Valuing Ecosystem Services in the Indiana Coastal Zone:
Literature Review

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Sea Grant
ILLINOIS - INDIANA

IISG-16-012

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Illinois-Indiana Sea Grant
IISG-16-012
July 2016

Acknowledgements

In 2015, Purdue University Calumet and Illinois-Indiana Sea Grant (IISG) received Grant No. CZ341-SG from the National Oceanic and Atmospheric Administration through the Indiana Department of Natural Resources, and Indiana Lake Michigan Coastal Program to quantify water-based ecosystem and economic benefits of restoration and management action in the Indiana coastal zone and build on a previously completed land-based assessment. The following objectives comprised the study: 1) identify water-based services provided by the Indiana coastal area habitats; 2) prioritize which ecosystem services are important in the coastal zone; and 3) review available economic value estimates of said prioritized services. The materials developed for this project are based on recommendations from our local environmental stakeholders. The authors would also like to thank N. Johnson, I. Miles and two anonymous reviewers for their constructive comments.

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Introduction

Indiana's coastal zone region consists of a portion of the Lake Michigan watershed, an area over 600 square miles of land and 240 square miles of Lake Michigan. This area contains five natural community classifications (and associated sub-classifications): 1) forest (upland, dune, floodplain, flatwoods); 2) prairie (prairie, sand prairie, hill prairie); 3) savanna (savanna, sand savanna); 4) aquatic (open water, marsh, swamp, bog, fen, sedge meadow, panne, seep and spring); and 5) primary (littoral - beach, foredune)[1]. These natural communities support a diversity of flora and fauna and are the result of climatic and geologic events occurring tens of thousands of years ago. They continue to benefit the present generation.

In addition to direct contributions to Indiana's economy (*economic impacts*)[2], Lake Michigan and its associated coastal resources provide importance *economic value* to citizens in the region through services provided by the ecosystem (*ecosystem services*). Ecosystem services are the benefits that people, communities, and economies receive from nature. Lake Michigan coastal residents benefit greatly from all of these services provided by the coastal zone. Benefit contributions to human well-being can be valued (*environmental valuation* or *ecosystem services valuation*) using methods developed by economists.[3] Thoughtful consideration of ecosystem services and their values can improve decision-making. Decision makers increasingly recognize that the full economic value of the coast is much greater than previously thought, and that knowledge of coastal ecosystem services and associated economic values can lead to improved management and planning decisions.[4]

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[1] //www.in.gov/dnr/files/Coastal_Areas_of_Significance.pdf

[2] Lake Michigan is an asset for economic development of the state's coastal region, an economy noted for supporting various industries, including legacy steel manufacturing, oil refining, gaming/amusements, and tourism (most notably Indiana Dunes National Lakeshore).

[3] Economic valuation methods have their theoretical basis in applied welfare economics, where values are derived from utility functions of the affected populations. Within the past decade, the ecosystem services framework has become increasingly popular, and application of economic valuation methods in the context is referred to as *ecosystem services valuation*.

[4] Guidance on incorporating ecosystem services into federal decision making directs agencies to consider the full range of ecosystem services and, among other outcomes, "where monetization is appropriate and feasible,

In accordance with the goals of the Coastal Zone Management Program (CZMP) established by the 1972 Coastal Zone Management Act (CZMA), the Indiana Lake Michigan Coastal Program (LMCP) addresses the management challenges facing Indiana's coast. The LMCP supports programing consistent with the goals of the CZMP within the coastal zone boundary including areas draining into Lake Michigan. The purpose of the Indiana LCMP is to enhance the state's role in planning and managing natural and cultural resources in the coastal region and to support partnerships between federal, state, and local agencies and organizations. The program relies on existing laws and programs as the basis for achieving its purpose. The LMCP vision is to facilitate the coordination of coastal resource protection, and preservation, through accountable and efficient planning, practice, and stewardship.

This first phase of LMCP ecosystem services project has the following objectives: identify the water-based ecosystem services provided by the Indiana LMCP area habitats, prioritize which ecosystem services are most important in the coastal zone, and review available economic value estimates of prioritized ecosystem services. The overarching project goal is to quantify the water-based ecosystem and economic benefits of restoration and management actions in the Indiana coastal zone to build on land-based assessments. [5]

[ecosystem services valuation can] promote cost efficiencies and increase returns on investment." U.S. Office of Management and Budget, Council of Environmental Quality, & Office of Science and Technology Policy. (2015, October 7). *Incorporating Ecosystem Services into Federal Decision Making* (M-16-01). Retrieved from https://www.whitehouse.gov/sites/default/files/omb/memoranda/2016/m-16-01.pdf.

[5]See, Varela, Weber, J. T., & Allen, W. (2015). *Valuation of Ecosystem Services for Lake, Porter, and LaPorte Counties, Indiana Provided by the Chicago Wilderness Green Infrastructure Vision*. Retrieved from http://www.nirpc.org/media/51550/giv_2.3_ecosystem_services_valuation_report.pdf

Coastal Services Ecosystem Valuation Workshop Summary

On September 18, 2015, Illinois-Indiana Sea Grant (IISG) facilitated a Coastal Services Ecosystem Valuation Workshop attended by 10 Indiana coastal zone stakeholders. Stakeholders included The Nature Conservancy, Indiana Dunes State Park, Indiana Dunes National Lakeshore, United States Geological Survey, Urban Waters Federal Partnership, Indiana Dunes Learning Center, Lake Michigan Coastal Program, and Purdue University Northwest at Calumet. The meeting began with a brief introduction highlighting the scope and mission of the Lake Michigan Coastal Program. Attendees then spent about an hour reviewing meeting materials. The group was asked to identify the top five threats to the coastal ecosystem. The top threats included: nutrients, climate change (with resultant habitat and shoreline change), water cycle changes (due to hydro-modifications and increasing impervious surfaces), invasive species, and airborne pollution (specifically, nitrogen, being very important).

For the next stage of the workshop, a handout that listed Indiana coastal zone ecosystem services was distributed to participants. Working together, attendees identified services that they considered most threatened in the watershed. The group identified the following services: 1) water purification; 2) native flora and fauna; 3) recreation (aesthetic and spiritual); and 4) erosion/sediment/flood control. These prioritized services are in the review of the economic valuation literature.

Table 1: Ecosystem Services Provided by the Indiana Coastal Zone

Ecosystem Service	Description
Provisioning Services	
Game and Fish Production	Provides habitat for the production of wild game and fish for human consumption
Food Production	Production of plant and fungal-based food for human consumption
Fiber Production (Fuel Wood)	Production of wood and other natural fibers for human use
Soil Formation	Long-term production of soil and peat for support of vegetation and other uses
Biochemical Production	Provisions of biochemical, natural medicines, pharmaceuticals
Genetic Information	Genetic resources for medical and other uses, including those not yet realized
Raw Material Production	Provides raw materials for building, construction, industrial use
Regulating & Supporting	
Hazard Control	
Flood Control/ Water Flow Regulation	Maintain water flow stability and protect areas against flooding (e.g., from storms)
Water Purification	Maintain water quality sufficient for human consumption and recreational uses
Erosion Control and Sediment Retention	Maintain soil and slope stability, retain soil/ sediment on site
Groundwater Recharge	Maintain groundwater recharge and aquifer replenishment
Air Purification	Removes particulates and other pollutants from the air
Climate	
Microclimate Moderation	Lower ambient and surface air temperature through shading
Regulation of Water Temperature	Moderate water temperature in streams
Carbon Storage	Sequester carbon in vegetation and soils, thereby reducing atmospheric CO_2
Biological	
Native Flora and Fauna	Maintain species diversity and biomass
Pollination	Provide pollinators for crops and other vegetation important
Pest and Disease Control	Provide biota which consume pests and control diseases
Nutrient Recycling	Facilitates natural storage and recycling of organic waste, pollutants, and nutrients
Cultural	
Recreation and Ecotourism	Outdoor experiences like hiking, birding, hunting, camping, etc.
Savings in Community Services	Retaining ecosystem service function by not converting natural land to houses
Increase in Property Values	Provide attractive location for homes and businesses
Science and Education	Existence of natural systems/areas for school excursions, research, knowledge advancement
Spiritual and Aesthetic	Aesthetic enjoyment or spiritual or religious fulfillment
Carrier Functions	Provide job opportunities for site managers, guides, land stewards, etc.
Bequest Value	The value placed on knowing that future generations will have the option to use a resource.
Existence Value	The non-use value of simply knowing that particular resources exist, even if they are not used

Literature Review

The literature review is a compilation of available economic value estimates of prioritized Indiana LMCP ecosystem services (water purification, native flora and fauna, recreation (spiritual and aesthetic aspects) and erosion/sediment/flood control). The literature review focused on obtaining original, peer-reviewed valuation studies from a search of the Environmental Valuation Reference Inventory (EVRI™) database.[6] The EVRI database assisted in conducting benefits transfer, a method that facilitates transfer of previous original valuation study results to evaluate other study sites and policy contexts. The review was limited to valuation studies with Great Lakes region geography. The resulting group of studies was then reviewed more closely, and study sites not within the Great Lakes basin, studies not using a primary valuation technique, and studies not pertaining to one of the ecosystem services identified by stakeholders were omitted. A subset of studies looking at the total economic value of habitat types (for example, wetlands), connecting economic and ecologic models, and using meta-analysis was also included in the literature review.[7] The resulting studies are presented below according to the primary ecosystem service being valued in the research.

The literature was organized as described here. The first section, Water Quality, includes Case 1, Table 2 with a summary of water quality studies, reference citations for the studies, meta-analysis studies on water quality, and reference citations for the meta-analyses. The second section, Native Flora and Fauna, includes Case 2, Table 3 with native flora and fauna studies, references for the studies, meta-analysis studies on native flora and fauna, and references for the meta-analyses. The third section, Recreation – Spiritual and Aesthetic, includes Cases 3-5, Table 4 with the non-extractive recreation studies, reference citations for the studies, meta-analysis studies on spiritual and aesthetic recreation, and references for the studies. The fourth section, Erosion, Sedimentation and Flood Control Estimates, includes Table 5 with the erosion, sedimentation and flood control studies and reference citations for these studies. The final section, Open Space and Habitat Types, includes Table 6 with the open space and habitat type studies, reference citations for these studies, and a meta-analysis on open space with citation included. At the end are Appendix A – Valuation Method and Other Indication Definitions and Appendix B – Components of Economic Value.

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[6] The EVRI database is the highest-rated available valuation database. Lantz, V., & Slaney, G. (2005). *An Evaluation of Environmental Valuation Databases Around the World*. Retrieved from https://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0571-02.pdf/$file/EE-0571-02.pdf.

[7] Meta-analysis involves combining the results of many individual studies using economic analysis. See Glass, G. V. 1976. *Primary, secondary, and meta-analysis of research*. Educational Researcher, 5 (10), 3–8.

