiding a recurrence of certain, previous HAB events. Thus, although the scenarios considered are based on past events (i.e., ex post), these events are considered as they would occur in the future.

Bishop et al. 1987. [Toward Total Economic Valuation of Great Lakes Fishery Resources](#)

Research dealing with the economic values of Great Lakes fish has focused on sport and commercial exploitation (consumptive use values). In this paper, we ask what other types of monetary values might be associated with Great Lakes fishery resources and examine how these other types of values (indirect use values and intrinsic values) relate to values derived from exploitation. We estimate a total value of \$12,000,000 per year to Wisconsin taxpayers for preservation of striped shiners *Notropis chrysocephalus*, Wisconsin endangered species that is resident in a tributary of Lake Michigan. For comparison, we estimate a total value of \$28,000,000 per year for preservation of bald eagles *Haliaeetus leucocephalus*, also endangered in Wisconsin. In neither case was consumptive use a determinant of value. We also discuss the validity of the technique used to estimate these values. We conclude that intrinsic values for Great Lakes fish may be substantial. Future research should attempt to measure total values and not just values from exploitation.

Bishop et al. 1990. [Benefit-Cost Analysis of Fishery Rehabilitation Projects: A Great Lakes Case Study](#)

Tools of benefit-cost analysis are used to evaluate a project to rehabilitate the yellow perch fishery of Green Bay, Wisconsin. Both sport and commercial fishers harvest from this stock, which has been suffering from much reduced productivity since the early 1960s. The project is composed of commercial quotas and other regulations. Measures of benefits and costs were used that explicitly incorporate uncertainty about the potential level of success of the project. The analysis shows that commercial fish producers will more or less break even compared to where they would have been without the project, but that substantial recreational benefits can be expected. This case study illustrates how benefit-cost

analysis can provide useful insights into the potential economic returns from rehabilitation projects. It also dramatizes unresolved research issues, particularly in the area of sport fishing valuation.

Boyle et al. A database on sportfishing values.

Report could not be located.

Braden et al. 2008. [Economic benefits of remediating the Sheboygan River, Wisconsin Area of Concern](#)

This study estimates the economic benefits of remediation in the Sheboygan River, WI Area of Concern (AOC) using two distinct empirical methods. The methodology parallels that described by Braden et al. (2008). The results are mixed. Using hedonic analysis of property sales, for owner-occupied homes within a 5-mile radius of the Sheboygan River AOC, the overall estimated loss of value is \$158 million (8% of market value). Of this total, only \$49 million in losses for homes closest to the upper river segment has strong statistical support. The impacts are greatest proportionally for properties closest to the AOC. A survey-based method yields a mean estimate of \$218 million (10% of property value) in willingness to pay for full cleanup of the AOC. If remediation were to induce recovery of property values, then the local communities could benefit through increased property tax revenues.

Braden et al. 2008. [Economic benefits of remediating the Buffalo River, New York Area of Concern](#)

This study estimates the economic benefits of remediation in the Buffalo River, NY Area of Concern (AOC) using two distinct empirical methods. One method analyzes the effects of proximity to the AOC on prices in the residential property market. The second uses a choice survey of recent home purchasers concerning the characteristics of homes and the river. After controlling for numerous structural, community, and spatial effects, the market analysis shows that single-family residential property prices south of the river are depressed due to their proximity to the AOC by \$118 million (5.4% of total market value). The impacts are greater for properties closer to the AOC. Prices to the north of the AOC do not appear to be affected. Recovery of \$118 million in property value losses could produce approximately \$4.7 million/year in new property tax revenues. Considering only the area for which the market study shows price discounts, the survey-based estimates reveal a willingness to pay (WTP) for full cleanup of the AOC of approximately \$250 million (14% of median-based market value). The reasons for discrepancies between the results of the two methods is a matter for further research.

Breffle et al. 2013. [Socioeconomic evaluation of the impact of natural resource stressors on human-use services in the Great Lakes environment: A Lake Michigan case study](#)

The Great Lakes watershed is home to over 40 million people (Canadian and U.S.) who depend on a healthy Great Lakes ecosystem for economic, societal, and personal vitality. The challenge to policy-makers and the public is to balance economic benefits with the need to conserve and replenish regional natural resources in a manner that ensures long term prosperity. Nine critical broad-spectrum stressors of ecological services are identified, which include pollution and contamination, agricultural erosion, non-native species, degraded recreational resources, loss of wetlands habitat, climate change, risk of clean water shortage, vanishing sand dunes, and population overcrowding. Many of these stressors overlap. For example, mining activities alone can create stress in at least five of these categories. The focus groups were conducted to examine the public's awareness of, concern with, and willingness to

expend resources on these stressors. This helped generate a grouping of stressors that the public is especially concerned about, those they care little about, and everything else in between. Stressors that the respondents have direct contact with tend to be the most important to them. This approach of using focus groups is a critical first step in helping natural resource managers such as Trustees and NGOs understand what subsequent steps to take and develop policy measures that are of most interest and value to the public. Skipping or glossing over this key first task could lead to difficulties with respect to survey design and model development in a non-market valuation study. The focus group results show that concern related to pollution and contamination is much higher than for any of the others. It is thus clear that outreach programs may be necessary to educate the public about the severity of some low-ranked stressors including climate change.

Brenden, et al. 2013. [Great Lakes commercial fisheries: historical overview and prognoses for the future](#), in *Great Lakes Fisheries Policy and Management*

Commercial fishing played an important role in the settlement of the Great Lakes region 34 of North America and continues to be an important industry in the area. Abundant fishery 35 resources were a key factor in the establishment of early settlements in many areas around the 36 Great Lakes. Along with timber, trapping, and mining, commercial fishing was one of the key 37 natural resource extraction industries that generated economic wealth to stimulate settlement and 38 development of many Great Lake ports. 39 The commercial fishing industry has had to respond to near continuous change in their 40 technology, the Great Lakes ecosystem, and the regulations imposed by fisheries management 41 agencies. The fact that a Great Lakes commercial fishing industry still exists is to some extent a 42 testament to the adaptability, perseverance, and dedication of commercial fishers. Although the 43 dynamic history of the commercial fishing industry in the Great Lakes can be partly explained by 44 examination of fishery yields, one cannot gain a full appreciation of the dynamics of the industry 45 without understanding the many factors that have affected and continue to affect the industry. 46 These include changes in gear, processing and distribution of commercial products, economics, 47 and regulation and management of the fisheries. In this chapter, we provide an overview of these 48 factors along with an assessment of the history and current status of the commercial fisheries in 49 each of the Great Lakes. More detailed analyses in the form of case studies for Great Lakes 50 percids (Rosemen et al. 2008, this volume), salmonids (Claramunt and Madenjian this volume), 51 lake sturgeon (Boase this volume), lake trout (Krueger this volume), and lake whitefish (Ebener 52 et al. 2008b) can be found elsewhere.

Brown. 1987. [Typology of Human Dimensions Information Needed for Great Lakes Sport-Fisheries Management](#)

Fisheries managers in the Great Lakes area and elsewhere have made relatively few efforts to gather socioeconomic information, or to use what information researchers have produced. Perhaps because resource conflicts involving fisheries have lower intensities than those involving forestry and wildlife, fisheries managers have lagged behind the other two resource professions in using socioeconomic, or human dimensions, information. A published matrix of wildlife agency decisions and concomitant needs for human dimensions information is transferred in this paper to a fisheries context. A new matrix of agency needs for human dimensions research by planning and decision-making horizons is developed and illustrated.

Brown and Connelly.2009. [Lake Ontario Sportfishing: Trends, Analysis, and Outlook](#)

Lake Ontario is New York's largest sport fishery, both in terms of angler days and expenditures. In 2007, angler effort on Lake Ontario (including embayments) exceeded 1.5 million angler days, and expenditures of Lake Ontario anglers in counties bordering the lake topped \$54 million (Connelly and Brown 2009). Lake Ontario's sport fisheries are diverse. Its salmonine fisheries have been important to anglers and an important economic generator to local communities since their introduction around 1970, resulting in the first salmon runs in the Salmon River and other tributaries in 1973 (Brown and Connelly 1991, Brown 1976). In addition, warmwater fishing for bass is important, especially in the Eastern Basin of the lake, and accounted for approximately 21% of all angler days lake-wide in 2007 (Connelly and Brown 2009). The lake also has a significant yellow perch fishery.

Brown et al. 1991. [Lake Ontario's Sport Fisheries: Socioeconomic Research Progress and Needs](#)

The management process of an aquatic system such as Lake Ontario depends on a dynamic information base and occurs within an environment comprising ecological, social, cultural, political, and economic factors. It is critical that this information base include socioeconomic components pertaining to resource user values and behaviors as well as the traditional ecological components. This paper reviews socioeconomic information pertaining to the utilization and valuation of Lake Ontario's sport fisheries. It also examines the socioeconomic components of assessing the risks to humans posed by contaminants present in sport fish, communicating this information to fish consumers, and monitoring and understanding human responses to these communications. Several studies have examined the economic impacts of sport fishing on coastal communities of Lake Ontario. Few studies have examined the net economic value of sportfishing to anglers, or how contaminants have reduced such values. Similarly, few studies have examined how the public responds to information about contaminants in sport fish. Some research in these areas is currently underway.

Burkett and Winkler. 2018. [Recreational fishing in Illinois: demographic analysis: using an age-period cohort approach to understand fishing participation.](#)

Excerpt from Executive Summary: In order to understand change in Illinois's anglers over time, researchers at Michigan Technological University partnered with the Great Lakes Fishery Commission and the Illinois Department of Natural Resources to analyze demographic patterns in the fishing population and to use those results to project future numbers of anglers in Illinois. We used an age-period-cohort regression model to analyze 10 years of Illinois resident fishing license sales data from 2006-2015. We specifically looked at differences by gender, age, and birth cohort among both total anglers and more specifically at Lake Michigan salmon/trout anglers.

Burkett and Winkler. 2017. [Recreational Fishing in Wisconsin: Demographic Analysis Using an Age-Period-Cohort Approach to Understand Angler Participation](#)

Excerpt from Executive Summary: In order to understand change in Wisconsin's anglers over time, researchers at Michigan Technological University partnered with the Great Lakes Fishery Commission and the Wisconsin Department of Natural Resources to analyze demographic patterns in the fishing population and to use those results to project future numbers of anglers in Wisconsin. We used an Age-Period-Cohort regression model to analyze 15 years of Wisconsin resident fishing license sales data from 2000 to 2014. We specifically looked at differences by gender, age, and birth cohort among both total anglers and more specifically at Great Lakes salmon/trout anglers.

Cangelosi et al. "[Revealing the Economic Value of protecting the Great Lakes](#)"

Excerpt from the Preface: This guidebook was produced as part of the overall effort to familiarize resource managers and decision-makers for the Great Lakes with the techniques currently available for economic analysis of environmental benefits, including the strengths and limitations of these techniques. Rather than advocate the use of these economic techniques, the guidebook takes an objective look, pointing out caveats and advantages associated with the techniques currently available. This fundamental information is extremely important in the process of building consensus around the use of information these techniques can supply.

The guidebook comprises contributions of a blue ribbon panel of leading resource economists from Great Lakes universities and national nongovernmental research organizations to focus on the application of environmental valuation methods to Great Lakes environmental concerns. The guidebook focuses on techniques that are either well-accepted or increasingly accepted in actual policy applications. Because it is geared to environmental management practitioners, the guidebook describes in less detail cutting-edge theory—for example, that which is emerging from the new field of ecological economics.

Chan et al. 2012. [Where are cultural and social in ecosystem services? a framework for constructive engagement](#)

A focus on ecosystem services (ES) is seen as a means for improving decisionmaking. In the research to date, the valuation of the material contributions of ecosystems to human well-being has been emphasized, with less attention to important cultural ES and nonmaterial values. This gap persists because there is no commonly accepted framework for eliciting less tangible values, characterizing their changes, and including them alongside other services in decisionmaking. Here, we develop such a framework for ES research and practice, addressing three challenges: (1) Nonmaterial values are ill suited to characterization using monetary methods; (2) it is difficult to unequivocally link particular changes in socioecological systems to particular changes in cultural benefits; and (3) cultural benefits are associated with many services, not just cultural ES. There is no magic bullet, but our framework may facilitate fuller and more socially acceptable integrations of ES information into planning and management.