Water Quality[8]

Natural landscapes protect water from nutrients and other pollutants by absorbing and filtering water containing pollutants. These ecosystems therefore provide a water purification service that improves water quality, and has resulting benefits for coastal zone residents, including a safer water supply, enhanced recreation experiences, and improved overall ecosystem health. The literature revealed that there were many dimensions of water quality, an issue that was referred to as *commodity heterogeneity.* This commodity heterogeneity limited study comparability, since there was no one common measurement for water quality. The water quality measurements used in the studies can be classified as:

- ***Pollutant(s) Concentrations*** – For example, dissolved oxygen, fecal coliform, pH, biochemical oxygen demand, temperature change, total phosphate, nitrate, turbidity, and total solids.[9]
- ***Water Clarity (Secchi Depth)*** – The depth at which a Secchi disk is visible in water. The greater the depth, the clearer the water and the better the water quality.
- ***Water Quality Ladders*** – range of water quality levels.
    - ***Recreation Support:*** For example, the Resources for the Future (RFF) ladder which correlates water quality with associated level of recreation support (boatable, fishable, swimmable).[10]
    - ***Water Quality Rating Scale:*** For example***,*** poor/fair/good/excellent).
    - ***Water Quality Index:*** For example, National Sanitation Foundation McClelland (1974).[11]

The economic valuation methods used in water quality studies included: actual market pricing methods, revealed preference (hedonic, travel cost, averting behavior), and stated preference (contingent valuation).[12] Summaries of the water quality valuation studies were included in Table 2, arranged by water quality measurement examined (pollutant concentration, water clarity, recreation support, water quality rating scale). Table 2 includes the study geography (location of study sites(s)); the change in ecosystem service provision that were valued, the valuation estimate and economic valuation method.

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[8] All dollar values are in U.S. unless otherwise stated. Values have not been converted to a common/base year.
[9] The pollutant concentration measures, combined, can be used to create a water quality index ranging from 0–100. See Brown, R.M., McClelland N.I., Deiniger R.A., Tozer, R.G.A. (1970). A water quality index – do we dare? *Water Sewage Works, 117*(10), 339-343
[10] For more information on the RFF water quality ladder, see: Mitchell, Cameron, R., & Carson, R. T. (1989). *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Washington, DC: Resources for the Future and Carson, R. T. & Mitchell, R.C. (1993). The Value of Clean Water: The Public's Willingness to Pay for Boatable, Fishable and Swimmable Quality Water, *Water Resources Research*, *29*(7), 2445-2454.
[11] McClelland, N.I. (1974). *Water Quality Index Application in the Kansas River Basin* (EPA – 907/9-74-001). Kansas City, MO: U.S. EPA.
[12] For brief descriptions of the economic valuation methods, see Appendix A.

For economic valuation of pollutant concentrations, studies were found examining: compliance with water quality standards, arsenic concentrations, pH level, nitrate, road salt, *Giardia lamblia,* and phosphorous. Since each of these studies used differing baseline levels of water quality, differing increments of change in water quality for the valuation scenario, and differing measures of water quality, the valuations were not directly comparable. The majority of the studies used stated preference methods (contingent valuation) though revealed preference methods were also used (hedonic, travel cost, averting behavior).

Four studies were found valuing changes in water clarity as measured using Secchi depth. While all the water clarity studies used similar water quality measures, again, the values could not be directly compared due to varying baseline conditions and differing increments of provision that were valued. Three of the four water clarity studies used the hedonic property method. In these studies, property value was modeled as a function of variables influencing property price, including the clarity of water in water bodies proximate to the property. Water quality measures observed by property owners, such as water clarity (turbidity), are captured in property prices.[13] Steinners (1992) noted that this relation held even when water appearance was not correlated with water quality, such as tannin staining. Economic theory predicts that a degradation in water quality results in a decrease in property values, all other factors held constant (and vice versa, a water quality improvement increased property values), and this relation held across the three hedonic property studies. A fourth study (Moore (2011) and Moore (2007)) explored the spatial variance of water quality in a contingent valuation method, finding spatial variance in willingness-to-pay (WTP) for water clarity improvements.[14]

Many economic studies estimated WTP for water quality improvements based on the relationship between enhanced and/or expanded recreation opportunities and water quality. These studies are presented in the *recreation support* section of Table 2. Some of these studies used a water quality index, such as the *water quality ladder*, a ranking scale from 0 (worst quality) to 10 (best quality), that also corresponded to the water quality goals of the Clean Water Act (boatable, fishable, swimmable).[15] Other indexes are also used, such as Uttormark's Lake Condition Index.[16] A large variety of other water quality

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[13] Brashares, E.N. (1985). *Estimating the Instream Value of Lake Water Quality in Southeast Michigan* (unpublished doctoral dissertation). University of Michigan, Ann Arbor, Michigan. Note that this study is not in the EVRI database.

[14] The two publications Moore (2007) and Moore (2011) use the same contingent valuation survey data.

[15] Vaughan, W. (1986). *The Use of Contingent Valuation Data for Benefit Cost Analysis in Water Pollution Control*. Mitchell, R., & Carson, R. (Eds.). Washington, DC: Resources for the Future.

[16] Uttormark, P.D., & Wall, J. P. (1975). *Lake classification: A trophic characterization of Wisconsin Lakes* (EPA 600/3-75-003). Corvallis, Oregon: U.S. EPA, National Environmental Research Center, Office of Research and Development.

measures are also used in the recreation support studies, as well as a variety of economic valuation methods (travel cost, combined revealed and stated preference, hedonic property, and contingent valuation).

Because studies contained multiple valuation estimates (stemming from multiple policy scenarios and/or model specifications) it was not possible to include the full range of value estimates in the table. In addition, population characteristics varied across studies (for example, income). While these characteristics affected valuations, they were not included in the table. Of note was that the initial state of the resource (for example, current phosphorous loadings) and the change being valued (for example, a 10% decrease in phosphorous loadings) limited the comparability of studies. Sediments impact water quality but were discussed in a separate section (erosion, sedimentation, and flood control estimates).

Refer to Case study 1 for a closer look.[17]

Case Study 1: Linking Land Use to Inland Lake Ecosystem Service Values (Campbell *et al*. 2013)

Campbell *et al*. used data from the upper Mississippi River watershed to estimate a hedonic property value model of the aesthetic ecosystem service provided by water purification (phosphorous removal). Models linking land use changes to lake trophic state and human well-being were combined. First, they used a phosphorus loading model to estimate nutrient runoff from differing land uses. Second, they linked the phosphorus loading model to the trophic state index (TSI) model, to get a measure of water quality on a scale of 0 (high quality) to 100 (poor quality) that was linked to lake trophic state and also translatable to Secchi depth. Third, a hedonic lake property value model was estimated to determine the economic benefits from lake water quality. The research found that for a 1-unit increase in TSI for oligotrophic Census Block Groups (BG) median home values decreased by $295; whereas for hypereutrophic lakes, the decrease in home values was $33. This finding was in keeping with the expectation that there was larger sensitivity of home values to water quality for the BGs containing oligotrophic lakes. The conclusions are based on the water quality situation at the time of the evaluation. Therefore, for a one unit change in TSI (lake water quality decrease) home values decrease, but a home on a pristine lake (oligotrophic) would have seen a greater decline in value as sensitivity to water quality decline was greater on pristine lakes versus already degraded lakes. The study concluded by looking at future land use scenarios. The authors noted an important limitation of the study was that the hedonic approach did not explicitly yield ecosystem services values (recreation demand, aesthetic demand) but rather implicitly gave these values ($2011 U.S.).

[17] Campbell, M., Howard, K., Le, K., Shriver, J., & Wan, L. (2013). *Linking land use to inland lake ecosystem service values.* Retrieved from https://deepblue.lib.umich.edu/bitstream/handle/2027.42/97434/NatCap_Linking%20Land%20Use.pdf?sequence =1The Trophic State Index is commonly used by the U.S. EPA. The break down is: oligotrophic (<41), mesotrophic (41-50), eutrophic (51-70), and hypereutrophic (>71).

Table 2: Summary of Water Quality Valuation Studies[18]

Pollutant Concentration				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Brox, J.A., R.C. Kumar, and K.R. Stollery, (1996); Brox, J.A., R.C. Kumar, and K.R. Stollery (2003)	ON	Several valuation scenarios including hypothetical water quality improvements from below provincial standards, to meeting those standards.	Estimated mean WTP/WTA ranged from $4.56 to $9.42 per household, per month ($1994 CAN).	Contingent valuation
Caudill, J.D. (1992)	MI	The baseline scenario was current groundwater quality; the alternate scenarios were a groundwater and a well protection policy.	Estimated mean annual household WTP ranged from $34.11 to $64.52 ($1990).	Contingent valuation
Cho, Y. (1996)	MN	The baseline level of provision was current levels of copper, sulfates, iron, and hardness (calcium and magnesium buildup). The alternate level of provision was levels below U.S. EPA standard levels.	Estimated annual mean WTP ranged from $32.16 to $43.56 to reduce iron levels, from $25.44 to $36.00 to reduce sulfate levels, from $33.36 to $47.88 to reduce hardness levels, and from $25.08 to $35.88 to reduce copper levels. Aggregate values are available ($1995).	Contingent valuation
Cho, Y., K. W. Easter and Y. Konishi (2010)	MN	Change in arsenic concentration from 50 micrograms to 10 micrograms per liter.	Estimated median WTP ranged from $6 to $23 annually per household ($2007).	Contingent valuation
Epp, D. J. and K. S. Al-Ani (1979)	PA	Change in residential property value associated with one point increase in the mean pH level of 5.5	For the pooled sample model, one point increase in the mean pH level could be expected to yield increase in mean sales value of a property by $653.96 ($1972).	Hedonic property
Giraldez, C. and G. Fox (1995)	ON	Reduction in agricultural nitrate emission from 147 kg/h to 140 kg/ha (16.67%) sufficient to achieve the 10mg/L acceptable standard.	The estimated annual benefits of improved ground water quality ranged from less than $1,000 to more than $30,000 ($CAN).	Averting behavior

[18] Values are in U.S. dollars unless otherwise indicated. When year of values is not indicated, this information was not available. Values have not been converted to a common/base year.