Connelly & Brown. 2010a. [Assessing the Economic Importance of Recreational Fishing for Communities Along Lake Ontario.](#)

A 2007 survey found that “tourist” anglers spent \$43 million in communities in New York State along the Lake Ontario shoreline. Using IMPLAN, a computerized input-output economic software package, the indirect and induced economic impacts of those expenditures was estimated. The total economic impact of recreational fishing to shoreline communities was \$60 million, which was associated with approximately 1,000 jobs. A regression model was developed that explains fishing participation on Lake Ontario using biological and socioeconomic variables. It predicts a decline in fishing participation over time on Lake Ontario. This model was used to forecast future economic impacts on Lake Ontario communities estimated at a loss of \$19 million in 5 years. Some suggestions were offered for altering the downward economic trend.

Connelly & Brown. 2010b. [Sportfishing Participation on Lake Ontario: Modeling the Past, Predicting the Future](#)

Lake Ontario, one of the five Great Lakes bordering the United States and Canada, has a long, rich tradition of sportfishing. The lake provides a good case study showing how biological, societal, and

managerial factors interact with each other to affect fishing participation. Fishing effort at Lake Ontario peaked in 1990 and has since trended downward. Using multiple-regression analysis, we found three variables that explain the number of fishing boat trips taken on Lake Ontario over time. The first variable, time, may be acting as a surrogate for two interacting phenomena: the novelty of Great Lakes salmonid fishing specifically, which appears to be gradually declining, and the declining interest in fishing and outdoor recreation seen nationally. Stakeholders may look first for local explanations for changes, but they need to consider that national and societal trends may be very important. Second, a biological variable, the number of Pacific salmon *Oncorhynchus* spp. stocked in Lake Ontario, is positively correlated with boat trips. Third, the number of black bass *Micropterus* spp. harvested is positively correlated with the number of trips. Although not significant at the cutoff level of 0.05, this variable was retained in the model because it was considered an important variable and was close to the cutoff at 0.074. Forecasting these variables into the future, the model predicts a decline of 32% in fishing trips in the ensuing 5 years. Armed with this information, local communities can choose to be proactive and try to counteract the trend predicted by the model. The use of case studies and regression analysis to explain and forecast trends may be applicable to many other fisheries situations across the country.

Connelly & Brown. 1991. [Net economic value of the freshwater recreational fisheries in New York](#)

A statewide angler survey was conducted in New York in 1988 in part to estimate the net economic value of the state's recreational fishery. Willingness-to-pay questions from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation were adapted to a mail survey format and respondents were asked how much they would be willing to pay above current expenditures for a specific fishing trip. The net economic value estimated from the responses exceeded \$284 million for the freshwater fisheries of New York in 1988. Although inland fisheries accounted for 76% of the statewide net economic value, \$69 million was associated with the portion of the Great Lakes assigned to New York. Comparisons with a 1976–1977 analysis of the net economic value of New York's Great Lakes fishery, which used a variation of the indirect travel cost methodology, showed a major shift in net economic value from trips for warmwater species to trips for coldwater or for both warm and coldwater species. Baseline data are now established for a variety of waterways in New York. Future research is needed to measure changes in value after environmental changes occur.

Criddle et al. [Participation decisions, angler welfare, and the regional economic impact of sportfishing](#)

We link a stochastic binary choice model of individual decisions to participate in the marine sport fisheries in Cook Inlet, Alaska, with a simulation-based sample enumeration procedure for aggregating estimates of individual angler welfare and a regionally adjusted zip code-level input-output model of regional economic activity. The result is a behaviorally based model for predicting changes in angler welfare and regional economic activity occasioned by changes in the demand for sportfishing that arise from changes in trip costs or the expected number, size, or mix of species caught. The advantages of this approach are that: changes in angler participation are determined by variables that are observable, predictable, or subject to management control; participation reflects declining marginal utility, and substitution and complementary effects across trip attributes; estimates of changes in aggregate angler welfare and changes in regional economic impacts are derived from changes in individual participation probabilities.

DFO. 2019. [Survey of Recreational Fishing in Canada](#)

The 2015 Survey of Recreational Fishing in Canada collected information about recreational fishing activities to assess the economic and social importance of recreational fisheries to Canada's provinces and territories. This nationally-coordinated study provides the most comprehensive information on recreational fisheries activities and harvests in all regions of the country. It is also the most up-to-date source of detailed statistics on the economic contribution made by anglers at both provincial/territorial and national levels.

DFO. 2017. [Ecological Risk Assessment of Grass Carp \(*Ctenopharyngodon idella*\) For the Great Lakes Basin](#)

Excerpt: In response to the increasing threat of Grass Carp introduction and to help prevent the arrival, establishment, and spread of Grass Carp to the Great Lakes, DFO's Asian Carp Program identified the need for a binational ecological risk assessment of Grass Carp to the Great Lakes basin. The purpose of this risk assessment is to determine the risk to the Great Lakes basin and to provide useful, scientifically defensible advice on prevention, monitoring, early detection, and management actions that are underway or could be taken. This assessment addresses only the current state of the system and management measures that were in place during the scoping of the risk assessment (baseline year = 2014) and focuses only on ecological consequences; socioeconomic consequences will be assessed separately using the results of this ecological risk assessment.

Dochoda and Fetterolf. 1987. [Public Purpose of Great Lakes Fishery Management: Lessons from the Management Experience](#).

Fishery managers must make decisions based on the best assessments and predictions available to them. Improvements in both biological and social sciences and their implementation are required to better protect resources (especially those in rehabilitative stages) from overharvest and habitat degradation, to more optimally and equitably utilize the available surplus, and to increase public confidence in management's assessments and predictions. Public understanding and support are essential for sustaining and increasing the benefits derived from Great Lakes fisheries.

Dorr, et al. 2002. [A socioeconomic and biological evaluation of current and hypothetical crappie regulations in Sardis Lake, Mississippi: an integrated approach](#)

We conducted a socioeconomic survey and review of existing biological data in an integrated evaluation of current and hypothetical fishery regulations on crappies *Pomoxis* spp. in Sardis Lake, Mississippi. The objectives of this study were to (1) assess angler acceptance of current and hypothetical harvest restrictions, (2) determine the recreational value of the crappie fishery to its participants, (3) estimate possible changes in recreational value based on angler responses to hypothetical regulations, and (4) integrate the results of the socioeconomic surveys with existing biological information. Using the travel cost method, we estimated mean expenditures at US\$29.48 and average consumer surplus per angler per trip at \$8.88. We estimated 75,601 crappie angler trips in 1995, yielding an annual consumer surplus for the Sardis Lake crappie fishery of \$671,000 and a gross willingness to pay (GWP) of \$2.9 million. Hypothetical changes in creel limits would have greater effects on the crappie fishery than would changes in length limits. If a creel limit of 10 crappies/d were implemented, 24,986 fewer angler trips could be expected, reducing both consumer surplus and GWP approximately 33% (\$222,000 and \$958,000, respectively). Changes in angler trips related to length limits were small (.4%) until a 31-cm length limit was proposed, for which 7,035 fewer angler trips could be expected, reducing consumer surplus and GWP approximately 9% each (\$61,900 and \$270,000, respectively). Biological evaluations

of the effects of length and creel limits suggested they are unlikely to affect crappie populations unless they are much more restrictive than current regulations. Combined, biological and socioeconomic information supported continuing the current 25.4-cm length limit and 30-fish/d creel limit.

Ebener et al. 2008. [Management of commercial fisheries for lake whitefish in the Laurentian Great Lakes of North America](#)

Excerpt from the introduction: Considerable research has been conducted on lake whitefish populations in the Great Lakes and at projecting appropriate harvest levels from the populations over the last 30 years (Patriarche 1976; Jacobsen and Taylor 1985; Rybicki and Schneeberger 1990; Ebener et al. 2005), yet few people have specifically described the commercial fishery for lake whitefish and its management (Ebener 1997; Mohr and Ebener 2005a) and no one has taken an objective look at the basinwide fishery. Significant ecological change brought about by recent invasive species has dramatically altered lake whitefish population dynamics, the fishery for them, and management (Mohr and Nalepa 2005). Our objective is to describe the status of the commercial fishery for lake whitefish in the Great lakes in relation to the fish's population dynamics, ecological change, market demands, and the global economy, and document evolution of management policies for regulating the fishery.

Eiswerth et al. 2008. [Examining angler behavior using contingent behavior modeling: A case study of water quality change at a Wisconsin lake](#)

We use contingent behavior (CB) analysis to examine the potential impacts of a hypothetical change in the clarity of a lake. We collect and use both CB and revealed preference data to estimate a pooled negative binomial count data travel cost model. From this analysis we calculate the consumer surplus per angling party day for our case study lake to be about \$104, or a total annual consumer surplus of \$1.4 million. Using this consumer surplus measure and changes in the intended number of visits obtained from the CB survey, we estimate the loss in consumer surplus associated with a decline in water clarity from 10 to 3 feet (1 foot = 0.3048 m) to be about \$522,000 annually (a 38% decrease). Since this is the first such application of CB analysis to estimate the effects of a water clarity change, the study may illustrate a method well suited to analyzing changes in water quality attributes that are easily observable and well understood by recreators.

Eschenroder.1987. [Socioeconomic Aspects of Lake Trout Rehabilitation in the Great Lakes](#)

During the 1940s and 1950s, the major fisheries for lake trout *salvelinus namaycush* in the Great Lakes declined precipitously because of predation by sea lampreys *petromyzon marinus* and overfishing. The need to control the sea lamprey and rehabilitate lake trout resulted in the establishment of institutional arrangements among the responsible state, provincial, and federal fishery agencies. Because most management agencies believe that lake trout return greater economic benefits in the sport rather than the commercial fishery, the catch in most areas is allocated exclusively to anglers. In the future, more public input is needed in decision processes that consider desirable mixes of salmonines and their prey for the Great Lakes. Because lake trout carry greater body burdens of contaminants than do other salmonines in the Great Lakes, a controversy exists as to how vigorously lake trout rehabilitation should be pursued when other species could be stocked in their place.

Fletcher et al. [The Value of Nature's Benefits in the St. Louis River Watershed](#)

Excerpt from the executive summary: Using the Benefit Transfer Method, we estimated the dollar value of ecosystem services provided by the thirteen ecosystems in the St. Louis River watershed. Data from previously published studies were used, which valued ecosystem services based on market pricing, cost avoidance, replacement cost, travel cost, hedonic values, and contingent valuation. These methods have been broadly used to monetize things like the relationship between proximity to natural areas and increased property values, people's willingness to pay for outdoor recreation, and the value of water quality improvements provided by wetlands.

Glass and Muth. 1987. [Pitfalls and Limitations in the Use of Fishery Valuation Techniques](#)

While considerable effort has been undertaken to develop fishery valuation techniques, there has been limited success in applying the results to management situations. Most of these valuation measures have been economic in nature so they must be interpreted within a broader context of valuation with particular concern for the objectives of public ownership and management. Added to the conceptual shortcomings of many valuation techniques are difficulties in securing consistent and accurate measurements. All of these limitations must be considered when valuation measures are applied to resource management situations.

Golet et al. 2006. [Assessing societal impacts when planning restoration of large alluvial rivers: a case study of the Sacramento River project, California](#)

Studies have shown that ecological restoration projects are more likely to gain public support if they simultaneously increase important human services that natural resources provide to people. River restoration projects have the potential to influence many of the societal functions (e.g., flood control, water quality) that rivers provide, yet most projects fail to consider this in a comprehensive manner. Most river restoration projects also fail to take into account opportunities for revitalization of large-scale river processes, focusing instead on opportunities presented at individual parcels. In an effort to avoid these pitfalls while planning restoration of the Sacramento River, we conducted a set of coordinated studies to evaluate societal impacts of alternative restoration actions over a large geographic area. Our studies were designed to identify restoration actions that offer benefits to both society and the ecosystem and to meet the information needs of agency planning teams focusing on the area. We worked with local partners and public stakeholders to design and implement studies that assessed the effects of alternative restoration actions on flooding and erosion patterns, socioeconomics, cultural resources, and public access and recreation. We found that by explicitly and scientifically melding societal and ecosystem perspectives, it was possible to identify restoration actions that simultaneously improve both ecosystem health and the services (e.g., flood protection and recreation) that the Sacramento River and its floodplain provide to people. Further, we found that by directly engaging with local stakeholders to formulate, implement, and interpret the studies, we were able to develop a high level of trust that ultimately translated into widespread support for the project.