Publication	Geography	Change Valued	Value Estimate ($Year)	Valuation Method
Henry, J.J. *et al*. (1991)	IL, IN, ME, MA, MI, NH, NY, PA, VT	Actual road salt application	The nine states spent about $1.8 million in prevention and remediation of drinking water contaminated by road salt (2,250,000 tons). In Indiana, $175,000 was spent (240,000 tons of salt spread annually) ($1989).	Actual expenditure
Konishi, Y. and K. Adachi (2010)	MN	Change in arsenic concentration from 50 micrograms to 10 micrograms per liter of drinking water.	Estimated mean WTP ranged from $47.5 to $520.8 ($2007).	Contingent valuation
Laughland. A.S., L.M. Musser, W.N. Musser and J.S. Shortle (1993)	PA	The baseline provision was drinking water quality prior to contamination by *Giardia lamblia*, and the alternate level of provision was drinking water quality after the contamination incident.	Estimated mean averting costs per month for boiling ranged from $16.50 to $51.18; the mean averting costs per month for purchasing water ranged from $21.31 to $27.88; the averting costs of hauling water per month ranged from $7.01 to $14.02. Aggregate values are available ($1989).	Averting behavior
Mathews, L. G., et. al (2002); Mathews, L.G., *et al*. (1999)	MN	A hypothetical 40 percent reduction in phosphorus pollution in the Minnesota River.	Estimated household WTP was $140 annually. Aggregate values are available ($1997).	Combined revealed and stated preference (Travel cost and Contingent Valuation)
Musser, W.N., et. al (1992); Laughland, A.S., *et al*. (1996)	PA	The baseline level was based on having to boil or haul safe drinking water from alternative sources. The alternate scenario was Giardia free drinking water.	Estimated mean WTP was $17.94–$11.40 for water. Estimates are available contingent on averting behavior undertaken. Estimated averting costs savings ranged from a low of $14.14 to $36.33 ($1988-1989).	Combined revealed and stated preference (Averting behavior and Contingent valuation)
Poe, G. L. and R. C. Bishop (1999)	W	A 25 percent reduction in health risk exposures to nitrate-contaminated groundwater	Estimated incremental benefits reached a maximum of $412/year at an intermediate nitrate exposure level, and then declined.	Contingent valuation
Poe, G.L., and R.C. Bishop (1992)	WI	The study presented a scenario with and without a groundwater protection program for the wells in Portage County that would keep nitrate levels below government health standards.	Estimated mean and median WTP values per household per year were $269.3 and $265.5, respectively (no information provided) and $414.8 and $400.3, respectively (information provided)	Contingent valuation

Publication	Geography	Change Valued	Value Estimate ($Year)	Valuation Method
Randall, A. and D. DeZoysa (1996) De Zoysa, A.D.N. (1995)	OH	Reduction in the range of groundwater nitrate levels from 0.5-3.0mg/liter to 0.5-1.0mg/liter in the Maumee River basin.	Median WTP for groundwater improvement program in a one-time payment was $20.80. Aggregate and spatial values are available ($1994).	Contingent valuation
Stumborg, B.E., K.A. Baerenklau, and R.C. Bishop (2001)	WI	Reducing the phosphorus load Lake Mendota received by 50 percent per year for 10 years; the frequency of algal blooms in Lake Mendota from one out of every two days to one out of every five days.	Mean sample household present value WTP of $353.53, aggregate estimates are available ($1990).	Contingent Valuation
Welle, P. G. and J. B. Hodgson (2011)	MN	Water quality improvement program	Estimated mean WTP for water quality improvement program was $145 per household per year (combined model), $296 (Margaret-Gull Chain), and $11 (Sauk Watershed).	Contingent valuation
Wright, C. (1988)	MI	The baseline level of provision was groundwater that would be contaminated in five years and unfit for drinking without treatment. The alternate level of provision was not contaminated water that could be consumed without treatment.	Annual household WTP to protect groundwater quality ranged from $296 to $696. Aggregate results are available.	Contingent Valuation

Water Clarity				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Ara, S., E. Irwin and T. Haab (2006)	OH	One count changes in fecal coliform and one centimeter changes in water clarity using Secchi disk depth readings.	Measured at the average house distance to a beach, the marginal implicit price for a one count change in fecal coliform was $1.94 while a one centimeter change in water clarity was $21.54. Net benefit estimates are available ($1996).	Hedonic Property
Krysel, C., E. M. Boyer, C. Parson and P. Welle, (2003)	MN	Change in water clarity by 1 meter.	For one meter increase in water clarity, the price change ranged from $3.14 to $423.58. For one meter decrease in water clarity, the price change ranged from $1.43 to $594.16 ($2003).	Hedonic property
Moore, R., *et al*. (2011) Moore, R. *et al*. (2007)	WI	An improvement in water clarity in lower Green Bay from the current condition which range from 0.5 feet of clarity to over 11 feet of clarity to a 5 foot improvement in clarity throughout the bay.	The predicted WTP values varied ranging from $0.0 to $640.59. Aggregate value estimates are available.	Contingent Valuation
Steinnes, D.N. (1992)	MN	An increase in water clarity, measured as the number of feet below the water surface that a Secchi disk reading could be observed.	Each additional foot increased the average price per lot by $206.00, the total price of all lots on the lake by $3,383.79, and the average price per foot of water frontage by $1.99.	Hedonic property

Recreation Support				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Croke, K., R. Fabian and G. Brenniman (1986)	IL	Water quality ladder (outings, boating, fishing)	Estimated mean WTP for an improvement in water quality to allow outings was $33.49; for an improvement in water quality to allow outings and boating was $37.76; and for improvements in water quality to allow outings, boating, and fishing was $46.05.	Contingent valuation
Desvousges, W.H., V.K. Smith, and A. Fisher (1987) Desvousges, W.H., V.K. Smith, and M.P. McGivney (1983) Smith, V.K., W.H. Desvousges and M.P. McGivney (1983)	PA	The baseline is the current condition of the water, which is described as suitable for boating, with a 45 percent saturation level for dissolved oxygen. The magnitude of change is an improvement in water quality to a level that would be suitable for either game fishing (64 percent saturation level for dissolved oxygen) or swimming (83 percent saturation level for dissolved oxygen).	The range in values for nonusers and users combined are as follows: 1) a decline in quality from boatable to unsuitable for any activity, a range of $29 to $57.40; 2) an improvement in quality from boatable to fishable, $15.90–$36.90; 3) an improvement in quality from fishable to swimmable, $8.70–$18.80; and 4) an improvement from boatable to swimmable, $25.10–$60.20. (annual values per user) ($1981). Travel cost estimates: avoiding decline in water quality from boatable to unsuitable for any activity was $82.65; improvement in water quality from boatable to fishable was $7.01; improvement in water quality from boatable to swimmable was $14.71 ($1981). The study found that an improvement in water quality from being suitable for boating to being adequate for game fishing was valued between $0 and $8.60 per household per season. For a water quality improvement from suitable for boating to adequate for swimming was valued between $0 and $18.30. The highest roundtrip travel cost incurred by a respondent amounted to $22.65 ($1977).	Travel cost method and contingent valuation
Dupont, D.P. (2003)	ON	Improvement in water quality from a boatable to fishable to swimmable level.	WTP was estimated to range from $12.30 to $57.57/household/year for swimming, from $6.28 to $33.13 for boating, and from $8.36 to $30.23 for fishing. ($1995 CAN)	Contingent valuation
Ecologistics Limited (1990)	ON	The baseline was the current water quality at study site beaches. The alternative was five changes in water quality: very poor; poor; fair; good; and very good.	The travel cost model estimated the annual value of a water quality change from existing to very good at $61 per household. That same estimate for contingent valuation was $62. Aggregate values are available ($1988 CAN).	Travel cost method and contingent valuation

Publication	Geography	Change Valued	Value Estimate ($Year)	Valuation Method
Hitzhusen, F.J., S. Lowder and R. Ayalasomayajula (2000)	OH	Improvements in water quality through various proposed Muskingum River corridor improvements such as repairing the locks and dams, improving residential septic systems, extending an existing bike trail, and implementing zoning.	The average annual WTP for the proposed improvements ranged from $0.86 to $2.07 per individual. Aggregate values are available ($1999).	Actual expenditure/market price of output, hedonic property, contingent valuation
Lindsey, G., Robert G. Paterson, and Michael L. Luger (1995)	MD, WI, NC	Improvement programs aimed at securing safe waters for fishing and swimming.	In Wisconsin the annual mean WTP for improvement programs that would clean up waters safe enough for swimming and fish habitat was $76 ($1989).	Contingent valuation
Meyer, A. (2013)	MN	Percentage of the Minnesota River basin cleaned (50, 60, and 70 percent). Water quality improved enough to 1) maintain healthy populations of aquatic organisms, and 2) be suitable for swimming and other water recreation. The baseline level was the current basin situation, where 0 percent of surface waters is considered clean.	The annual mean WTP per person over a five year period for an additional 1 percent of river basin cleanup was $8.86. The present value of a five-year cleanup project was $35.38 if the project started immediately and $19.45 if the project was delayed 5 years.	Contingent valuation
Mitchell, R.C., and R.T. Carson (1986)	PA	Changes in water quality from boatable to fishable and from fishable to swimmable levels.	The authors estimated that the value of an incremental change in water quality from boatable to fishable levels was $79. Aggregate values are available.	Contingent valuation
Montgomery, M. and M. Needelman (1997)	NY	Three policy scenarios to eliminate toxic contamination in New York fish were investigated: 1) Eliminate toxic contamination in all lakes; 2) Raise pH in acidic lakes so that none is threatened or impaired; and 3) Carry out scenarios 1 and 2. Two additional scenarios were analyzed: 1) all toxic lakes are closed to fishing and 2) all acidic lakes are closed to fishing. The baseline scenario is without the policy.	The compensating variation per capita for eliminating toxic contamination was about $0.45 per day and $63.25 per season. Closing toxic sites to fishing generated the largest per capita benefit ($0.62/day and $87.09/season) among the alternative policy scenarios. Eliminating acidity so that no lake or pond was threatened or impaired generated a per capita benefit of only $0.10 per day or $13.82 per season. The benefit of closing acidic sites was $0.10/day and $14.85/season ($1989).	Combined revealed and stated preference
Ochs, J., and R.S. Thorn (1984)	OH	Improvement in Mahoning River water quality so that the Ohio Water Quality Standard is satisfied.	The total value of a fishing day is $85. Aggregate values are available.	Travel cost method

Publication	Geography	Change Valued	Value Estimate ($Year)	Valuation Method
Parsons, G.R. and M.S. Needleman (1992)	WI	The baseline level of provision was the current level of water quality. Four alternate levels of provision were valued: 1) an improvement of all study lakes to a near pristine quality; 2) a modest improvement of only the dirtiest study lakes; 3) a degradation of all study lakes to the lowest quality; and 4) a modest drop in water quality of only the cleanest lakes.	The welfare gain per individual per trip for attaining a pristine level of water quality in Wisconsin lakes ranged from $1.50 to $47.50 ($1978).	Travel cost method
Patrick, R., J. Fletcher, S. Lovejoy, W. Van Beek, G. Holloway, and J. Binkley (1991)	IN	The baseline condition was the current level of total suspended solids (TSS) and other pollutants in Indiana streams and lakes used for recreational fishing. The following magnitudes of change were examined: 1) a one, five, ten, and fifteen percent increase in the total suspended solids (TSS), and 2) similar percentile increases in TSS plus other pollutants.	Sample mean estimates for individual anglers were: 1 percent Total Suspended Solids (TSS) reduction is $0.52; 5 percent reduction is $2.63; 10 percent is $5.26; and 15 percent is $7.92. Plus: 1 percent reduction in TSS and other pollutants $0.53; 5 percent reduction in TSS and other pollutants $2.66; 10 percent reduction is $5.32; and 15 percent reduction is $7.99.	Travel cost method
Phaneuf, Kling, Herriges (1998)	Great Lakes	Scenarios: 1) 20 percent reduction in toxins at all sites or 2) loss of southern Lake Michigan for angling entirely.	Average of $35.85 per angler per season gain from scenario 1. For scenario 2, range of $98.34 to $849.09 per angler/season. The high range included non-use but not existence values.	Travel Cost Method
Ribaudo, M. O. and Donald J.E. (1984) Ribaudo, Marc, C. Edwin Young, and Donald Epp. (1984)	VT	Water quality in St. Albans Bay improved so it is as clean as in other familiar areas of Lake Champlain.	For current users of St. Albans Bay, the mean level of annual benefits for an improvement in bay water quality was $123 per person per year. For former users, the mean level of annual benefits attributable to an improvement in St. Albans Bay water quality was $97 per person per year ($1982).	Travel Cost
Young, C.E, and F.A. Teti (1984)	VT	The baseline condition was shoreline property values along St. Albans Bay, which was impacted by extensive macrophyte growth such as Eurasian watermilfoil, water chestnut, and floating yellow heart that thrived in shallow shoreline waters.	The property value losses were imputed by the water quality rating variable in the hedonic price model. For a unit change in this variable, the marginal sales price increased by $1,417. Aggregate values are available.	Hedonic property
Zegarac, M. and T. Muir (1998)	ON	An increase in harbor recreational opportunities created by the construction of several parks and a pier, development of an island, as well as improvements in lake water quality from boatable to swimmable.	Property values close to the harbor front increased in value when compared to similar properties a specified distance away. For example, this difference increased from statistically similar property values in 1983 to a difference of $8,495 in the 1994–1996 period.	Hedonic property