Graefe et al. 2018. [Assessing the Economic Impact and Significance of Recreational Angling on Lake Erie Waters: Final Report](#)

Excerpt from Executive Summary: The overarching goal of the study was to assess the economic impact and significance of the recreational angling industry within the Pennsylvania section of Lake Erie. For a guiding framework, this study utilized an exploratory mixed methodology with three connected phases which resulted in 1,189 completed online and mail-back questionnaires (Phase I), 516 completed on-site questionnaires of Lake Erie anglers (Phase II), and approximately 15 hours of stakeholder interviews

(Phase III). Readers are encouraged to review these findings as reflective of anglers within the Pennsylvania section of Lake Erie, and not representative of all Lake Erie anglers. Study results and analyses are further detailed throughout the various sections of this report.

Graziano et al. 2019. [Understanding an emerging economic discourse through regional analysis: Blue economy clusters in the U.S. Great Lakes basin](#)

The Blue Economy (BE) is rapidly becoming one of the most commonly applied regional economic paradigms in coastal and maritime regions globally. Since the late 1970s, the U.S. Great Lakes basin has searched for ways to reverse its economic decline, and the BE offers new opportunities to sustain the region's economic development, possibly sustaining its transition towards new economic sectors. In developing, applying, and critically appraising a definition of the BE in one of the largest fresh-water systems in the world, our work identifies how regional characteristics and intersectoral conflicts can pose issues to both policymakers and researchers. The use of standard metrics (e.g. location quotients) allows us to compare our findings with previous works conducted in other regions. From this comparison, and by comparing inter-state differences, we find that the BE in the region comprises highly-productive clusters, although employment specialization remains low. In addition, several BE clusters are dominated by industries that are different compared to those in other regions. To the Great Lakes basin, our work represents a benchmark analysis that builds upon existing concepts used locally by researchers and policymakers alike for crafting policies aimed at supporting economic growth in a region only recently emerging from a long period of economic and demographic decline.

Gregory. 1987. [Nonmonetary Measures of Nonmarket Fishery Resource Benefits](#)

This paper addresses the validity and usefulness of nonmonetary approaches to valuing public investments in freshwater fishery resources. It identifies, defines, and gives examples drawn from four valuation approaches: measures of social well-being, psychophysical measures, attitude measures, and multiattribute choice measures. Each of these nonmonetary approaches provides useful information regarding the socioeconomic consequences of a proposed project, thereby complementing more conventional evaluation frameworks that tend to emphasize the biological or financial implications of a change. In addition, the argument is made that greater concern should be placed on the compatibility between a selected response mode and how people customarily think about the environmental asset under consideration.

Hanson. 1986. [Bioeconomic Model of the Lake Michigan Alewife \(*Alosa pseudoharengus*\) Fishery](#)

A stochastic bioeconomic model is developed for the Lake Michigan alewife fishery. This theoretical model possesses an intermediate degree of complexity and realism. Other Lake Michigan fish stocks are included in a simplified way as an aggregate, to account for interspecific predation by salmonids, but competition could be treated as well. Both alewife and aggregate fisheries are modeled by modifications of Beverton-Holt single cohort models with growth in weight and interspecific interactions. The alewives are also subjected to large random disasters and it is demonstrated that these are density independent. The methodology is stochastic, feedback, optimal control using dynamic programming. Stochastic terms are used to represent random disasters in the alewife population. The computational results are given in terms of the maximal, expected economic values of the combined fishery and the optimal rates of harvest for both the alewives and aggregate fisheries. These results are new in the sense that continuous dynamic programming has been applied to a model for several interacting species undergoing occasional random shocks. The expected, optimal economic value of the combined fishery is much less sensitive to the initial recruitment of alewives than to that of the salmonid aggregate.

Comparison with a deterministic model that does not include the random disasters, shows that the disasters reduce the economic value of the combined fishery by 10 to 15 per cent. The results are sensitive to reasonable data estimates and confirm the overexploitation of alewives by both alewife fishery and salmonid predation. The need for reliable data with a common basis is emphasized with regard to comparing commercial and sport fisheries.

Hayder. 2019. [Socio-Economic Risk Assessment of the Presence of Grass Carp in the Great Lakes Basin](#)

Excerpts from the Executive Summary: “Socio-Economic Risk Assessment of the Presence of Grass Carp in the Great Lakes Basin” provides a detailed socio-economic analysis of the potential economic impact to Canada and the US of the establishment of Grass Carp in the Great Lakes.

The methodology adopted in the study is the Total Economic Valuation technique. Of the major activities presently occurring in and around the Great Lakes Basin, based on the results reported in DFO (2017), Cudmore et al. (2017), and discussions with subject matter experts, the scope of the study included commercial fishing, recreational fishing, recreational boating, recreational hunting, wildlife watching, and the beaches and lakefront use activities for both baseline and risk assessments, as they are perceived to be impacted by Grass Carp. In order to estimate the economic values of identified activities, the study arrived at best estimates of the expenditures made and of the consumer surplus generated by the activities in Canada.

In the absence of additional measures to prevent the presence of Grass Carp from the Great Lakes basin, the study estimated that, starting in 2024, the present value of impact on Great Lakes commercial fishing industry in Canada would be at \$244 million and \$1,300 million in 10 years and 40 years, respectively. The present value of impact on Great Lakes commercial fishing industry in the US would be at \$102 million and \$663 million in 10 years and 40 years starting 2024, respectively (see Table 1).

Heck, Stedman and Gaden.2016. [Human dimensions information needs of fishery managers in the Laurentian Great Lakes](#)

Fishery management is increasingly moving towards ecosystem-based approaches that integrate ecological and human dimensions of fisheries. Studies on the human dimensions (HD) of fisheries have increased in recent years. A gap, however, remains between the nature of available information and the information needed by fishery managers. Our paper addresses this gap for the Great Lakes fisheries. We explicitly explored information needs of fishery managers to better reconcile the supply and demand of HD information. Our study finds that managers need HD information in particular to demonstrate the achievements of management goals and to address management issues. In addition, understanding the purpose and timing of information is important in order to provide timely and relevant information as fishery managers identify distinct information needs for planning, decision-making, and evaluation of management. Fishery managers in our study were particularly interested in direct and indirect economic values of the fisheries as well as values, beliefs, attitudes, and behaviors of users. Interviewed managers were not only interested in the status quo of these factors but also wanted to understand what influences and shapes them. In addition, fishery managers would like to understand the contribution of fisheries to ecosystem services in the basin including cultural values. Our interviews did not detect interest in information on long-term HD trends or the explicit need for interdisciplinary studies. Such information, however, would be critical to understand and predict changes in the human dimensions of the fisheries and to develop management strategies to cope with these changes.

Hodges et al. 2012. [Economic Analysis of Working Waterfronts in the United States](#)

Excerpt from the Executive Summary: Waterfront communities in the United States, whether rural or urban, recreational or industrialized, have been subject to economic, technological, ecological, and demographic changes that challenge their continued existence or development. The purpose of this study is to document the current status, contribution to regional economies, and future prospects of U.S. coastal communities in order help promote their long-term economic prosperity. A review of the relevant literature on economic valuation of waterfront and ocean-related economic activities found that previous studies usually evaluated only one particular economic sector or specific region. The present study attempts to provide a comprehensive evaluation of all ocean-related economic activity for all coastal regions of the United States.

A commonly accepted definition of ocean-related economic activity was adopted for this analysis based on specific industry sectors (NAICS codes) developed under the National Ocean Economics Program¹. This classification scheme includes six major industry groups: marine construction, marine living resources (fishing, aquaculture, seafood processing), offshore minerals (oil and gas production, sand and gravel mining), ship and boat building/repair, coastal tourism/recreation (boat dealers, marinas, waterfront hotels, restaurants, tours, marine parks, etc.), and marine transportation (ports, shipping, warehousing, passenger transportation) (Table 1). Data on economic activity in these sectors were compiled for the period 1990-2010, including information on employment, wages and value added or contribution to Gross Domestic Product (GDP)². In addition, data were gathered on specific high profile industries such as commercial fishing, port shipping, and passenger cruise ships.

Hudson and Ziegler. 2014. [Environment, Culture, and the Great Lakes Fisheries](#)

The commercial fisheries of the United States and Canadian Great Lakes are in a long period of decline. Detailed statistics kept for well over a century document a fluctuating pattern of harvests of the major commercial species. In the 1940s, sea lamprey began to devastate the fisheries, an effect that has not been fully countered. Overfishing, nonnative species, declining nutrient levels, and chemical pollution have contributed to reduced catches. Court decisions in the United States and Canada during the past thirty years have awarded a sizable share of commercial fishing rights to Native North Americans for their own support and sustenance. The Lake Erie yellow perch and walleye fishery, based mainly in Ontario, is the most successful commercial fishing operation in the region. Despite the many environmental and cultural challenges, the Great Lakes fisheries live on.

Hunt et al. 2021. [Per trip changes to the economic value of Ontario, Canada anglers fishing the Laurentian Great Lakes under target species transitions](#)

Changing fish communities in the Laurentian Great Lakes could substantially affect how anglers value fishing trips. Using responses from licensed Ontario, Canada anglers to potential fishing trip options, we estimated changes to per-trip values for transitioning from a walleye (*Sander vitreus*) to a bass (*Micropterus* spp.) fishery, and from a Chinook Salmon (*Oncorhynchus tshawytscha*) to a lake trout (*Salvelinus namaycush*) fishery. These walleye and salmon transitions, respectively, were estimated to produce large per-trip losses for active (\$64 and \$35 CAD 2017) and potentially large losses for non-active but interested Great Lakes anglers (\$29 and \$34). These aggregate estimates masked significant differences among anglers. For example, a class of more-specialized, active anglers would lose more from walleye (\$102) and from salmon (\$46) transitions than would less specialized anglers (\$19 and \$2,

respectively). These results confirm that fish community changes can strongly affect economic values among active and potential Great Lakes anglers.

Hunt et al. 2007. [Predicting Fishing Participation and Site Choice While Accounting for Spatial Substitution, Trip Timing, and Trip Context.](#)

We developed choice models to understand and predict the amount, timing, and locations of recreational fishing trips taken by anglers in northwestern Ontario, Canada. These models incorporated several improvements over previous models to account for complex patterns of spatial substitution among fishing sites, the context of fishing trips, and the importance of tradition and weather on the timing of trips. Joint models of fishing participation and site choice were developed for two resident populations of anglers from northern Ontario. For both populations, the three innovations provided significant improvements to the models and important information for understanding and predicting recreational fishing behaviors. The utility of the model to fisheries managers was illustrated through a management scenario that involved the restoration of walleyes *Sander vitreus* in a large water body. The forecasts suggested that the effect of this restoration on fishing effort at other waters was influenced by spatial proximity and temporal use at the fishing sites.

Hunt et al. 2019. [Catch and Non-catch-related Determinants of Where Anglers Fish: A Review of Three Decades of Site Choice Research in Recreational Fisheries](#)

Studies of where people recreationally fish were reviewed to understand which attributes influence these choices, to make this literature accessible to individuals who manage or rely upon recreational fishers, and to shape future research. Between 1988 and 2017, researchers published 114 studies and 189 distinct models of angler behaviors from 96 unique data sets. On average, costs such as travel were universally important while measures of catch-related fishing quality also generally and positively influenced choices of fishing sites. Although frequently omitted from studies, facility quality (e.g., boat launch presence), destination size (e.g., lake area), and measures of environmental quality (e.g., water quality) tended to positively influence choices of fishing sites by anglers. Finally, the influence of regulations and congestion on fishing site choices was more often a significant factor in the choice of hypothetical (i.e. stated preference) than actual (i.e. revealed preference) fishing trips. Researchers are also encouraged to facilitate future reviews by: (i) more clearly communicating details of their studies; (ii) enhancing comparability among studies by using where possible standardized attribute measures; (iii) explicitly testing alternate model specifications related to how anglers' tradeoff fishing site attributes and; (iv) expanding the scope and scale of research on where people fish.