Water Quality Rating Scale				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Bouwes, N. W. and R. Schneider, (1979); Caulkins, P.P., Bishop, R.C. and Bouwes, N.W. (1986)	WI	The study measured water quality using LCI (Uttormark's Lake Condition Index).	Estimated $38,964 loss in consumer surplus from a water quality deterioration of 7 points on the LCI scale.	Travel cost method
Farber, S. and B. Griner (2000)	PA	A stream quality improved from moderately polluted to unpolluted for the Loyalhanna Creek sub-basin (stream A) and from severely polluted to either moderately or unpolluted for the Conemaugh River (stream B).	The marginal valuations for improvement in stream A from moderately polluted to unpolluted ranged from $26.63 to $51.35. For stream B, marginal valuations for improvements from severely to moderately polluted ranged from $35.90 to $67.64 and $75.63 to $112.44 to return to its unpolluted level. The values represented household WTP per year for five years ($1996).	Conjoint Analysis
Lant, C.L. and R.S. Roberts (1990) Lant, C.L., and G.A. Tobin (1989)	IA, IL	Discrete improvements in river quality, from poor to fair, fair to good, and good to excellent, were considered.	The study estimated the combined mean WTP for an improvement from poor to fair at $68.11, from fair to good at $84.26, and from good to excellent at $84.73. Estimated annual WTP for an increase from poor to excellent water quality ranged from $166.73 for the Edwards basin to $281.73 for the Wapsipinicon basin. Additionally, the value of wetlands per acre was estimated ($1987).	Contingent valuation
Luzadis, V.A. (1997)	NY	Protection of water quality from forestry non-point source pollution.	Forest owners were willing to pay $9,000–$10,000 to protect water quality in the New York City watershed ($1996).	Contingent valuation

Pollutant Concentration

Brox, J. A., Kumar, R. C., & Stollery, K. R. (1996). Willingness to Pay for Water Quality and Supply Enhancements in the Grand River Watershed. *Canadian Water Resources Journal, 21*(3), 275-288.

Brox, J. A., Kumar, R. C., & Stollery, K. R. (2003). Estimating Willingness to Pay for Improved Water Quality in the Presence of Item Nonresponse Bias. *American Journal of Agricultural Economics, 85*(2), 414-428.

Caudill, J. D. (1992). *The Valuation of Groundwater Pollution Policies: The Differential Impacts of Prevention and Remediation* (Doctoral dissertation). Retrieved from WorldCat. (Accession No. 32233739)

Cho, Y. (1996). *Willingness to Pay for Drinking Water Quality Improvements: A Contingent Valuation Study for Southwestern Minnesota* (Doctoral dissertation). Retrieved from WorldCat. (Accession No. 222164879)

Cho, Y., Easter, K.W., & Konishi, Y. (2010). Economic Evaluation of the New U.S. Arsenic Standard for Drinking Water: A Disaggregate Approach. *Water Resources Research, 46*.

De Zoysa, A.D.N. (1995). A benefit evaluation of programs to enhance groundwater quality, surface water quality and wetland habitat in Northwest Ohio (Doctoral dissertation). Retrieved from WorldCat. (Accession No. 34727047)

Epp, D. J. & Al-Ani, K.S. (1979). The Effect of Water Quality on Rural Nonfarm Residential Property Values. *American Journal of Agricultural Economics, 61*(3), 529-534.

Giraldez, C. & Fox, G. (1995). An Economic Analysis of Groundwater Contamination from Agricultural Nitrate Emissions in Southern Ontario. *Canadian Journal of Agricultural Economics*, *43*, 387-402.

Henry, J.J. et al. (1991). *Road Salt Impact on Drinking Water, in Highway Deicing: Comparing Salt and Calcium Magnesium Acetate*. Transportation Research Board, Committee on the Comparative Costs of Rock Salt and Calcium Magnesium Acetate for Highway Deicing (Eds.). Washington, DC: Transportation Research Board, National Research Council.

Konishi, Y. & Adachi, K. (2010). A framework for estimating willingness-to-pay to avoid endogenous environmental risks. *Resource and Energy Economics, 3*, 130–154.

Laughland, A.S., Musser, L.M., Musser, W.N., & Shortle, J.S. (1993). The Opportunity Cost of Time and Averting Expenditures for Safe Drinking Water. *Water Resources Bulletin, 29*(2), 291-299.

Mathews, L.G., Homans, F.R., & Easter, K.W. (2002). Estimating the benefits of phosphorus pollution reductions: an application in the Minnesota River. *Journal of the American Water Resources Association 38*(5), 1217-1223.

Mathews, L.G., Homans, F.R., & Easter, K.W. (1999). Reducing Phosphorus Pollution in the Minnesota River: How Much Is it Worth? (Staff Paper P99-4). Retrieved from Research in Agricultural & Applied Economics website: http://ageconsearch.umn.edu/handle/13771

Musser, W.N., Musser, L.M., Laughland, A.S., & Shortle, J.S. (1992). *Contingent Valuation and Averting Costs Estimates of Benefits for Public Water Decisions In A Small Community*. University Park, PA: Agricultural Economics and Rural Sociology Dept., College of Agricultural Sciences, Pennsylvania State University.

Laughland, A.S., Musser, W.N., Shortle, J.S., & Musser, L.M. (1996). Construct Validity of Averting Cost Measures of Environmental Benefits. *Land Economics, 72*(1), 100-112.

Poe, G. L. & Bishop, R.C. (1999). Valuing the Incremental Benefits of Groundwater Protection when Exposure Levels are Known. *Environmental and Resource Economics, 13*, 341-367.

Poe, G.L., & Bishop, R.C. (1992). Measuring the Benefits of Groundwater Protection from Agricultural Contamination: Results from a Two-Stage Contingent Valuation Study (Staff Paper No. 341). Retrieved from Agricultural & Applied Economics website: http://ageconsearch.umn.edu/handle/200549

Randall, A. & DeZoysa, D. (1996). *Groundwater, Surface Water, and Wetlands Valuation for Benefits Transfer: A Progress Report* (W-133). Retrieved from http://fes.forestry.oregonstate.edu/sites/fes.forestry.oregonstate.edu/files/PDFs/W133%209th%20Interim%20Report%201996.pdf

Stumborg, B.E., Baerenklau, K.A., & Bishop, R.C. (2001). Nonpoint Source Pollution and Present Values: A Contingent Valuation Study of Lake Mendota. *Review of Agricultural Economics 23*(1), 120-132.

Welle, P. G. & Hodgson, J.B. (2011). Property Owners' Willingness to Pay for Water Quality Improvements: Contingent Valuation Estimates in Two Central Minnesota Watersheds. *Journal of Applied Business and Economics 59*(1), 81 -94.

Wright, C. (1988). An Economic Assessment of Groundwater Pollution (Unpublished master's thesis). Central Michigan University, Michigan

Water Clarity

Ara, S., Irwin, E., & Haab, T. (2006). Measuring the Effects of Lake Erie Water Quality in Spatial Hedonic Models. Paper presented at Environmental and Resource Economists, Third World Congress. Kyoto, Japan.

Krysel, C., Boyer, E.M., Parson, C. & Welle, P. (2003). *Lakeshore Property Values and Water Quality: Evidence From Property Sales in the Mississippi Headwaters Region*. Retrieved from http://www.friendscvsf.org/bsu_study.pdf

Moore, R., Provencher, B., & Bishop, R.C. (2011). Valuing a Spatially Variable Environmental Resource: Reducing Non-Point-Source Pollution in Green Bay, Wisconsin. *Land Economics*, *87*(1), 45-59.

Moore, R., Bishop, R.C., & Provencher, B. (2007). Valuing a Spatially Diverse Non-market Good: The Benefits of Reduced Non-point Source Pollution in Green Bay, WI. Paper presented at the American Agricultural Economics Association Annual Meeting, Portland, Oregon.

Steinnes, D.N. (1992). Measuring the Economic Value of Water Quality: The Case of Lakeshore Land. *The Annals of Regional Science, 26*, 171-176.

Recreation Support

Croke, K., Fabian, R., & Brenniman, G. (1986). Estimating the Value of Improved Water Quality in an Urban River System. *Journal of Environmental Systems, 16*(1), 13-23.

Desvousges, W. H., Smith, V. K., and McGivney, M. P. (1983). *A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvements*. (EPA Reference No. W.83.6). Washington, DC: Office of Policy Analysis.

Desvousges, W. H., Smith, V. K., and McGivney, M. P. (1983). *A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvements*. (EPA Reference No. W.83.6). Washington, DC: Office of Policy Analysis.

Dupont, D. P. (2003). CVM Embedding Effects When there Are Active, Potentially Active and Passive Users of Environmental Goods. *Environmental and Resource Economics, 25*, 319-341.

Ecologistics Limited. (1990). *Benefits to Beach Users from Water Quality Improvements*. Toronto, Ontario: Queen's Printer for Ontario.

Hitzhusen, F. J., Lowder, S., & Ayalasomayajula, R. (2000). Muskingum River Economic Valuation. Department of Agricultural, Environmental and Development Economic, The Ohio State University.

Lindsey, G., Paterson, R. G., & Luger, M. L. (1995). Using Contingent Valuation in Environmental Planning. *Journal of the American Planning Association, 61*(2), 252-262.

Meyer, A. (2013). Intertemporal Valuation of River Restoration. *Environmental and Resource Economics, 54*(1), 41-61.

Mitchell, R. C., & Carson, R. T. (1986). *The Use of Contingent Valuation Data for Benefit/Cost Analysis in Water Pollution Control*. Washington, DC: Resources for the Future.

Montgomery, M. & Needelman, M. (1997). The Welfare Effects of Toxic Contamination in Freshwater Fish. *Land Economics, 73*(2), 211-223.

Ochs, J., & Thorn, R. S. (1984). Measuring the Site-specific Recreation Benefits Resulting from Improved Water Quality: An Upper Bound Approach. *Water Resources Bulletin, 20*(6), 923-927.

Parsons, G. R. & Needleman, M. S. (1992). Site Aggregation in a Random Utility Model of Recreation. *Land Economics, 68*(4), 418-433.

Patrick, R., Fletcher, J., Lovejoy, S., Van Beek, W., Holloway, G., & Binkley, J. (1991). Estimating Regional Benefits of Reducing Targeted Pollutants: a n Application to Agricultural Effects on Water Quality and the Value of Recreational Fishing. *Journal of Environmental Management, 33*, 301-310.

Phaneuf, D. J., Kling, C. L., & Herriges, J. A. (1998). Valuing Water Quality Improvements Using Revealed Preference Methods When Corner Solutions are Present. *American Journal of Agricultural Economics, 80*(5), 1025-1031.

Ribaudo, M. O., & Donald, J. E. (1984). The Importance of Sample Discrimination in Using the Travel Cost Method to Estimate the Benefits of Improved Water Quality. *Land Economics, 60*(4), 397-403.

Ribaudo, M., Young, C.E., & Donald E. (1984). *Recreation Benefits from an Improvement in Water Quality at St. Albans Bay, Vermont. Natural Resource Economics Division*. Washington, DC: U.S. Dept. of Agriculture, Economic Research Service, Natural Resource Economics Division.

Smith, V.K., Desvousges, W.H., & McGivney, M.P. (1983). Estimating Water Quality Benefits: an Econometric Analysis. *Southern Economic Journal, 50*(2), 422-437.

Young, C.E, & Teti, F.A. (1984). *The Influence of Water Quality on the Value of Recreational Properties Adjacent to St. Albans Bay, Vermont.* Washington, DC: U.S. Department of Agriculture, Economic Research Service, Natural Resource Economics Division.

Zegarac, M. & Muir, T. (1998). *The Effects of RAP Related Restoration and Parkland Development on Residential Property Values: A Hamilton Harbour Case Study*. Burlington, Ontario: Environment Canada, Ontario Region.

Water Quality Rating Scale

Bouwes, N.W., & Schneider, R. (1979). Procedures in Estimating Benefits of Water Quality Change. *American Journal of Agricultural Economics 61*(3), 535-539.

Caulkins, P.P., Bishop, R.C., & Bouwes, N.W. (1986). The travel cost model for lake recreation: a comparison of two methods for incorporating site quality and substitution effects. *American Journal of Agricultural Economics, 68*(2), 291-297.

Farber, S. & Griner, B. (2000). Using Conjoint Analysis to Value Ecosystem Change. *Environmental Science and Technology,* 34(8), 1407-1412.

Lant, C.L., & Roberts, R.S. (1990). Greenbelts in the Cornbelt: Riparian wetlands, Intrinsic Values, and Market Failure. *Environment and Planning A, 22*, 1375-1388.

Lant, C.L., & Tobin, G.A. (1989). The Economic Value of Riparian Corridors in Cornbelt Floodplains: A Research Framework. *Professional Geographer 41*(3), 337-349.

Luzadis, V.A. (1997). *The Integrated Valuation Method as a Holistic Approach to Measuring Forest Values for Policy Development* (Doctoral dissertation). Retrieved from WorldCat. (Accession No. 38274118)

Water Quality Meta-Analysis Valuation Studies[19]

Several studies have used the meta-analysis technique in an attempt to combine and compare water quality valuation estimates, including Alvarez and Asci (2014), Ge *et al*. (2013), Johnston *et al*. (2014) and Johnston *et al*. (2005), Koteen J. *et al*. (2002) and Van Houtven *et al*. (2007). The intention of meta-analytic studies is to improve the literature review process by using econometric techniques to examine sources of variation in value estimates to better perform benefits transfer – the transfer of values from an original study site to a different site or policy context. Sources of variation in value estimates may result from: study characteristics (year of study, survey mode, response rate), method (payment vehicle, elicitation format, and estimation method), sample population characteristics (income, sample representation), geography (availability of substitutes, geographic region, and site size), water body characteristics (river, stream, lake, and estuary), and resource characteristics (baseline water quality, extent of water quality change).

Alvarez and Asci (2014) examined 39 economic non-market valuation studies of water quality, choosing to include 16 studies (176 valuation estimates) in a meta-analysis. The authors constructed a water quality ladder to translate the varying measures of water quality across studies into a common measurement scale, coding the original water measure used in each study to the water quality ladder. The ladder was based on a scale of 0 to 10, with 0 meaning not safe for recreation and other human uses, 5 meaning fishable, and 10 meaning pristine or unpolluted. A variable for the difference between the baseline and end state (the change in water quality valued) was then constructed. The authors specified a valuation function where WTP is a function of several variables anticipated to influence WTP, including: baseline level of water quality, the magnitude of change in water quality being valued, demographics of the study population (income, population density), study site and resource characteristics (pollution source, point or non-point), and study methodology (estimation technique, sampling method, valuation elicitation format, payment vehicle, type and frequency, type of WTP measure, types of values elicited). The authors then used the estimated valuation function to perform a benefits transfer to Florida water quality improvements. The authors concluded that meta-analysis estimates could be considered "ballpark" estimates for the water quality improvement at the policy site (ranging from \$200 – \$500 per person/year, depending on the change in water quality being valued (\$2013)).

Ge *et al*. (2013) used 38 studies containing 332 valuation observations from economic non-market studies in a meta-analysis of water quality improvements. The authors created a common water quality measure across the studies using a water quality index ranging from 1 to 100, an index developed by the National Sanitation Foundation.[20] This index corresponded and weighted nine differing water quality dimensions (dissolved oxygen, fecal coliform, pH, biochemical oxygen demand, temperature change, total phosphate, nitrates, turbidity, and total solids). The authors used the National Lakes Assessment to incorporate Secchi

[19] All dollar values are in U.S. unless otherwise stated. Values have not been converted to a common/base year.
[20] Brown, R.M., McClelland N.I., Deiniger R.A., Tozer, R.G.A. (1970). A water quality index – do we dare? *Water Sewage Works, 117*(10), 339-343.

depth into the water quality index using a conversion tool. WTP was estimated as a function of the initial water quality index, change in the water quality index, site characteristics (size, type, location), sample characteristics (income, sample region) and research method (date, model, elicitation methods, water quality indicator). The study found that for a 10-point change in the 100-point water quality index, average WTP was $45 (per household, $2010), and that WTP increased with the site size, on average $0.60 higher for every 10 square miles. The authors noted that their work expanded on the work of Van Houtven and Johnson *et al*. (2005) in three ways: first, by controlling for site and region size; second, by not only including contingent valuation studies but also travel cost and hedonic methods as well; and third, by incorporating Secchi depth studies. The authors concluded that the model could be used to perform benefits transfer for water quality improvements.

Johnston *et al.* (2014) started with the data contained in the Johnston *et al.* (2005) study, and updated it so that 52 state preference WTP studies with 143 observations were included in the analysis. The WTP for water quality improvement was modeled as a function of: study method and year (year of study, payment vehicle, elicitation format, estimation method); region and surveyed population (region of U.S., income, sample representation), market area and study site (size of market area, land cover, site substitutes); affected water body (hydrological feature, recreational uses impacted, geospatial scale) and water improvement (water quality baseline condition, extent of water quality change). Water quality measures were standardized to the 100-point water quality index used in Johnson *et al*. (2005), scaled up from a 10-point water quality ladder. Estimated mean WTP for the mean water quality improvement (3.596–18.335) ranged from $27.45 to $234.50, depending on the model specification ($2007). The authors examined the benefit transfer implications of their model by estimating WTP for water quality improvements. The results indicated that benefits transfer is sensitive to geospatial variable errors (scale, market extent, and substitutes). This resulted in transfer errors of over 300 percent and brought the validity of benefits transfers that fail to consider geospatial variation into question. The authors recommended that geospatial variance be considered to improve the accuracy of the benefits transfer.

Van Houtven *et al*. (2007) used 18 studies containing 131 WTP estimates to estimate WTP as a function of: water quality characteristics (baseline level, change, type of resource, region), study population characteristics (income, price effects, other sociodemographic variables), and study characteristic (year published, valuation question format, response rate, survey method, sample size). Water quality changes were converted to a common measure using a 10-point water quality index. The authors examined the meta-analysis results for use in benefits transfer applications from three scenarios: water quality index (change of 1, 3, and 6), finding an estimated mean WTP of $3–$5 (for nonusers) and $56–$58 (for users) for a one unit water quality index change ($2000). The study concluded that the meta-analysis results could be used for benefit transfer functions but was limited in that sources of variation in WTP estimates remained unexplained, such as spatial characteristics. It was recommended that water quality valuation research be conducted on benefits transfer, specifically in relation to better defined water quality changes, larger-scale and under-represented geographies, and improvements in the data reported in the published valuation studies.

Koteen *et al*. (2012) looked at addressing the issue of defining water quality in economic terms. They evaluated six water uses, including municipal, industrial, hydroelectric, recreation, agricultural, and nonmarket-based. In the recreational section, there was enough data to conduct a meta-analysis. Using nine studies with 17 different marginal values per acre-foot (VAF), Koteen *et al*. wanted to determine if there was a relationship between an increase in VAF and water flow, valuation method, and recreational activity. These variables included fishing and boating as recreational activities, water flow based on cubic-feet-per-second, and differences between contingent valuation and travel cost methods. After conducting the analysis, it was seen that travel cost increased the VAF by $50.42 along with an increase in $35.84 from boating activity ($1998). This data would help with future management and planning decisions when it came to comparing the values between nonmarket water quality and the values of water for agriculture and other market based uses.

Alvarez, S. & Serhat, A. (2014, February 1-4). *Estimating the Benefits of Water Quality Improvement using Meta-Analysis and Benefits Transfer.* Paper presented at the Southern Agricultural Economics Association Annual Meeting, Dallas, TX.

Ge, J., Kling, C. L., & Herriges, J. A. (2013). *How much is clean water worth? Valuing water quality improvement using a meta-analysis* (Working Paper No. 13016). Retrieved from Digital Repository at Iowa State University website: http://lib.dr.iastate.edu/econ_las_workingpapers/51/

Johnston, R. J., Besedin, E. Y., & Stapler, R. (2014). *Enhanced Geospatial Data for Meta-Analysis and Environmental Benefit Transfer: An Application to Water Quality Improvements.* Paper presented at the Meta-Analysis of Economics Research Network 2014 Athens Colloquium, Athens, Greece. Retrieved from: metaanalysis2014.econ.uoa.gr/fileadmin/metaanalysis2014.econ.uoa.gr/uploads/Johnston_Robert.pdf

Koteen, J., Alexander, S. J., Loomis, J. B. (2002). *Evaluating benefits and costs of changes in water quality* (Report No. PNW-GTR-548). Retrieved from http://www.fs.fed.us/pnw/pubs/gtr548.pdf

Van Houtven, G., Powers, J., & Pattanayak, S. K. (2007). Valuing water quality improvements in the United States using meta-analysis: Is the glass half-full or half-empty for national policy analysis? *Resource and Energy Economics, 29*(3), 206-228.

Native Flora and Fauna

Northwest Indiana is one of the most biologically diverse regions in the country and is home to several species that are now endangered. Over the past century, development and urbanization have impacted the habitat available for flora and fauna. For example, of the estimated pre-settlement 1,400 plant species of the Indiana dunes area, only 653 have been documented recently.[21] Flora and fauna diversity is one of the key representations of environmental health. When this diversity changes or is lost, it can be an indicator that something is occurring that is harming the ecosystem.

Summaries of economic valuation studies of flora and fauna for the Great Lakes region that were found in the EVRI™ database are summarized in Table 3. The economic valuation literature does not have a good representation of the types of plants and animals found in the Great Lakes region. Studies are arranged according to topic, including:

- ***Flora*** – plant species.
- ***Fauna Insects*** – insect species.
- ***Fauna*** – animal species.
- ***Invasive Species*** – species that are not native to the Great Lakes region and cause harm to the ecosystem.