Hunt et al. 2013. [Illustrating the critical role of human dimensions research for understanding and managing recreational fisheries within a social-ecological system framework.](#)

Effective management of recreational fishing requires understanding fishers and their actions. These actions constitute critical links between social and ecological systems that result in outcomes that feedback and influence recreational fishers' actions and the management of these actions. Although much research exists on recreational fishers and their actions, this research is often disconnected from management issues. One way to help to overcome this disconnect is to illustrate how past research on the social component of recreational fishing fits within an emerging coupled social-ecological system (SES) framework. Herein, a conceptual SES is first developed with specific attention to recreational fisheries. This SES is then used to illustrate the importance of considering human dimensions research

for articulating, studying and ultimately managing key outcomes of recreational fisheries (e.g. fish population conservation, fisher well-being) using the example of harvest regulations and a brief review of past interdisciplinary research on recreational fishing. The article ends by identifying key research needs including understanding: how factors such as management rules affect the diversity of actions by recreational fishers; how governance and management approaches adapt to changing social and resource conditions; and how recreational fishers learn and share information.

Hushak et al. 1988. [Economic Value of Great Lakes Sportfishing: The Case of Private-Boat Fishing in Ohio's Lake Erie](#)

Recreation demand functions were estimated and economic values were derived for three geographic and fish species components of the private-boat fishery in Ohio's portion of Lake Erie. For two components, i.e., western basin walleye *Stizostedion vitreum* and yellow perch *Perca flavescens* samples, gross economic value (willingness to pay) exceeded US\$73.00/d when human time was valued at 25% of the wage rate, and consumer surplus (the excess of value over cost) exceeded \$3.00/d. In contrast, central basin results showed a gross economic value of \$44.00/d and a consumer surplus of \$0.40/d. Public investments of \$3.00/angler-day for the western basin and \$0.40/angler-day for the central basin can be justified for maintenance and preservation of the respective fisheries for these uses. If an investment strategy to upgrade the central basin fishery to western basin quality could be developed, public investment of \$3.00/angler-day would be justified to implement such a strategy.

Hunt et al. 2005. [Recreational fishing site choice models: insights and future opportunities, human dimensions of wildlife](#)

This article reviews published research that has focused on the recreational fishing site choices made by anglers. A conceptual model for predicting fishing site choice is developed by synthesizing the findings from past studies that employed fishing site choice models. From these and other relevant studies, six general attributes (i.e., costs, fishing quality, environmental quality, facility development, encounters with other anglers, and regulations) are identified that may influence an angler's selection of a fishing site. The article also enhances the conceptual model by accounting for differing preferences among anglers, for complex substitution patterns among fishing sites, for fishing participation decisions, for habit forming behaviors and for differences in anglers' awareness levels for fishing sites. Finally, the article discusses several avenues that researchers could exploit to improve on past fishing site choice model studies.

Isely et al. 2018. [A socioeconomic analysis of habitat restoration in the Muskegon Lake area of concern.](#)

As part of the 2009 American Recovery and Reinvestment Act (ARRA), a \$10 million grant was awarded to restore wetlands and stabilize shoreline along the south shore of Muskegon Lake (MI), a Great Lakes Area of Concern. A socioeconomic analysis was conducted as part of this award, which included a travel cost survey for lake recreation and a hedonic housing valuation to estimate return on investment. The value of a trip to Muskegon Lake was estimated to be \$39.76; when applied to the anticipated increase in post-restoration recreational trips to Muskegon Lake, and using a conservative 7% discount rate, the Net Present Value over 20 years is \$38.1 million. The hedonic analysis examined values for houses between 100 and 800 m from the shoreline, using both the current shoreline distances and the new

shoreline distances after restoration; this resulted in a predicted \$11.9 million in additional housing value as a result of the improved shoreline features. Summing the hedonic value and travel cost estimates, along with the original \$10 million spent, the result is that over 20 years, the total value generated for the local region is nearly six times the initial ARRA spending. In other words, of the \$60 million of value created on the Muskegon Lake restoration, \$50 million is increased environmental value over the 20 year period.

Isely et al. 2017. [Phragmites Removal Increases Property Values in Michigan's Lower Grand River Watershed.](#)

The presence of *Phragmites australis*, an invasive wetland plant, negatively affects coastal property values and home prices rise with distance from *Phragmites*. Home prices increased as distance to *Phragmites* increased at a rate of \$3.90/meter. Removing *Phragmites* from a property so that the next closest *Phragmites* was 400 m away results in a property value increase of over \$1,500. Removing all *Phragmites* within 400 m of any property results in a total property value impact of \$837,000. This generates about \$13,457-\$15,121 in additional property taxes each year once the prices and taxes adjust to the plant's removal. We estimated the cost of *Phragmites* removal at \$687/ha. Removing the approximately 36 ha of *Phragmites* in the area would cost about \$25,041. Future treatments would likely be less than that of the first year. The estimated cost of the first year of *Phragmites* removal is less than the estimated two years of annual property tax revenue increases.

Johnston et al. 2017. [Contemporary Guidance for Stated Preference Studies](#)

This article proposes contemporary best-practice recommendations for stated preference (SP) studies used to inform decision making, grounded in the accumulated body of peer-reviewed literature. These recommendations consider the use of SP methods to estimate both use and non-use (passive-use) values, and cover the broad SP domain, including contingent valuation and discrete choice experiments. We focus on applications to public goods in the context of the environment and human health but also consider ways in which the proposed recommendations might apply to other common areas of application. The recommendations recognize that SP results may be used and reused (benefit transfers) by governmental agencies and nongovernmental organizations, and that all such applications must be considered. The intended result is a set of guidelines for SP studies that is more comprehensive than that of the original National Oceanic and Atmospheric Administration (NOAA) Blue Ribbon Panel on contingent valuation, is more germane to contemporary applications, and reflects the two decades of research since that time. We also distinguish between practices for which accumulated research is sufficient to support recommendations and those for which greater uncertainty remains. The goal of this article is to raise the quality of SP studies used to support decision making and promote research that will further enhance the practice of these studies worldwide.

Keeler et al. 2012. [Linking water quality and well-being for improved assessment and valuation of ecosystem services.](#)

Despite broad recognition of the value of the goods and services provided by nature, existing tools for assessing and valuing ecosystem services often fall short of the needs and expectations of decision makers. Here we address one of the most important missing components in the current ecosystem services toolbox: a comprehensive and generalizable framework for describing and valuing water quality-related services. Water quality is often misrepresented as a final ecosystem service. We argue

that it is actually an important contributor to many different services, from recreation to human health. We present a valuation approach for water quality-related services that is sensitive to different actions that affect water quality, identifies aquatic endpoints where the consequences of changing water quality on human well-being are realized, and recognizes the unique groups of beneficiaries affected by those changes. We describe the multiple biophysical and economic pathways that link actions to changes in water quality-related ecosystem goods and services and provide guidance to researchers interested in valuing these changes. Finally, we present a valuation template that integrates biophysical and economic models, links actions to changes in service provision and value estimates, and considers multiple sources of water quality-related ecosystem service values without double counting.

Kinnunen. 2003. [Great Lakes Commercial Fisheries](#)

The Great Lakes still support a sustainable commercial fishery. The activity of this commercial fishery varies from state to state and the province of Ontario. Commercial fishery operations are licensed through the states, province of Ontario, and the tribal nations. Every lake has a Native American component of the commercial fishery except Lake Erie. The commercial fishery is generally regulated by the amount of fish that can be caught (quota) and/or the amount and type of gear that can be used (effort). In the province of Ontario dockside monitoring occurs where the commercial fisher actually has to have his catch paperwork already filled out before he reaches the dock and 50% of the total catch is actually checked annually.

Different types of fishing gear are used to catch the various species found in the Great Lakes. In the U.S. waters of the Great Lakes trap nets are used to catch lake whitefish, carp, catfish, sheepshead, white bass, white perch, yellow perch, and eel. Gill nets are used to catch lake whitefish, lake trout, salmon, walleye, yellow perch, and white perch. Hoop nets are used to catch bullheads and eel. Seines are used for carp and white bass. Trawl fishing is used for smelt and lake whitefish, and hook/trot lines are used for catfish and eel.

In the Canadian waters of the Great Lakes trap nets are used for all commercial species in Lake Ontario and for lake whitefish, lake trout, walleye, yellow perch, white perch, and white bass in the other Great Lakes. Gill nets are used for lake whitefish, lake trout, walleye, yellow perch, white perch, and white bass. Hoop nets are used to catch all commercial species. Seines are used for carp, yellow perch, and a variety of panfish. Trawl fishing is used for both lake whitefish and smelt but is still experimental in Canada.

To keep a sustainable commercial fishery in the Great Lakes there are various closures of the fishery during spawning season, and in various areas of the Great Lakes there are both permanent and seasonal designated refuge areas. With many fish species there is a minimum size restriction to allow them to at least spawn once before they enter the fishery.

In 2000 the lake whitefish was the most harvested fish in both U.S. and Canadian waters of the Great Lakes accounting for over 21 million pounds and worth over \$18 million in dockside value (Table 1). Yellow perch and walleye each were worth over \$10 million in dockside value in the year 2000. The commercial fish that had the most value per pound was the yellow perch at just over \$2 per pound.

Knoche and Ihde. 2018. [Estimating ecological benefits and socio-economic impacts from oyster reef restoration in the Choptank River complex Chesapeake Bay](#)

Excerpt from the Executive Summary: Fisheries managers, seafood harvesters, and other commercial fishing stakeholders are increasingly seeking information regarding the regional economic impacts resulting from fisheries management decisions. This project contributes to addressing this need by generating estimates of key economic measures associated with the commercial fishing industry - and connected industries - of the Choptank River System. This project is a Regional Economic Impact Analysis, which accounts for changes in spending and the resulting changes in regional economic activity. The types of economic measures provided here are different from the measures needed for an economic Benefit-Cost Analysis – a different methodological approach that evaluates a project’s contribution to aggregate economic welfare. Please see below for key findings associated with this project.

Knuth et al. 1995. [Fishery and environmental managers’ attitudes about and support for lake trout rehabilitation](#)

An ecosystem approach to Great Lakes lake trout rehabilitation requires explicit consideration of all stakeholders. Fishery and environmental resource managers are stakeholders whose views are critical to adopting and implementing lake trout rehabilitation program objectives. We used a self-administered mail questionnaire to census 919 Great Lakes fishery and environmental managers to (1) characterize the beliefs and attitudes of Great Lakes managers toward fishery management goals and lake trout rehabilitation; and (2) compare these variables based on level of government (provincial/state vs. federal), type of job responsibility (environmental management vs. fishery management), and, for fisheries agencies, country (Canada vs. United States). Provincial/state fishery managers expressed stronger support for artificial vs. natural systems, for utilitarian vs. ecological goals, and for placing relatively greater emphasis on anglers and economic benefits compared to federal fishery managers. Environmental managers assigned higher priority to goals associated with reestablishing native species, and lower priority to goals associated with satisfying anglers than did their fishery management counterparts. Differences observed for Canadian vs. U.S. fishery managers were similar to those between environmental vs. fishery managers. In addition, Canadian fishery managers tended to have a broader view of which groups were important stakeholders in lake trout management, placing less relative emphasis on anglers and more on other citizens in the Great Lakes Basin and on nonconsumptive fishery users. The challenge for the future of ecosystem management is to either recognize and accept these differences and work within their bounds, or to work to change the beliefs held by various stakeholders related to lake trout rehabilitation support or opposition.

Kotchen et al. 2006. [Environmental Constraints on Hydropower: An Ex Post benefit-Cost Analysis of Dam Relicensing in Michigan](#)

We conduct a benefit-cost analysis of a relicensing agreement for two hydroelectric dams in Michigan. The agreement changed daily conditions from peaking to run-of-river flows. We consider three categories of costs and benefits: producer costs of adapting electricity production to the new time profile of hydroelectric output; benefits of reductions in air pollution and greenhouse gas emissions; and benefits of improved recreational fishing. The best estimates suggest that the aggregate benefits are more than twice as large as the producer costs. The conceptual and empirical methods provide a template for investigating the effects of an environmental constraint on hydroelectric dams.

Krantzberg and De Boer. 2006 [A Valuation of Ecological Services In The Great Lakes Basin Ecosystem to Sustain Healthy Communities and a Dynamic Economy](#)

This analysis of the value of the Great Lakes to the health of people, communities and the economy in Ontario has been designed to provide the Ontario Ministry of Natural Resources (MNR) with a credible assessment of the contributions made by the Great Lakes and to the local, provincial, regional, and national economies. For non-traditional benefits assessment, we provide methods for valuation of natural resources and options for MNR to more thoroughly quantify benefits that we can only estimate by extrapolation from existing literature.

This document first characterizes the major uses of the Great Lakes for which economic value can be calculated either directly or indirectly. It then portrays a subset of the major stressors many of which have not historically been addressed through COA and/or the Great Lakes Water Quality Agreement (GLWQA). After a brief review of valuation methods, the document describes different categories of benefits ascribable to different aspects of the Great Lakes economy. A short number of case histories are then provided for studies that have calculated values of some Great Lakes attributes that go beyond direct market values. The document concludes with recommendations as to what methods and studies could be undertaken to more fully value particularly difficult attributes that have inherent, but not market value.

Krantzberg and De Boer. 2008. [A valuation of ecological services in the Laurentian Great Lakes Basin with an emphasis on Canada](#)

An estimated 35 million people rely on the Great Lakes for safe drinking water, and millions depend on healthy fish and wildlife safe for consumption. The authors note that the natural capital of the Great Lakes is worth tens of billions of dollars each year and that investing in the protection of this resource is ethically and financially imperative. The economic value of the Great Lakes and its value to the health of the people and the economy in Ontario, Canada, are described in this article. The authors provide a credible assessment of the contributions made by the Great Lakes to the local, provincial, regional, and national economies of Canada and to the Great Lakes region of the United States. The major uses of the Great Lakes for which economic value can be calculated either directly or indirectly are characterized, and the different benefits ascribable to different aspects of the Great Lakea economy that rely on water quality and water quantity are described.

Lee. 2016. [The Relationship between Visual Satisfaction and Water Clarity and Quality Management in Tourism Fishing Ports](#)

Visual satisfaction of the tourists with a water body is strongly influenced by water clarity, which is in turn influenced by a number of water quality parameters. Visual satisfaction thus stands to benefit from having a water quality management tool that results in better water clarity. A Clarity Suitability Index of Water Quality (CSIWQ), derived from clarity suitability curves of selected water quality parameters, can allow estimation of optimal values for these parameters, while ensuring high visual satisfaction among tourists. The present study used sampling and survey methodologies to investigate water clarity and quality at five tourism fishing ports; simultaneously, tourists' visual satisfaction with a water body was assessed through a questionnaire based on their perceptions. The relationship between tourists' visual satisfaction and water clarity was found to be positive and strong, with water clarity having predictive power of 74.2%. The study showed that DO, BOD, TP, and SS were the most critical parameters for water clarity. A continued product approach of CSIWQ was found to be most appropriate for describing the relationship between water clarity and these four parameters. This enabled a CSIWQ Index value to be calculated. With a CSIWQ value of 0.6, water clarity would be more than 2.08 m, and tourists would

experience very high satisfaction. CSI curves showed that DO would preferably be 9.0 mg/L, and BOD, TP, and SS less than 0.5 mg/L, 0.12 mg/L, and 45.0 mg/L, respectively. The model thus produced valuable insights for assessing and improving water quality and ensuring high levels of visual satisfaction among tourists in tourism fishing ports. This model identified only four parameters but could be improved by ensuring that other water quality parameters were included, to encourage an increase in the number of tourists and to include monitoring of more pollutant sources.

Levine et al. 2020. [What do our lakes mean to us? An understanding of Michigan coastline communities' perceptions of the Great Lakes](#)

Four of the Great Lakes and Lake St. Clair serve as part of the 5261 km coastline of the State of Michigan. Understanding of the relationship between Michigan residents and these Lakes are important for the creation of messages designed to instill the desire to become better stewards of the Michigan coastline. Focus groups totaling 100 Michigan residents were held across the State to learn how residents feel about general issues facing Michigan's coastline. The two major themes that emerged from the focus groups were issues related to the rising lake waters and the need for education on coastline awareness and stewardship.

Other important themes emerged for the focus areas of the research team and its funding organization. There were differences of opinion on some of the issues between residents of the Upper and Lower Peninsulas (for example, public access was not as important an issue in the Upper Peninsula) and also for residents of Lake Michigan versus Lake Huron coastlines in the Lower Peninsula (storms are causing more damage and erosion on the Lake Michigan beaches).

Loomis et al. 2000. [Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey](#)

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.

Lower et al. 2020. 2019 [Update To An Impact Assessment of Great Lakes Aquatic Nonindigenous Species](#)

Excerpt from the Summary: This report includes all major updates to the earlier Risk Assessments on nonindigenous species conducted by the GLANSIS project during the 2019 calendar year. All new assessments were conducted following the same methods outlined in the original technical memorandum, NOAA Technical Memorandum GLERL-161 "An impact assessment of Great Lakes aquatic nonindigenous species" (Sturtevant et al, 2014). All re-assessments are based on new literature surveys

using the original as a baseline and conducted to the same methods. All assessments were reviewed by members of the GLANSIS Team (according to expertise) and by select external reviewers. Results of each risk assessment are incorporated into the species profiles found on the GLANSIS website (www.glerl.noaa.gov/glansis/).

Lowther and Liddel. 2016. [Fisheries of the United States 2015](#)

This publication is the annual National Marine Fisheries Service (NMFS) yearbook of fishery statistics for the United States for 2015. The report provides data on U.S. recreational catch and commercial fisheries landings and value as well as other aspects of U.S. commercial fishing. In addition, data are reported on the U.S. fishery processing industry, imports and exports of fishery-related products, and domestic supply and per capita consumption of fishery products.

Lupi and Hoehn. 1997. [Recreational fishing use-values for Michigan's Great Lake trout and salmon fisheries](#)

The manuscript summarizes the results of a travel cost model developed for recreational angling in Michigan. The model and method are briefly described. The discussion focusses on how Great Lakes trout and salmon catch rates were related to angler behavior. The model is used to value changes in trout and salmon catch rates at Great Lakes fishing sites in Michigan. Fish population levels can be linked to a host of Great Lakes environmental quality issues including fish stocking, fish habitat restoration/preservation, and control/prevention of non-indigenous species. Particular emphasis is placed on the environmental data needed in order to establish pathways for valuing environmental quality with the travel cost method.

Lupi et al. 2003. [Using an economic model of recreational fishing to evaluate the benefits of sea lamprey \(*petromyzon marinus*\) control on the St Marys River.](#)

This paper describes efforts to estimate economic benefits of improved sea lamprey (*Petromyzon marinus*) suppression on the St. Marys River. By linking an economic model of recreational fishing in Michigan to fish populations in the Great Lakes, a method is illustrated for estimating economic benefits that accrue to recreational anglers when fish populations increase. Previous economic efforts to evaluate sea lamprey control have taken a basin-wide view to determine optimal steady-state control levels based on economic injury levels, or have focused on whether or not the entire sea lamprey treatment program is justified. While capable of being adapted to either of these types of evaluations, the method presented here was used to estimate benefits to Michigan anglers of several sea lamprey treatments options for the St. Marys River. When estimated benefits are compared to treatment costs, all treatment options examined are shown to have different, but positive, net present value. Thus, the results suggest that sea lamprey suppression efforts on the St. Marys River yield economic benefits that exceed costs, and this holds even though only part of the economic benefits have been measured.

Lupi et al. 2000. [The Michigan Recreational Angling Demand Model](#)

The paper reports on a large-scale demand model for recreational fishing in Michigan. The model is based on the travel cost method and is specified as a four-level nested-logit. Seasonal participation is modeled by repeating the site choice logit over the course of a season. Data on anglers' trips and site choices were collected using a year-long telephone panel survey of over 1,900 Michigan residents. The

model distinguishes among a broad range of fishing trip types including trips of different lengths; trips for different species; and trips to Great Lake, inland lake, and inland stream sites. For Great Lakes fishing, anglers' site choices are related to catch rates which vary spatially and temporally (i.e., time-varying site quality characteristics).

Marbek.2010. [Economic Value of Protecting the Great Lakes](#) - Literature Review Report

Excerpt from the Executive Summary: This report provides a comprehensive review and synthesis of the literature relating to the economic benefits the Great Lakes provide to society. It provides a better understanding of the direct, indirect, option and non-use values associated with Great Lakes protection.

The specific objectives are:

- To summarize relevant literature on the economic value of the goods and services provided by Great Lakes;
- To explain main stressors to the Great Lakes ecosystem, and therefore impacts on the goods and services provided;
- To discuss limitations and gaps of previous studies;
- To contextualize the value estimates by reviewing a select number of cost benefit analysis; and
- To summarize economic valuation data that will contribute to stage two of this project.

The report is concerned with the Ontario side of the Great Lakes. While defining the exact boundaries of this study is challenging, we focused on benefits that are directly related to the Great Lakes themselves. Literature directly related to this area is the most relevant and given the most emphasis. However, in the cases where there are little to no Great Lakes related literature, studies from other regions are included.

To conduct a proper cost benefit analysis, there is a need for a common valuation method¹, a unifying framework, and a common metric. This report reviews and synthesizes the Great Lakes economic literature using the economic valuation method, according to the Total Economic Framework (TEV), and presenting the results in a common monetary metric.

Martin.1987. [Economic Impact Analysis of a Sport Fishery on Lake Ontario: An Appraisal of Method](#)

This paper summarizes the application of a Keynesian-type economic impact model to the Bay of Quinte sport fishery in eastern Lake Ontario for 1984-1985. After the study procedure and findings are outlined, the method is assessed in the context of information needs of resource planners and managers. The Bay of Quinte study is a vehicle for critically examining the concept of impact and the empirically derived measures of expenditures and income used to describe it. A substantial leakage of angler dollars from the region and the consequential low “normal” income multiplier is attributed to the tendency for local businesses and households to import goods and services. Analysts must choose between more information and increased cost in conducting economic impact analysis; the scope of an impact study must be determined by the questions that need answering. Economic impact analysis can indicate a role for sportfishing in economic development and tourism programs. It can identify the relative contributions of angler groups, identify businesses directly impacted, and suggest approaches to strengthening a region’s intersectoral linkages in order to maximize impact.

Melstrom and Lupi. 2013. [Valuing Recreational Fishing in the Great Lakes](#)

We estimated a pair of models to characterize the demand for Great Lakes recreational fishing in Michigan. With a nested logit framework, the models tested whether anglers have an unobserved tendency to substitute between fishing sites based on target species or lake-specific preferences. Results indicated that anglers tend to substitute more readily between sites within a lake, although we found that the choice of model did not qualitatively influence measures of nonmarket value. Both models predicted that the fishing destinations of anglers would be strongly influenced by catch rates. Using these results, we estimated the sportfishing value for several fish species and found that anglers have the highest willingness to pay for Chinook Salmon *Oncorhynchus tshawytscha*, Coho Salmon *O. kisutch*, steelhead *O. mykiss*, and Walleyes *Sander vitreus*. We also derived the access values of Michigan's coastal fishing sites and determined that day trips to a typical Great Lake site are worth about \$30 per trip.

Melstrom et al. 2015. [Valuing recreational fishing quality at rivers and streams](#)

This paper describes an economic model that links the demand for recreational stream fishing to fish biomass. Useful measures of fishing quality are often difficult to obtain. In the past, economists have linked the demand for fishing sites to species presence-absence indicators or average self-reported catch rates. The demand model presented here takes advantage of a unique data set of statewide biomass estimates for several popular game fish species in Michigan, including trout, bass and walleye. These data are combined with fishing trip information from a 2008-2010 survey of Michigan anglers in order to estimate a demand model. Fishing sites are defined by hydrologic unit boundaries and information on fish assemblages so that each site corresponds to the area of a small subwatershed, about 100-200 square miles in size. The random utility model choice set includes nearly all fishable streams in the state. The results indicate a significant relationship between the site choice behavior of anglers and the biomass of certain species. Anglers are more likely to visit streams in watersheds high in fish abundance, particularly for brook trout and walleye. The paper includes estimates of the economic value of several quality change and site loss scenarios.