The methods used to value native flora and fauna include: actual expenditure, revealed preference (hedonic, travel cost), stated preference (contingent valuation), replacement costs, and experimental cash market value[22]. These economic valuation methods are indicated in the last column of the table. The remaining data for each article is organized by the publication information, geographic location, change in the amenity being studied, and the final value estimate.

All three flora articles looked at the value of trees. Sander *et al.* (2010) used a hedonic property method to estimate the value of increasing tree cover by 10 percent. Scarpa *et al.* (2000) also used the hedonic method to determine the harvest and potential harvest values of maple birch forests. Nowak *et al*. (2002) used an actual expenditure method to determine the compensatory value of urban trees on an aggregate scale.

Winfree *et al.* (2011) used a replacement cost method to determine the pollination service that native bees and honey bees provide to the watermelon industry. Two articles used the contingent valuation to determine willingness-to-pay (WTP) from managing an insect infestation and reducing the risk of tick-borne diseases, respectively.

[21] Choi, Y. D. (1999/2000). *Wetland flora of the Grand Calumet River in Northwest Indiana: potential impacts of sediment removal and recommendations for restoration*. Retrieved from https://www.csu.edu/cerc/researchreports/documents/WetlandFloraGrandCalumetRiverNWIndianaPotentialImpactsSedimentRemoval2000.pdf

[22] For brief descriptions of the economic valuation methods, see Appendix A.

All fauna studies used the contingent valuation method to estimate economic value. Moore *et al.* (2010) and Bowker and Stoll (1988) both looked at whooping cranes. The first article looked at WTP to increase the flock size and the other estimated WTP to view the species. Looking at bald eagles and striped shiner, Bishop *et al*. (1987) and Boyle *et al*. (1987) both valued WTP to a preservation program to protect these species from becoming extinct. Lastly, Chambers and Whitehead (2003) valued two different types of management programs for wolf populations, while Frederick and Fischhoff (1997) valued timber wolf reintroduction.

This section of the literature review is focused on native flora and fauna, so invasive species have been placed in their own category because of their impacts on native species. Species examined include: emerald ash borer, Eurasian watermilfoil, hemlock woolly adelgid, sea lamprey, and Asian carp. Holmes *et al*. (2010) used hedonic property methods to see the property value losses from the hemlock woolly adelgid. Provencher *et al*. (2012) used contingent valuation to determine the WTP for a prevention program of boats spreading Eurasian watermilfoil. Yue *et al*. (2011), on the other hand, looked at the harm towards the economy, environment, and human health caused by invasive plants through experimental cash market methods. Finally, Lupi *et al*. (2003) looked at the economic use-value of several sea lamprey treatment options through travel cost methods.

Because studies contained multiple valuation estimates (stemming from multiple policy scenarios and/or model specifications) it was not possible to include the full range of value estimates in the table. In addition, population characteristics varied across studies (for example, income). While these characteristics affected valuations, they were not included in the table. Of note was that the baseline resource state and the increment of resource change valued also varied across the studies, which limited the comparability of studies.

Refer to Case study 2 for a closer look.[23]

Case Study 2: Economic Linkages Between Coastal Wetlands and Habitat/Species Protection: A Review of Value Estimates Reported in the Published Literature (Kazmierczak 2001)

Kazmierczak provides a summary of eight studies examining the economic value of wetlands, and provides a summary of the knowledge regarding wetland habitat protection ecosystem service. The author finds habitat/species protection values ranging from $169/acre/year to $403 acre/year ($2000). The author found that the type of wetland as well as the geographic location of the wetland have little impact on the values.

[23] Kazmierczak, R. F. (2001). Economic linkages between coastal wetlands and habitat/species protection: a review of value estimates reported in the published literature. Retrieved from ageconsearch.umn.edu/bitstream/31689/1/lsu0104.pdf.

Table 3: Summary of Native Flora and Fauna Valuation Studies[24]

Flora				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Nowak, D.J., D.E. Crane, and J.F. Dwyer (2002)	GA, MD, MA, NJ, NY, CA, PA	Compensatory value of urban trees (value of a tree as a structural asset).	The value of urban trees in cities ranged from $101 million to $5.2 billion. In states, the urban forest was valued $146.8 million - $913 million. Aggregate values are available.	Actual expenditure
Sander, H., S. Polasky and R. G. Haight (2010)	MN	Proximity to amenities (park, trail head, lake) and 10 percent increase in view.	The increase in home value for every 100 meters closer to: a park is $136, a trail is $119, a lake is $216, and a stream is $127. The marginal prices of increasing the percentage of a home's view of grassy surfaces or water by 10 percent are $5517 and $7417 ($2005).	Hedonic property
Scarpa, R., J. Buongiorno and J. Hseu (2000)	WI	Values for timber harvested from maple birch forests and the potential timber that could have been harvested.	The study found national forests valued at $49.6/ha/year, which is almost ten times its timber only value of $5.40 ($1984).	Hedonic property

Fauna – Insects				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
MacDonald, H., D.W. McKenny and V. Nealis (1997)	ON	WTP to either use a biologic to control an infestation of insects or provide compensation packages to those experiencing losses from the infestation.	Individual, one-time WTP for biologic control of Jack pine budworm and Gypsy moth ranged $14.89 to $15.15 and $18.1 to $27.44. The WTP for letting compensation packages ranged $2.07 to $5.14 and $4.98 to $7.38 ($1997 CAN).	Contingent valuation
Morlando, S., S. J. Schmidt and K. LoGiudice (2012)	NY	Reduction in the risk of tick-borne disease due to restoration of habitat for endangered species in Albany Pine Bush Reserve.	The annual WTP was $4.24 per household. Aggregate values are available ($2008).	Contingent valuation
Winfree, R., B. J. Gross and C. Kremen (2011)	NJ, PA	Pollination service of crops by bees.	The annual net income value of watermelon is $3.63 million/year, $2.25 million in pollination services by native bees, and $1.38 million/year by honey bees ($2009).	Replacement costs

[24] Values are in U.S. dollars unless otherwise indicated. When year of values is not indicated, this information was not available. Values have not been converted to a common/base year. When individual estimate values are available, they are reported in the tables otherwise aggregate estimate values are stated.

Fauna				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Bishop, R.C., K.J. Boyle, and M.P. Welsh (1987)	WI	WTP an individual supporting membership to prevent bald eagle extinction in Wisconsin.	The estimated annual WTP are $11.84–$75.31 ($1984).	Contingent valuation
Bowker, J.M. and J.R. Stoll (1988)	TX, CA, IL, NY	Individual WTP for whooping crane viewing.	Annual WTP are $21–$149.	Contingent valuation
Boyle, K. J. and R.C. Bishop (1987)	WI	WTP to a program to prevent the bald eagle and striped shiner from becoming extinct.	Bald eagle existence values are annually ranging from $10.62–$30.78. The individual WTP for striped shiner are $5.66 and $4.16 ($1984).	Contingent valuation
Chambers, C.M. and J.C. Whitehead (2003)	MN	Two state funded wolf management strategies are described to respondents. First strategy is a minimum population and the second livestock compensation.	The annual WTP was $21.49–$20.16 ($2001).	Contingent valuation
Frederick, S. and B. Fischhoff (1998)	ME, WI	Three alternate levels of provision for the reestablishment of timber wolves.	The individual annual WTP for timber wolf reintroduction was $20 in Wisconsin, Maine, and in both states together	Contingent valuation
Moore, R., R. C. Bishop, B. Provencher and P. A. Champ (2010)	WI	To increase the wild flock of whooping cranes to 125 cranes.	The individual one-time WTP for whooping crane reintroduction was between $21.21 and $69.38 ($2004).	Contingent valuation

Invasive Species				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Holmes, T. P., A. M. Liebhold, K. F. Kovacs and B. Von Holle (2010)	US[25]	The spread of hemlock woolly adelgid in Eastern U.S. forests.	The aggregate estimate of residential property value losses was $12.4 million–$29.5 million over 10 years.	Hedonic property
Lupi, F., J.P. Hoehn, and G.C. Christie (2003) (1995)	MI	Benefits to Michigan anglers of several sea lamprey treatment options for the St. Mary's River.	The economic use-values were $2.6–$4.7 million ($1994).	Travel cost method
McDermott, M. S., D. C. Finoff and J. F. Shogren (2013)	OH	Ash timber shortage in Ohio due to impact of invasive emerald ash borer.	The annual impact by households is estimated to be $63.23 million. Aggregate values based on models are available.	Actual expenditure
Provencher, B., D. J. Lewis and K. Anderson (2012)	WI	Spread of Eurasian watermilfoil by boaters on the lakes of Vilas County.	The annual WTP for the prevention program was $563 and $577 per individual. The present value of loss was estimated to range from $11,443 to $52,221 ($2008).	Contingent valuation
Yue, C., T. M. Hurley and N. Anderson (2011)	MN	Economic harm, environmental harm, or harm to human health caused by invasive plant species	Individual WTP was a one-time premium of $0.35 for plants labeled noninvasive and native. Discounted plants labeled invasive and nonnative by $1.01 and plants labeled invasive and native by $1.66.	Experimental cash market value

[25]The geography for this article says US in table but actually has a geography of CT, DE, GA, MA, MD, ME, NC, NH, NJ, NY, PA, RI, TN, VA, WV

Flora

Nowak, D. J., Crane, D. E., & Dwyer, J. F. (2002). Compensatory value of urban trees in the United States. *Journal of Arboriculture*, *28*(4), 194-199.

Sander, H., Polasky, S., & Haight, R. G. (2010). The value of urban tree cover: a hedonic property price model in Ramsey and Dakota counties, Minnesota, USA. *Ecological Economics*, *69*, 1646-1656.

Scarpa, R., Buongiorno, J., & Hseu, J. (2000). Assessing the non-timber value of forests: a revealed-preference, hedonic model. *Journal of Forest Economics*, *6*(4), 83-107.

Fauna – Insects

MacDonald, H., McKenny, D. W., & Nealis, V. (1997). A bug is a bug is a bug: symbolic responses to contingent valuation questions about forest pest control problems. *Canadian Journal of Forest Economics*, *45*, 145-163.

Morlando, S., Schmidt, S. J., & LoGiudice, K. (2012). Reduction in Lyme disease risk as an economic benefit of habitat restoration. *Restoration Ecology*, *20*(4), 498-504.

Winfree, R., Gross, B. J., & Kremen, C. (2001). Valuing pollination services to agriculture. *Ecological Economics*, *71*, 80-88.

Fauna

Bishop, R. C., Boyle, K. J., & Welsh, M. P. (1987). Toward total economic valuation of great lakes fishery resources. *Transactions of the American Fisheries Society*, *116*, 339-345.

Bowker, J. M., & Stoll, J. R. (1988). Use of dichotomous choice nonmarket methods to value the whooping crane resource. *American Agricultural Economics Association*, *70*(2) 373-381.

Boyle, K. J., & Bishop, R. C. (1987). Valuing wildlife in benefit-cost analyses: a case study involving endangered species. *Water Resources Research*, *23*(5), 943-950.

Chambers, C. M., & Whitehead, J. C. (2003). A contingent valuation estimate of the benefits of wolves in Minnesota. *Environmental and Resource Economics*, *26*, 249-267.