Milliman et al. 1992. [The Bioeconomics of Resource Rehabilitation: A Commercial-Sport Analysis for a Great Lakes fishery](#)

We construct a fishery model which simulates: stochastic population fluctuations; and harvest shifts between commercial and sport user groups. This model then assesses, for both commercial and sport harvesters, the bioeconomic impact of an ongoing rehabilitation plan for the yellow perch fishery of Green Bay, Lake Michigan. Overall economic gains from this plan are positive, with sport anglers reaping sizeable benefits, while commercial harvesters lose moderately. Using probing exercises which approximate economic optimization, the efficient allocation of harvest between sport and commercial user groups is also explored. Uncertainties about sport effort levels greatly influence this optimal allocation.

Mitchell et al. 2020. [Identifying key ecosystem service providing areas to inform national-scale conservation planning](#)

Effectively conserving ecosystem services in order to maintain human wellbeing is a global need that requires an understanding of where ecosystem services are produced by ecosystems and where people benefit from these services. However, approaches to effectively identify key locations that have the capacity to supply ecosystem services and actually contribute to meeting human demand for those

services are lacking at broad spatial scales. We developed new methods that integrate measures of the capacity of ecosystems to provide services with indicators of human demand and ability to access these services. We then identified important areas for three ecosystem services currently central to protected area management in Canada—carbon storage, freshwater, and nature-based recreation—and evaluated how these hotspots align with Canada's current protected areas and resource development tenures. We find that locations of ecosystem service capacity overlap only weakly (27–36%) with actual service providing areas (incorporating human access and demand). Overlapping hotspots of provision for multiple ecosystem services are also extremely limited across Canada; only 1.2% (~56 000 km²) of the total ecosystem service hotspot area in Canada consists of overlap between all three ecosystem services. Canada's current protected area network also targets service capacity to a greater degree than provision. Finally, one-half to two-thirds of current ecosystem service hotspots (54–66%) overlap with current and planned resource extraction activities. Our analysis demonstrates how to identify areas where conservation and ecosystem service management actions should be focused to more effectively target ecosystem services to ensure that critical areas for ecosystem services that directly benefit people are conserved. Further development of these methods at national scales to assess ecosystem service capacity and demand and integrate this with conventional biodiversity and conservation planning information will help ensure that both biodiversity and ecosystem services are effectively safeguarded.

Muth et al. 1987. [Subsistence Use of Fisheries Resources in Alaska: Implications for Great Lakes Fisheries Management](#)

Use of fisheries resources for subsistence by rural populations is becoming an increasingly controversial issue in industrialized societies. Alaska is the only state which has enacted a law to provide for subsistence uses of renewable natural resources by both natives and nonnatives. The legal context of subsistence allocation and management is governed by both state and federal laws that currently ascribe subsistence rights only to rural Alaskan residents. Implications of the Alaskan experience for Great Lakes fisheries management include the need to identify the nature and extent of subsistence use of fisheries resources in the Great Lakes region and the importance of an impact assessment framework for evaluating the effects of specific policies and management actions on subsistence uses.

O'Keefe et al. [Factors influencing charter fishing effort trends in Lake Huron](#)

From 2002 to 2011, the number of charter fishing trips in Michigan waters of Lake Huron declined by 51%. Declines in catch rates, rising gasoline prices, and the economic downturn have been suggested as possible reasons for this decline. To better understand the relative importance of these factors, five catch-based and six economic variables were evaluated using multiple regression, with charter effort from 1992 to 2011 as the response variable. Declining catch rate of introduced Chinook Salmon *Oncorhynchus tshawytscha* was more closely linked to declining effort than catch rate of native Lake Trout *Salvelinus namaycush* or Walleye Sander *vitreus*. The price of gasoline was a better predictor of effort than other economic variables. Although Chinook Salmon catch rate explained more variation in charter effort than any other variable, factors beyond the influence of fisheries management also influenced effort. Ecosystem changes that led to declines in salmon abundance created favorable conditions for Walleye, leading to some localized increases in charter effort.

Palm-Forster et al. 2016. [Valuing Lake Erie beaches using value and function transfers](#)

Two benefit-transfer approaches are used to estimate welfare losses from closure of Lake Erie beaches. We identify conditions for which the function transfer, which is more time-consuming and data-intensive, is worth the effort relative to a simple value transfer. The function transfer was essential for estimating beach demand (trips) and demand elasticity (change in trips); when evaluating individual beach closures with known trip demand, the two methods yielded similar results. Results produced by the two transfer methods deviated (up to 106 percent) when multiple beaches were closed simultaneously because value transfer did not account for the loss of beach substitutes.

Parsons. 2017. [Travel Cost Models. A primer on nonmarket valuation.](#)

This chapter provides an introduction to Travel Cost Models used to estimate recreation demand and value recreational uses of the environment such as fishing, rock climbing, hunting, boating, etc. It includes a brief history, covers single-site and random-utility-based models, and discusses current issues and topics. The chapter is laid out in a step-by-step primer fashion. It is suitable for first-timers learning about travel cost modeling as well as seasoned analysts looking for a refresher on current approaches. The chapter includes an application of the random-utility-based model to beach use on the east coast of the USA along with measures of welfare loss for beach closures and changes in beach width.

Poe et al. 2013. [Net Benefits of Recreational Fishing in the Great Lakes Basin: A Review of the Literature](#)

Excerpt from Executive Summary: This report reviews the recreational valuation literature on fishing in the Great Lakes Basin. Its purpose is to determine whether the existing literature is sufficient to: (a) estimate the current net value of recreational fishing activities in the study region; and (b) estimate how these values might change with the introduction of aquatic nuisance species.

Pope et al. 2016. [Fishing for ecosystem services](#)

Ecosystems are commonly exploited and manipulated to maximize certain human benefits. Such changes can degrade systems, leading to cascading negative effects that may be initially undetected, yet ultimately result in a reduction, or complete loss, of certain valuable ecosystem services. Ecosystem-based management is intended to maintain ecosystem quality and minimize the risk of irreversible change to natural assemblages of species and to ecosystem processes while obtaining and maintaining long-term socioeconomic benefits. We discuss policy decisions in fishery management related to commonly manipulated environments with a focus on influences to ecosystem services. By focusing on broader scales, managing for ecosystem services, and taking a more proactive approach, we expect sustainable, quality fisheries that are resilient to future disturbances. To that end, we contend that: (1) management always involves tradeoffs; (2) explicit management of fisheries for ecosystem services could facilitate a transition from reactive to proactive management; and (3) adaptive co-management is a process that could enhance management for ecosystem services. We propose adaptive co-management with an ecosystem service framework where actions are implemented within ecosystem boundaries, rather than political boundaries, through strong interjurisdictional relationships.

Propst and Gravilis. 1987. [Role of Economic Impact Assessment Procedures in Recreational Fisheries Management](#)

By estimating such impacts as changes in employment and income, economic impact assessments (EIAs) help fisheries managers, elected officials, administrators, and interest groups describe the effects of policy and investment decisions. Such assessments also reveal the distribution of economic effects across regional sectors. Compared to benefit-cost analyses, EIAs are less appropriate for measuring social benefits and require somewhat different data. Among the various EIA techniques, the hybrid data input-output model can satisfy the widest range of fisheries information needs with reasonable cost and acceptable levels of accuracy, except perhaps when long-range forecasts are required. Multipliers, a deceptively simple EIA result, are prone to mis-interpretation and misuse primarily when analysts fail to state the type of multipliers calculated, the context in which they were derived, and how they should be used to help guide policy and investment decisions. In recreational fisheries, typical "ratio" multipliers should not be applied to consumer spending to compute a total impact figure; instead, a "Keynesian" relationship, which expresses additional impacts per unit of consumer spending, should be applied. Regardless of the EIA procedure or multiplier type employed, the limiting factor in the natural resources field is quality data on consumer spending and industrial output.

Rabinovici et al. 2004. [Economic and Health Risk Trade-Offs of Swim Closures at a Lake Michigan Beach](#)

This paper presents a framework for analyzing the economic, health, and recreation implications of swim closures related to high fecal indicator bacteria (FIB) levels. The framework utilizes benefit transfer policy analysis to provide a practical procedure for estimating the effectiveness of recreational water quality policies. Evaluation criteria include the rates of intended and unintended management outcomes, whether the chosen protocols generate closures with positive net economic benefits to swimmers, and the number of predicted illnesses the policy is able to prevent. We demonstrate the framework through a case study of a Lake Michigan freshwater beach using existing water quality and visitor data from 1998 to 2001. We find that a typical closure causes a net economic loss among would-be swimmers totaling \$1274-37 030/ day, depending on the value assumptions used. Unnecessary closures, caused by high indicator variability and a 24-h time delay between when samples are taken and the management decision can be made, occurred on 14 (12%) out of 118 monitored summer days. Days with high FIB levels when the swim area is open are also common but do relatively little economic harm in comparison. Also, even if the closure policy could be implemented daily and perfectly without error, only about 42% of predicted illnesses would be avoided. These conclusions were sensitive to the relative values and risk preferences that swimmers have for recreation access and avoiding health effects, suggesting a need for further study of the impacts of recreational water quality policies on individuals.

Ready et al. 2012. [Net Benefits of Recreational Fishing in the Great Lakes, Upper Mississippi River, and Ohio River Basins](#)

This report provides estimates of the net value to anglers of recreational fishing in the Great Lakes and Upper Mississippi and Ohio River basins within the following 12 states: Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Kentucky, Michigan, Ohio, West Virginia, Pennsylvania and New York. Within these three basins, particular attention is given to those lakes, ponds, rivers, and streams that are located downstream from all barriers impassable to fish (dams, waterfalls, etc.). It is these waters that the United States Army Corps of Engineers (USACE) considers susceptible to the effects of possible aquatic nuisance species (ANS) transfer between the Great Lakes basin and the Upper Mississippi and Ohio River basins (in either direction).

Cornell University (CU) developed an economic model to estimate net baseline recreational fishing values using the travel cost valuation method. The development of these net benefit estimates took place in three stages: (a) a series of focus groups with recreational anglers; (b) surveys of recreational anglers; and (c) the development and estimation of an economic model of angler behavior. The surveys were also used to develop estimates of trip expenditures.

Based on fishing license sales data provided by the states, it was estimated that 6.6 million anglers lived and fished in the 12-state study area in 2011. These anglers spent an estimated 62.9 million days fishing in those portions of the Great Lakes basin below barriers impassable to fish. They spent 57.6 million days fishing in those portions of the Upper Mississippi and Ohio River basins that are below barriers impassable to fish.

The average net value per angler day, estimated from CU's recreational fishing model, was \$19.52. The aggregate net value of recreational fishing in those portions of the Great Lakes basin below barriers impassable to fish is estimated to be \$1.228 billion for calendar year 2011. The corresponding aggregate net value of recreational fishing in those portions of the Upper Mississippi and Ohio River basins below barriers impassable to fish is estimated to be \$1.124 billion.

Although CU was originally tasked with estimating the impacts of ANS on the net value of recreational fishing, USACE was not able to obtain sufficient information to quantify the timing or magnitude of impacts of ANS on sportfish populations in the Great Lakes, Upper Mississippi River, and Ohio River Basins. Consequently, this report serves as an indicator of the net value of recreational fishing that *could* be impacted in the future without-project (FWOP) condition – the case where no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins.

Richardson et al. 2014. [Assessing the value of the Central Everglades Planning Project \(CEPP\) in Everglades restoration: an ecosystem service approach](#)

This study identifies a full range of ecosystem services that could be affected by a restoration project in the central Everglades and monetizes the economic value of a subset of these services using existing data. Findings suggest that the project will potentially increase many ecosystem services that have considerable economic value to society. The ecosystem services monetized within the scope of this study are a subset of the difference between the future-with the Central Everglades Planning Project (CEPP) and the future-without CEPP, and they totaled ~\$1.8 billion USD at a 2.5% discount rate. Findings suggest that the use of ecosystem services in project planning and communications may require acknowledgment of the difficulty of monetizing important services and the limitations associated with using only existing data and models. Results of this study highlight the need for additional valuation efforts in this region, focused on those services that are likely to be impacted by restoration activities but were notably challenging to value in this assessment due to shortages of data.

Rosaen et al.2012. [The Costs of Aquatic Invasive Species to Great Lakes States](#)

The purpose of this report is to analyze the economic impact of existing Aquatic Invasive Species (AIS) on businesses and households in Great Lakes states. We explore the economic impact of AIS from two perspectives. First, we examine the existing evidence of AIS-related costs to households and businesses. Second, we identify the set of industries most directly affected by AIS in the region and quantify their size.

Overall, we find that AIS disrupt economic activity on a large scale in each of the Great Lakes states. AIS impose real costs on industries, consumers, and governments. Costs to individual companies and households include direct expenditures on combating an invasive species or repairing the damage it has done, and include indirect costs such as reduced productivity and higher prices in industries particularly affected by AIS. Governments and private actors such as nonprofits also devote significant resources to addressing AIS. The industries most acutely affected by AIS include sport and commercial fishing, water treatment, power generation, industrial facilities using surface water, and tourism. Together, these industries employ over 125,000 workers in the Great Lakes region.

While comprehensive cost estimates (including all industries, species, and waterways of the Great Lakes region) are not available, there are many individual estimates focusing on part of the problem. These cost estimates range from millions of dollars in cost and lost output for individual large industrial and power facilities to hundreds of dollars annually spent by individual households to control AIS on their property. It is likely that the overall aggregate level of cost to the Great Lakes region is significantly over \$100 million annually.

Samonte et al. 2017. [Socioeconomic Benefits of Habitat Restoration](#)

Excerpt from the Executive Summary: The ability to quantify the economic output and socioeconomic benefits of restoration projects is critical to better understand the short and long-term values of these projects to local communities. The findings in this study, and future similar studies, are important to increase the understanding of the role of green jobs in the economies of local communities, as well as the long-term ecosystem services the restoration projects provide, including reduction of damage to life and property.

Socioeconomic benefits of healthier rivers and coastal habitats:

- There are additional benefits from restored ecosystem services such as; storm and erosion protection, carbon sequestration as well as other non-market economic benefits derived from habitat improvements. Also referred to as “co-benefits.” Some of our ARRA project partners measured these socioeconomic benefits.
- Restored wetlands and stabilized shoreline along the south shore of Muskegon Lake, Michigan will generate a \$12 million dollar increase in property values, up to \$600,000 dollars in new tax revenue annually, and more than \$1 million dollars in new recreational spending with nearly 65,000 additional visitors annually over 15 years. The total value generated is nearly six times the initial investment.
- Sixty acres of restored freshwater tidal marsh and improved passage to 15 miles of high-quality habitat for chum, coho, threatened Chinook salmon in Washington’s Skagit Delta, are expected to generate an estimated \$21 million dollars in economic benefits by reducing the risk of flood damage and drainage maintenance costs over 50 years.
- Restored urban wetlands in Huntington Beach, California generated carbon storage and sequestration benefits of \$130,000 dollars per year over 50 years. The restoration investment also increased the extent of open water wetlands in the region, enhancing space and aesthetics as reflected in increased residential property values of \$36.3 million dollars.

In terms of economic growth, the 2,280 jobs supported through ARRA funding signify a valuable contribution to our nation’s restoration economy¹ that may have a long-lasting effect in local economies. This study determined that habitat restoration projects supported, on average, 15 jobs per

million dollars spent for restoration projects, and 30 jobs per million dollars invested in labor intensive restoration projects. It also determined that aside from immediate ecological and economic benefits, coastal restoration projects can provide significant long-term benefits through the rehabilitation and strengthening of the ecosystem services restored areas provide.

Samples and Bishop. 1982. [An Economic Analysis of Integrated Fisheries Management: The Case of the Lake Michigan Alewife and Salmonid Fisheries](#)

Intense predator-prey relationships exist between stocks of alewives and salmonids in Lake Michigan. In this paper, the economic implications of these biological interactions are explored and suggestions regarding efficient fisheries management options are made. A theoretical optimal control model is developed which delineates conditions for optimizing alewife and salmonid harvest rates. Model results indicate that the indirect effects which harvesting in one fishery have on harvest costs and returns in the other must be considered if economic efficiency in alewife/salmonid management is to be achieved. Furthermore, marginal net social values associated with alewife and salmonid harvests must be equated. It is estimated that alewives currently have a marginal net social value close to zero compared to \$4.10 per salmonid. These findings strongly suggest that utilization of alewife biomass as a forage base for predatory salmonids is more efficient than direct harvesting of alewives in a commercial fishery.

Schuette.2017. [Aquaculture not permitted in the Michigan waters of the Great Lakes](#)

Only operations that meet the definition of an “aquaculture facility” under the Michigan Aquaculture Development Act, 1996 PA 199, MCL 286.871 *et seq.*, may be registered to engage in aquaculture in the State of Michigan. Under the Act, an aquaculture operation in the Michigan waters of the Great Lakes could not be registered to engage in aquaculture because the operation would not meet the current definition of an “aquaculture facility” since the Michigan waters of the Great Lakes are not “privately controlled waters” as defined in the Act.

Smith et al. 2019. [Estimating the Economic Cost of Algal Blooms in the Canadian Lake Erie Basin](#)

Over the past two decades there has been a re-emergence of regular harmful algal blooms in Lake Erie due to increasing phosphorus loading, mainly from non-point agricultural sources. The Canadian and United States governments have jointly agreed to reduce phosphorus loadings to the lake in order to control the extent and severity of the blooms. Citizens on both sides of the border face a number of economic costs, both market and non-market, as a result of the blooms. This study values these costs for the Canadian portion of the Lake Erie basin economy using standard economic approaches that are widely applied within the world of cost-benefit analysis. The results suggest that algal blooms will impose equivalent annual costs equal to \$272 million in 2015 prices over a 30-year period if left unchecked. The largest market costs will be imposed on the tourism industry (\$110 million in equivalent annual costs) and the largest non-market costs will be borne by recreational users and those who place inherent value on the lake's quality (\$115 million in equivalent annual costs). Management action to reduce phosphorus loadings is found to be justified on economic grounds if the 30-year net present value of the reduction program is less than \$1294 million.

Southwick & Associates. 2019. [Economic Contributions of Recreational Fishing Within U.S. States and Congressional Districts](#)

Recreational angling constitutes one of the largest components of outdoor recreation in the U.S., having generated over \$49 billion in retail sales in 2016 (USFWS, 2016), and contributed \$125 billion to the national economy (ASA, 2018). At the state level, anglers spent \$41.8 billion within the states where they live and \$7.9 billion beyond the borders of their home state. The spending by residents supported 802 thousand jobs worth \$38 billion in wages and income. These economic effects are also important at smaller scales. In this study we estimate the contributions that anglers make to their respective state economies based on their residence in each of the 435 U.S. congressional districts. Results are presented at the state level (Table 1) as well as the congressional district level (Table 2).

Sterner et al. 2020. Ecosystem services of Earth's largest freshwater lakes

Fresh water is distributed unevenly across the globe. Earth's 21 largest lakes hold ~2/3 of all global, liquid, surface, fresh water and occupy diverse ecological and social settings. We identified seven ecosystem services for which there were quantitative data across most or all of these large lakes.

Approximately 1.35 million tonnes of fish are harvested per year from these lakes by commercial or artisanal means, with approximately 95% of this harvest coming from the African large lakes. The 21 lakes support the generation of at least 62.2 GW of power and the transportation of 195 million tonnes/year of cargo, with the Laurentian Great Lakes especially important in those. More than five billion m³ of potable drinking water is treated annually from large lakes, and an additional 812 million m³ water per year is extracted for irrigation purposes. The pattern of services provided to humans by large lakes differs based on social and environmental settings.

While we assembled systematic data on some important ecosystem services from large lakes, many other important, especially non-commercial services could not similarly be examined due to lack of data. More work is needed to show the value of the full set of ecosystem services provided by large lakes.

Steinman et al. 2017. [Ecosystem services in the Great Lakes](#)

A comprehensive inventory of ecosystem services across the entire Great Lakes basin is currently lacking and is needed to make informed management decisions. A greater appreciation and understanding of ecosystem services, including both use and non-use services, may have avoided misguided resource management decisions in the past that have resulted in legacies inherited by future generations.

Given the interest in ecosystem services and lack of a coherent approach to addressing this topic in the Great Lakes, a summit was convened involving 28 experts working on various aspects of ecosystem services in the Great Lakes. The invited attendees spanned a variety of social and natural sciences. Given the unique status of the Great Lakes as the world's largest collective repository of surface freshwater, and the numerous stressors threatening this valuable resource, timing was propitious to examine ecosystem services. Several themes and recommendations emerged from the summit. There was general consensus that 1) a comprehensive inventory of ecosystem services throughout the Great Lakes is a desirable goal but would require considerable resources; 2) more spatially and temporally intensive data are needed to overcome our data gaps, but the arrangement of data networks and observatories must be well-coordinated; 3) trade-offs must be considered as part of ecosystem services analyses; and 4) formation of a Great Lakes Institute for Ecosystem Services, to provide a hub for research, meetings, and training is desirable. Several challenges also emerged during the summit, which are discussed in the paper.

Stewart et al. 2003. [Recommendations for Assessing Sea Lamprey Damages: Toward Optimizing the Control Program in the Great Lakes](#)

The Great Lakes sea lamprey (*Petromyzon marinus*) control program currently allocates stream treatments to optimize the number of juvenile sea lampreys killed for a given level of control. Although the economic benefits derived from control appear to outweigh the dollars spent on control efforts, optimizing the number of sea lampreys killed will not necessarily optimize the economic benefits provided by the fish communities. These benefits include both non-consumptive and fishery values. We emphasize that the biological damages caused by each juvenile sea lamprey will vary, as will the economic value associated with each host that is killed. We consider issues related to assessing damages due to sea lampreys, taking into account effects on the fish community and fisheries, so as to improve the sea lamprey control program. We recommend a consolidation of information regarding the valuation of benefits, better understanding of variation in host-parasite interactions among the Great Lakes, and integration of the control program with other fisheries management objectives and activities. Adoption of these recommendations should promote lake trout rehabilitation in the Great Lakes, healthy fish communities and prudent use of limited fishery management resources.

Sturtevant et al. 2014. [An Impact Assessment of Great Lakes Aquatic Nonindigenous Species](#)

Excerpt from the Executive Summary: This project seeks to identify and compare the realized impacts of all ANS in the Great Lakes basin. Given the large scale of this effort, the wide variability in taxa and available information, and the desire to account for as many impacts as possible, a primarily qualitative approach was chosen. Like many risk and impact assessments, it depends on a customized scoring system that can account for qualitative information across taxa.

Talhelm. 1987. [Recommendations from the SAFR Symposium](#)

Participants in the Social Assessment of Fisheries Resources Symposium recommended several steps to increase the use of social sciences in Great Lakes fishery resource management. They urgently recommended greater use of existing social science research methods and findings in fishery management. They also recommended multidisciplinary research on total value assessment as a means of integrating contributions of social sciences in evaluating human dimensions of fishery resource management. By consensus, they recommended three short-term activities: (1) integrative case studies in which social scientists and Great Lakes fishery managers jointly evaluate and manage important current or emerging issues to help improve science methods, to solve real problems, and to demonstrate research and problem-solving methods; (2) science transfer projects that would help managers learn to better use social sciences; and (3) a "field guide" to social science methods that would help managers become familiar with the various methods. They also recommended by consensus (1) that politicians and resource managers be better educated about social science concepts, (2) that communication be improved between social scientists and others, and (3) that social scientists be integrated into management agencies. Other recommendations involved social science development and interpretation.

Talhelm. 1988. [Economics of Great Lakes Fisheries: A 1985 Assessment](#)

Hundreds of millions of dollars are spent annually to manage and protect Great Lakes fisheries and the related ecosystem—some \$60 million in fisheries management and protection alone. The public demands accountability and reasonable returns for its hard-earned dollars. Administrative, legislative and

judicial branches of government increasingly rely on benefit-cost and related economic and social assessments for this accountability. This report summarizes the latest estimates of Great Lakes fisheries-related economic values and economic impacts, and describes how to interpret this information in evaluating public sector fisheries management choices.