Frederick, S., & Fischhoff, B. (1998). Magnitude Insensitivity in Elicited Valuations: Examining Conventional Explanations. *Risk Decision and Policy, 3*(2) 108-123*.*

Moore, R., Bishop, R. C., Provencher, B. & Champ, P. A. (2010). Accounting for respondent uncertainty to improve willingness-to-pay estimates. *Canadian Journal of Agricultural Economics*, *58*, 381-401.

Invasive Species

Holmes, T. P., Liebhold, A. M., Kovacs, K. F., & Von Holle, B. (2010). A spatial-dynamic value transfer model of economic losses from biological invasion. *Ecological Economics*, *70*, 86-95.

Lupi, F., Hoehn, J. P., & Christie, G. C. (2003). Using an economic model of recreational fishing to evaluate the benefits of sea lamprey (*Petromyzon marinus*) control on the St. Marys River. *Journal of Great Lakes Research*, *29*(1), 742-754.

Lupi, F., Hoehn, J. P., & Christie, G. C. (1999). Valuing non-indigenous species control and native species restoration in Lake Huron. In *Benefits and Costs of Resources Policies Affecting Public and Private Land,* 241-262. (W. Douglas Shaw, ed.), Western Regional Research Publication.

McDermott, M. S., Finoff, D. C., & Shogren, J. F. (2013). The welfare impacts of an invasive species: endogenous vs. exogenous price models. *Ecological Economics*, *95*, 43-49.

Provencher, B., Lewis, D. J., & Anderson, K. (2012). Disentangling preferences and expectations in stated preference analysis with respondent uncertainty: the case of invasive species prevention. *Journal of Environmental Economics and Management*, *64*, 169-182.

Yue, C. Hurley, T. M., & Anderson, N. (2011). Do native and invasive labels affect consumer willingness to pay for plants? Evidence from experimental auctions. *Agricultural Economics*, *42*, 195-205.

Native Flora and Fauna Meta-Analysis Valuation Studies[26]

Loomis and While (1996) reviewed 20 studies of rare and endangered species, modeling mean WTP as a function of sample frame (visitors vs. households), elicitation method (open-ended, dichotomous choice), the species valued (fish, marine mammal, bird), the proposed change in the species population being valued, the survey response rate, and the survey year. The authors found that WTP estimates vary according to increment of population change being valued, with a 1 percent increase in species population translating into a WTP increase of 0.769–0.803 percent. The study concludes that the meta-analytic equation can be used for benefits transfer to yield an approximate value for a benefit-cost analysis, though an original valuation study would be necessary. The authors recommended more attention be given to plant preservation valuations as well as to habitat-based valuation, rather than single species valuation.

Brouwer *et al*. (2009) looked at the economic value of wildlife for the benefits of decision making in an international setting. By using 41 studies, they were able to collect 91 separate values to calculate the WTP, the damage per household, and the value per animal. By collecting articles from 21 countries, they had 35 different species, 77 percent of which were classified as concerned, endangered, or critically endangered. After converting all economic values to $2005, they conducted their meta-analysis. The results gave an average WTP per person of $33, damages of $371 per household and a value of $2,117,060 per animal. The biggest observation taken from this data was that as a species population decreased in numbers as its value actually increased.

Loomis *et al*. (2008) explained the benefits of an online toolkit containing databases, average table values, meta-analysis templates and estimation models for wildlife habitat and recreation. Throughout the article, they explained how the meta-analysis tool has fields to enter information based on the user's area of study and what information is currently available on what topic. Another toolkit source is a model determining property value premiums related to the amount of open space in the study area. The goal of the toolkit is to help decision-makers take into account the values of non-market based resources and to encourage the creation of similar models for non-wildlife recreation, such as hiking or camping.

Rush *et al*. (1996) conducted a meta-analysis on economic value of wildlife in Alberta, Canada. The entire database has 53 reports but only 25 were used for the analysis, which gave 92 benefit values. Using $1994, the top three significant variables were substitute sites, hunting, and a person's WTP. Hunting was the only variable that had a positive impact on the final wildlife value. The remaining two had negative impacts; substitute sites might cause individuals to lower their values because of possible cheaper locations, while WTP is impacted by a person's income constraints compared to a person's willingness-to-accept (WTA). Even though these two variables have a negative impact, it provides a more accurate overall value for wildlife, which can influence proper compensation and policy decisions. One additional finding

[26] All dollar values are in US unless otherwise stated. Values have not been converted to a common/base year.

was that the location where the study was conducted was not significant, and “this could indicate that in times of restrict budgets, sharing of information between regions and borders would be successful.”

Brouwer, R., Schaafsma, M., & McLennan, S. (2009, June 27). *The economic value of wildlife: a meta-analysis*. Paper presented at Ecosystems 4***.***

Loomis, J. B., & White, D. S. (1996). Economics benefits of rare and endangered species: summary and meta-analysis. *Ecological Economics, 18*, 197-206.

Loomis, J., Kroeger, T., Richardson, L., & Casey, F. (2008*). A benefit transfer toolkit for fish, wildlife, wetlands, and open space.* Paper presented at the Western Economics Forum.

Rush, B. C., Philips, W. E., & Adamowicz, W. L. (1996). *The economic value of wildlife in Alberta: a database and analysis of benefit and expenditure estimates* (Project Report 96-01). Alberta, Canada: Wildlife Management Division Alberta Environmental Protection.

Recreation – Spiritual and Aesthetic

The Indiana coastal zone provides both material services to residents, but it also provides non-material services to residents, such as spiritual and aesthetic values.[27] Ecosystems provide places that connect people and the environment, forging belief and value systems based on human-nature interactions.
In the Great Lakes, recreational services are considered one of the most important cultural services.[28] Table 4 presents the non-extractive recreation and non-use economic valuation studies that have been conducted in the Great Lakes region. The articles are arranged according to topic in Table 4 by:

- ***Land Based Recreation***[29] – The value of a land-based recreation trip in the Great Lakes region.
- ***Water Based Recreation*** – Recreation, such as boating and swimming that occurs in freshwater.
- ***Beach Recreation*** – Beach visits.
- ***Wildlife Recreation***[30] – Recreation, such as wildlife viewing and fishing.
- ***Land Protection for Recreation*** – Protecting land for recreational purposes.
- ***Scenic Views*** – Views of lakes, rivers, open space, or any other landscape view.

The methods used to evaluate spiritual and aesthetic recreation include actual expenditure, revealed preference (hedonic wage/property, travel cost), and stated preference (contingent valuation)[31]. These are represented in the last column of the tables. The remaining data for each article is organized by the publication information, geographic location, changing value studied, and the final value estimate by dollar year.

The articles addressing land-based recreation used three types of valuation methods – travel cost, actual expenditure, and contingent valuation. Kreutizwiser (1981) used the travel cost method alongside actual expenditure to determine the consumer surplus of a trip to Long Point or Point Pele Marsh. Using actual expenditure and contingent valuation, Shantz *et al.* (2004) and Rollins and Dumitras (2005) analyzed the economic value of a recreational trip in Ontario.

Looking at water-based recreation, Connelly *et al.* (2007) were the only researchers that did not use travel cost methods during their evaluation of recreational boating. Englin and Shonkwiler (1995) used hedonic wage methods to look at the opportunity cost of leisure time. The remaining articles looked at per trip values of freshwater recreation trips, the value of freshwater bodies for boating, and the estimated

[27] deGroot, R., & Ramakrishnan, P.S., et al. *Ecosystems and human well-being: Current state and trends*, *Vol 1*. R. Hassan, R. Scholes, & N. Ash (Eds.). Washington, DC: Island Press.
[28] In terms of the Millennium Ecosystem Assessment typology, these services belong to the larger category of *Cultural Ecosystem Service*s that are nonmaterial in nature and include contributions to human well-being resulting from being in the landscape.
[29] Articles that included both land- and water-based recreation or unidentified recreation are included here.
[30] Fishing and hunting articles were not included in the literature review because they are considered extractive activities, and when this literature review only includes non-extractive recreation.
[31] For brief descriptions of the economic valuation methods, see Appendix A.

customer surplus from a one-day recreation trip. The two studies focused on beach recreation and used travel cost methods to estimate the value of day trips. Sohngen *et al.* (1999) studies the differences in trip values between Maumee Bay and Headlands beaches. While Song *et al.* (2010) consider the possible benefits and costs towards Great Lakes beaches.

Two types of valuation methods were used for wildlife viewing studies – the travel cost method and contingent valuation. Waddington *et al.* (1994) used contingent valuation to estimate the average value of wildlife viewing while two studies used this method along with travel cost. They looked at the value of a one-day trip to a wilderness area and the average net worth of bird watching in Point Pelee National Park. Researchers from the final two articles used only the travel cost method in their work. Hushak *et al.* (1999) estimate the economic value per angler and diver from an artificial reef. Upneja *et al.* (2001) calculate per angler values as well but for one recreational trip towards sports fishing and wildlife views.

Only two articles were found that specifically examined land protection for recreational purposes. Sverrisson (2008) used hedonic property and contingent valuation methods to see a household's willingness-to-pay (WTP) for different levels of land protection. Whitehead *et al.* (2009) uses travel cost methods and stated preferences to determine the recreational and non-recreational values of coastal marsh land protection to individuals on three different scales. Each of these studies uses a type of both revealed and stated preferences; because of this, certain estimate values can be compared.

Hedonic property methods and contingent valuation were used throughout all articles for scenic views. Using both methods, Blomquis (1987) determined the market values of Lake Michigan views in Chicago homes. The three articles using only contingent valuation looked at WTP for different types of scenic river views, the aesthetic damage from a four-lane divided highway, and the WTP for changes in night-sky visibility. The remaining articles all used hedonic property methods. The articles looked at the value effect on households from natural features, the change in property values from access to open spaces, the aesthetic quality provided by tree cover, the increase in home value from access to open spaces and landscape views, and the values of buildings close to forest preserves.

Because studies contained multiple valuation estimates (stemming from multiple policy scenarios and/or model specifications) it was not possible to include the full range of value estimates in the table. In addition, population characteristics varied across studies (for example, income). While these characteristics affected valuations, they were not included in the table. Of note was that the baseline resource state and the increment of resource change valued also varied across the studies, which limited the comparability of studies.

Refer to Case studies 3-5 for a closer look.[32]

Case Study 3: The Value of Beach Visits and the Effect of Swim Bans in Chicago (Shaikh 2005)

Sabina Shaikh conducted a study during a Chicago beach season at nine locations. By using two separate valuation methods, estimates for beach trips and loss of consumer surplus from swim bans were determined. The valuation methods used were travel cost and contingent valuation to assess WTP for different responses to uncertainty. Shaikh got survey responses from beach goers on reasons for coming to the beach, reasons for not swimming, methods of transportation, and views about possible tax implementation to reduce swim bans. The data analysis showed that the travel cost for cars and taxis were the most expensive at $22.10 and $26.20, respectively, per trip ($200). When the beach goers got to their destinations, their three top reasons to stay an average of 3 hours were people watching, sunbathing, and enjoying the views and swimming. The final analysis showed that an individual's day at the beach is valued at $35 and they spend an average of $4.27. This turns out to be over $1 billion in seasonal value and $100 million spent. Due to historically low attendance when this study was conducted, about $801 million was spent that year. The second half of the study focused on swim bans and their impact on the beach economy. Shaikh found that a person's WTP for a reduction in these bans was from $38 to $65, depending on assumptions. This creates an aggregate value from $850 million to $1.5 billion for ban reduction.