Talhelm et al. 1987. [Introduction to the Social Assessment of Fisheries Resources Proceedings](#)

No abstract was part of the paper. From the introduction: The Social Assessment of Fisheries Resources (SAFR) Symposium was held at Kettunen Center, Tustin, Michigan, on September 3-6, 1985. About 55 social scientists and senior fishery managers of North America's Great Lakes met to consider how social sciences might be used more effectively in fishery management. The Great Lakes Fishery Commission developed and sponsored the symposium to facilitate increased use of social sciences for the benefit of Great Lakes fisheries.

Talhelm et al. 1987. [Product Travel Cost Approach: Estimating Acid Rain Damage to Sportfishing in Ontario](#)

Acid rain threatens the productivity and perhaps existence of fisheries in parts of North America and Europe. A major focus of abatement negotiations is the costs of emission controls as compared to the associated benefits in avoided environmental damages. We used Talhelm's product travel cost approach to estimate changes in angler consumer surplus under varying acid rain loadings in lakes of eastern Ontario. Under the most severe acid loadings simulated over the next 50 years, a lake-by-lake biological model predicted that 5% of the lakes would eventually provide no angling, and angling quality would significantly change in another 20%. As a result, the annual amount of angling in the region would decline by 1% (6,000 angler-days). Annual angling consumer surplus would decline 4% (\$400,000 Canadian). The present value lost over the 50 years was estimated to be \$6,600,000, compared to a present value loss of \$328,000,000 if all angling in the region were eliminated for the entire period. We conclude that the approach is a powerful tool relative to other methods, not only for estimating economic values of existing fisheries but also for (1) evaluating angler preferences for levels of specific angling quality, (2) estimating economic values of changes (e.g., changes in creel restrictions, catch rates, species composition, and angling methods), and (3) projecting future angling use under altered management regimes. Like all socioeconomic assessment techniques, however, the reliability of the results is highly contingent on the underlying projections of ecological response and impact.

Taylor et al. 2019. [The changing face of Great Lakes fisheries](#)

Fisheries productivity in the Laurentian Great Lakes has changed dramatically over the past century. Invasions of non-native species and anthropogenically induced environmental changes in habitat quality and quantity have significantly altered the species composition and abundance of Great Lakes fishes, thereby affecting the social and economic well-being of coastal communities that rely on the good and services that these fishes provide. Our increased ability to locate, access, catch, preserve, and transport fish while modifying their habitats has resulted in the loss of native fish populations, which has profoundly impacted the ecological functioning and thus the productivity, structure, and services of Great Lakes ecosystems. Further, our lack of predictable scientific knowledge and control over factors affecting the productivity of the various Great Lakes fisheries, coupled with the failure of fisheries governance systems to manage these resources sustainably, have often left Great Lakes commercial, recreational, and subsistence fisheries and their local fishing communities impoverished and in disarray. In this paper, we discuss the environmental, cultural, and socioeconomic changes that have

characterized the Great Lakes basin in the last century. We also share our perspectives and personal stories about the impacts of these changes on ecosystems, fisheries, and the local and regional communities and economies that depend on them for their health and well-being. A key lesson learned was, that if we are to ensure the integrity and productivity of Great Lakes fisheries in the future, we must become better stewards, possessing a more predictable scientific and ecosystem-based understanding of fishes and their habitats while communicating the value of fisheries in food, recreational opportunities, and the economic and social wealth of local communities. The fate of Great Lakes fisheries and the quality of life of the people who use these resources are inextricably linked and can only be sustained in productive, well-governed, and well-balanced fisheries managed holistically at the ecosystem level.

University of Michigan. 2018. [The Socioeconomic effects of the Great Lakes Restoration Initiative](#)

This report analyzes the economic impacts of the funding provided by the Great Lakes Restoration Initiative (GLRI) from 2010 through 2016 on the Great Lakes region using a combination of econometric analysis (looking back in time) and regional economic modelling (looking back in time and projecting into the future); the study was conducted by a team of economists at the University of Michigan's Research Seminar in Quantitative Economics.

We estimated that there was a total of \$1.4 billion in federal spending on GLRI projects in the Great Lakes states between 2010 and 2016. Matching funds, primarily from state and local governments, contributed an estimated additional \$360 million in funding, bringing total spending on GLRI projects in the Great Lakes states to \$1.7 billion.

Some key results from the study were:

- Every dollar of federal spending on projects funded under the GLRI from 2010–2016 will produce a total of \$3.35 of additional economic output in the Great Lakes region through 2036.
- Every dollar of GLRI spending from 2010–2016 increased local house prices by \$1.08, suggesting that GLRI projects provided amenities that were valuable to local residents.
- Additional tourism activity generated by the GLRI in the Great Lakes region will increase regional economic output by \$1.62 from 2010–2036 for every \$1.00 in federal government spending, nearly half of the total increase we estimated.
- The GLRI created or supported an average of 5,180 jobs per year and increased personal income by an average of \$250 million per year in the Great Lakes region from 2010–2016.

We employed a conservative approach to modelling the regional economic impacts of the GLRI, and we believe that our estimates are likely to understate the program's true impacts. Although the GLRI was designed and implemented as an environmental restoration program, rather than an economic development program, it nonetheless produced economic benefits for the Great Lakes region that were on par with more traditional economic stimulus measures.

USACE. 2008. [Great Lakes Recreational Boating](#)

Excerpt from the Executive Summary: This report was prepared in response to Section 455(c) of the Water Resources Development Act of 1999, which directed the Secretary of the Army, in cooperation with the Great Lakes States, to submit a report to Congress detailing the economic benefits of recreational boating in the Great Lakes basin, particularly at harbors benefiting from operation and maintenance projects of the Army Corps of Engineers. This report was prepared by the Detroit District of

the Army Corps of Engineers, with assistance from the Great Lakes Commission. It is for informational purposes only and does not contain any conclusions or recommendations for Federal action.

The report does not include an evaluation of National Economic Development benefits, defined in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources, which is a standard requirement for studies of water resources projects. Instead, the report measures the regional economic impacts of recreational boating, in terms of boater spending and job creation in the Great Lakes basin. The 911,000 recreational boaters on the Great Lakes:

- spend \$2.36 billion per year on boating trips;
- spend \$1.44 billion per year on boats, boating equipment and supplies;
- create 60,000 jobs with \$1.77 billion in personal income; and
- increase the quality of life and appreciation of the environment for many Americans.

USACE. 2012. [Commercial fisheries baseline economics assessment: US waters of the Great Lakes, Upper Mississippi, and Ohio River Basins](#)

In support of the Great Lakes and Mississippi River Interbasin Study (GLMRIS), this report will establish the current economic value of the *commercial* fisheries in the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins based on the most recent annual harvest data available from state agencies (or equivalents) and inter-tribal agencies or organizations. This document is an assessment of the ex-vessel value of commercial fisheries in these basins- this includes both tribal and state-licensed commercial harvests. These values will set the baseline against which future conditions will be compared in GLMRIS.

Vesterinen et al. [Impacts of changes in water quality on recreation behavior and benefits in Finland](#)

The implementation of the European Union Water Framework Directive (WFD) requires nationally generalizable estimates of the benefits of protecting inland and coastal waters. As an alternative to benefit transfers and meta-analyses, we utilize national recreation inventory data combined with water quality data to model recreation participation and estimate the benefits of water quality improvements. Using hurdle models, we analyze the association of water clarity in individuals' home municipalities with the three most common water recreation activities--swimming, fishing and boating. The results show no effect on boating, but improved water clarity would increase the frequency of close-to-home swimming and fishing, as well as the number of fishers. Furthermore, to value the potential benefits of the WFD, we estimate the consumer surplus of a water recreation day using a travel cost approach. A water policy scenario with a 1-m improvement in water clarity for both inland and coastal waters indicates that the consumer surplus would increase 6% for swimmers and 15% for fishers. In contrast to previously estimated abatement costs to improve water quality, net benefits could turn out to be positive. Our study is a promising example of applying existing national recreation inventory data to estimate the benefits of water quality improvements for the purposes of the WFD.

Wang et al. 2016. [An integrated model for marine fishery management in the pearl River estuary: linking socio-economic systems and ecosystems](#)

The paper devises an integrated ecological-economics-social model to assess the implementation of ecosystem-based fisheries management in the Pearl River Estuary (PRE) in the South China Sea (SCS). In

particular, this paper presents the development of an integrated model, which links a regional economics social accounting matrix (SAM) model to an ecological model constructed using Ecopath with Ecosim (EwE) software. The impacts on the ecological-economics-social system are examined by varying fishing efforts for four scenarios, including status quo management, fishing effort reduction policy, fishing gear switch policy, and summer closure extension policy. Key results from the predictions (2010-2020) and policy simulations illustrate that the collapse effect is apparent in the status quo scenario. Further, reducing or switching of fishing effort (e.g. elimination of overfishing and reduced habitat disturbance) positively affects the ecosystem and can lead to economic and social welfare gains in the PRE's economy. The gear switch scenario presents a compromise among the economics, social, and conservation metrics, and also outperforms other scenarios in terms of biomass at the end of the simulation period. The fishing effort reduction policy performs better than the summer closure extension policy in terms of the conservation metrics but does relatively poorly in economic terms.

Wang. 2019. [Lake Erie Ecosystem Services Assessment: Economic Benefits from Phosphorus Reductions](#)

Excerpt from the Executive Summary: In the Lake Erie subregion, an ecosystem assessment framework allows us to connect biophysical processes to economic outcomes. This creates a more complete picture of environmental interventions that could result in the greatest change in benefits to communities and the general public over space and time by quantifying the value that we receive from those affected ecosystem services.

Specifically, we quantify benefits gained and costs avoided for achieving the GLWQA target 40% phosphorus reduction goal for spring total phosphorus (TP) and soluble reactive phosphorus (SRP) loads as well as other general phosphorus reductions. Following the model allows us to:

- Measure how changes in ecosystem outcomes (and indicators) will occur by achieving the target, specifically changes in the frequency, severity, and toxicity of HAB events,
- Estimate changes in the established target ecosystem services for evaluation - recreation, aesthetics, food/nutrition, raw materials, waste assimilation, and water supply, and
- Quantify the benefits (or avoided losses) people in the Lake Erie subregion would gain if phosphorus reductions are achieved.

Wolf et al.2017. [Reeling in the Damages: Harmful Algal Blooms' Impact on Lake Erie's Recreational Fishing Industry](#)

Lake Erie is one of the most valuable natural resources in the United States, providing billions of dollars in benefits each year to recreationalists, homeowners and local governments. The ecosystem services provided by Lake Erie, however, are under threat due to harmful algal blooms. This paper provides recreational damage estimates using spatially and temporally varying algae measures and monthly fishing permit sales collected between 2011 and 2014. Results indicate that fishing license sales drop between 10% and 13% when algal conditions surpass the World Health's Organization's moderate health risk advisory threshold of 20,000 cyanobacteria cells/mL. For Lake Erie adjacent counties experiencing a large, summer-long algal bloom, this would result in approximately 3600 fewer fishing licenses issued and approximately \$2.25 million to \$5.58 million in lost fishing expenditures. Our results show a discrete jump in reduced angling activity upon crossing this threshold, with limited additional impacts associated with more severe algal blooms. This suggests that policies aimed at eliminating, rather than mitigating, algal levels are most beneficial to the Ohio angling industry.

Zhang and Sohngen. 2018. [Do U.S. Anglers Care about Harmful Algal Blooms? A Discrete Choice Experiment on Lake Erie Recreational Anglers](#)

Despite the growing awareness of harmful algal blooms (HABs) in the US and abroad, estimates of welfare losses due to their presence are missing from the literature. Using a mail survey of 767 Ohio Lake Erie recreational angler respondents and a choice experiment, this study provides the first empirical quantification of the economic impacts of HABs on US recreational anglers. Our results demonstrate a significant and substantial willingness to pay by anglers for reduction in HABs, beyond the benefits associated with conventional water quality measures such as catch rates and water clarity. For instance, we find that anglers are willing to pay \$8–\$10 more per trip for one less mile of boating through HABs enroute to a fishing site. This finding suggests that explicit measures of HABs need to be collected and considered when valuing water quality in nutrient-rich waterbodies. We evaluate the welfare improvements resulting from several nutrient reduction policies, and find that anglers are willing to pay on average \$40-60 per trip for a policy that cuts upstream phosphorus loadings by 40%. The majority of welfare gains for anglers result from improving the non-catchable component of the fishing experience, notably water clarity and HAB reduction, as opposed to better chances of angler success.