[32] Case 3: Shaikh, S. The value of beach visits and the effect of swim bans in Chicago. Retrieved from www.deliveringhealthywater.net/wp-content/uploads/2012/10/Sabina-Shaikh_REVISED.pdf and Shaikh, S. (2005). Does uncertainty matter? An application to the willingness to pay to reduce swimming bans in Chicago. Retrieved from ageconsearch.umn.edu/bitstream/19134/1/sp05sh03.pdf.

Case 4: Chen, M. (2013). Valuation of public Great Lakes beaches in Michigan. (Unpublished doctoral dissertation). Michigan State University: Lansing, MI.

Case 5: Whitehead, John C., and Suzanne Finney (2003), Willingness to Pay for Submerged Maritime Cultural Resources, Journal of Cultural Economics, 27(3-4):231-240. Published by Springer (ISSN: 0885-2545).

Case Study 4: Public Great Lakes Beaches in Michigan (Chen 2013)

While the roughly 590 public beaches in Michigan are generally free, they have value to beach goers. Min Chen notes while there are previous studies examining the value of beach recreation, very few of these have looked at Great Lakes beaches. The author notes that even around the Great Lakes themselves, there is variation in values between lakes, and therefore, uncertainty in transferring benefits estimates across the lakes. Chen additionally notes that most studies have limited valuation estimates to current users of the resource, and have not included potential beach users. Chen uses the travel cost approach to estimate the value of public beaches in Michigan, finding an estimated \$32–\$39 person/day trip, and \$53 person/day for extended, multi-day trips (\$2011). She notes that 58 percent of adults in the study area visit Lake Michigan beaches for recreation, for an aggregate value of \$400 million annually.

Case Study 5: Submerged Maritime Cultural Resources (Whitehead *et al*. 2003)

This study uses the contingent valuation method to examine the nonmarket value of maintaining shipwrecks in their submerged state. Non-market value includes both use value (benefits to recreational divers) and non-use value (benefits to people who derive utility from learning/knowing about shipwrecks without actually visiting the wreck in-person. Regarding maritime cultural resource policy, estimates of the economic value of shipwrecks can be used to ascertain the appropriate level of social resources to allocate to shipwreck protection. The study finds that households are willing to pay about \$35 in a one-time increase in state taxes to maintain shipwrecks. Given a population of 650,000 in the study sampling region, the aggregate WTP is over \$21 million. Given that residents outside of the sample/study area value shipwreck protection, this is a lower-bound (conservative) estimate.

Table 4: Summary of Recreation – Spiritual and Aesthetic Valuation Studies33

Land Based Recreation				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Bhat, G., J. Bergstrom, R. J. Teasley, J. M. Bowker and H. K. Cordell (1998)	US	Land and water-based recreation.	Consumer surplus value was $261.12/day for developed and primitive camping in the same region.	Travel cost method
Dwyer, J. F., G. L. Peterson and A. J. Darragh (1983)	IL	The economic value of urban forests at three sites, one arboretum, and two park conservatories.	User WTP averaged at $12.71, $8.68 and $4.54 for a visit to the Lincoln Park Conservatory, the Garfield Park Conservatory, and the Morton Arboretum.	Travel cost
Kreutzwiser, R. (1981)	ON	One trip to Long Point or Point Pele marsh for recreational purposes.	The mean consumer surplus for all primary user-parties was $34.85/trip. Aggregate values are available. ($1978 CAN)	Actual expenditure & Travel cost method
Rollins, K. and D. E. Dumitras (2005)	ON	Recreation trip.	WTP ranged from $18.85/day/trip to $30.50/day/trip. ($2004)	Contingent valuation
Shantz, P., K. Rollins, L. Johnson and W. Wistowsky (2004)	ON	One recreational trip.	Aggregate values are available. ($2003 CAN)	Actual expenditure & Contingent valuation
Yeh, C. (2005)	OH	Changes in the numbers and levels of recreational amenities provided.	Ranges in marginal welfare due to location and amenity changes were $1.92–$11.48/trip.	Travel cost method

[33] Values are in U.S. dollars unless otherwise indicated. When year of values is not indicated, this information was not available. Values have not been converted to a common/base year. When individual estimate values are available, they are reported. When they are not present, aggregate estimate values are stated.

Water Based Recreation				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Connelly, N. A., T. L. Brown and J. W. Brown (2007)	NY	Economic value of recreational boating.	Boaters spent an average of $137 per day per boat. The consumer WTP was $69.36. The value per person was $23. Aggregate values are available ($2002).	Contingent valuation
Englin, J. and J.S. Shonkwiler (1995)	VT	Freshwater recreational trips (boating, swimming, and fishing).	Consumer surplus ranged from $30.58 to $59.17/trip ($1989).	Travel cost method
Feather F. and W. D. Shaw (1999)	WA, PA, IN, NE	The opportunity cost of leisure time for water-based recreation.	The average per trip welfare for river recreation ranged from $6.23 to $16.02 per trip ($1994).	Hedonic wage and Travel cost method
Schaefer, E.L., A. Upneja, W. Seo, and J. Yoon (2000)	PA	Valued freshwater bodies used for recreational power boating.	The consumer surplus associated with a per-visitor power boating trip was $68. Aggregate values are available ($1994).	Travel cost method
Smith, V.K., (1988) Smith, V.K. (1993)	PA	One recreational trip.	Estimated consumer surplus values in 1988 for lake activity were $0.23–$1.67/trip. In 1993, consumer surplus was estimated from $0.6 –$1.38/trip. ($1981)	Travel cost method

Beach Recreation				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Sohngen, B., F.Lichtkoppler and M. Bielen (1999)	OH	Recreation visit Maumee Bay and Headlands Beach.	Individual day trip values of $25.60 for Maumee and $15.50 for Headlands ($1997) Aggregate values are available.	Travel cost method
Song, F., F. Lupi and M. Kaplowitz (2010)	Michigan	Recreational use values of Great Lakes beaches.	An increase in beach length increases welfare by $4.2 per trip and an additional beach closure day had a welfare loss of $0.94 per trip. Aggregate values are available ($2006).	Travel cost method

Wildlife Recreation				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Hushak, J. L., D. O. Kelch and S. J. Glenn (1999)	OH	Economic value derived from the artificial reef made in Lorain County from anglers and divers.	Per angler values ranged from $302.08–$341.01. Aggregate values are available ($1992).	Travel cost method
Hvenegaard, G. T. and J. R. Butler (1989)	ON	Bird watching at Point Pelee National Park (PPNP) in Ontario, Canada.	The average net worth was about $256/trip and $76/day. The potential sales to bird watchers were $78/person. Aggregate values are available ($1987).	Travel cost method & Contingent valuation
Shafer, E. L., R. Carline, R. W. Guldin, and H.K. Cordell (1993)	PA	One day trip to a wilderness area.	Consumer surplus for catch-and-release fishing was $16.10–$44.50/visitor day; wildlife viewing was $3.57–$20.43/visitor day. Aggregate values are available ($1988).	Travel cost method & Contingent valuation
Upneja, A., E. L. Shafer, W. Seo and J. Yoon (2001)	PA	One recreation trip for sport fishing and wildlife viewing.	Average out-of-pocket cost per angler trip was $94 ± $12.60. The average for a wildlife-watching trip was $32.40 ± $4.64. Aggregate values are available ($1996).	Travel cost method
Waddington, D.G., K.J. Boyle, and J. Cooper. (1994)	U.S.	Wildlife viewing.	The average value of wildlife viewing per year was estimated to be $278 per individual ($1991).	Contingent valuation

Land Protection for Recreation				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Sverrisson, D. (2008)	ON	Three different levels of protection showing a minor, medium, and major expansion (1, 5, and 12 percent)	The WTP/household/year was $102.99 for a 1 percent expansion, $183.99 for a 5 percent expansion, and $225.46 for a 12 percent expansion. Aggregate values are available ($CAN).	Hedonic property and Contingent valuation
Whitehead, J. C., P. A. Groothuis, R. Southwick and P. Foster-Turley (2009)	MI	WTP for three different acreage amounts of further protection were examined: 1,125, 2,500, and 4,500.	The value of each acre of coastal marsh is $1,870 for recreation and $551 per acre for no recreation annually. Aggregate values are available ($2005).	Travel cost method, Combined revealed and stated preference

Scenic Views				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Blomquist, G. (1987)	IL	Views of Lake Michigan from Chicago dwellings.	The monthly market value was $31.85–$147.06 and an increase in dwelling height was $25.21–$31.42 ($1981).	Hedonic property & Contingent valuation
Boyle, K.J., and R.C. Bishop (1988)	WI	Different types of scenic beauty along the lower Wisconsin River.	The mean individual annual WTP ranged from $18.88–$29.82 ($1982).	Contingent valuation
DSS Management Consultants Inc. (2009)	ON	The amenity value effect on households located within 100 meters of natural features.	Natural feature appreciation impact was $8,010/property in the south and $10,273/property in the north. Aggregate values are available ($CAN).	Hedonic property
Kapper, T. (2000)	WI	Aesthetic damage caused by widening the current two-lane highway to a four-lane divided highway.	A WTP of $224.24/household and a WTP of $153.60 per commuter group. Aggregate values are available ($1999).	Contingent valuation
Lake, M.B., and K.W. Easter (2002)	MN	The change in property value that results from a 100 foot decrease in the distance to the nearest open space.	Homeowners pay $115 to live 100 feet closer to open space. ($2000-2001).	Hedonic property
Sander, H. A. and R.G. Haight (2012)	MN	Aesthetic quality (views), access to outdoor recreation and benefits provided by tree cover.	A one-hectare increase of a home's viewshed gave an increase in sales price of $181. Increases in lake views and stream views increase prices by $1741 and $81, respectively ($2005).	Hedonic property
Sander, H. A. and S. Polasky (2008)	MN	Access to open spaces and the quality of landscape views.	Increase in house value by being 100m closer to: a park is $136, a trail is $119, a lake is $216, and a stream is $127. Prices of increasing a home's view of grassy surfaces or water by 10 percent are $5517 and $7417, respectively ($2005).	Hedonic property
Simpson, S. N. and B. G. Hanna (2010)	NY	Changes in night-sky visibility using illustrative pictures of various sky appearances.	The individual one-time WTP estimates range from $0.47 to $142.74 ($2009).	Contingent valuation
Thorsnes, P. (2002)	MI	Building lots close to forest preserve.	The building lots had premium values of $5,800–$8,400. For houses that border a preserve the values were $6,262–$15,961 ($2002).	Hedonic property

Land-Based Recreation

Bhat, G., Bergstrom, J. Teasley, R. J., Bowker, J. M., & Cordell, H. K. (1998). An ecoregional approach to the economic valuation of land- and water-based recreation in the United States. *Environmental Management*, *22*(1), 69-77.

Dwyer, J. F., Peterson, G. L., & Darragh, A. J. (1983). Estimating the value of urban forests using the travel cost method. *Journal of Arboriculture*, *9*(7), 182-185.

Kreutzwiser, R. (1981). The economics significance of the Long Point Marsh, Lake Erie, as a recreation resource. *Journal of Great Lakes Research*, *7*(2), 105-110.

Rollins, K. & Dumitras, D. E. (2005). Estimation of median willingness to pay for a system of recreation areas. *International Review of Public and Non Profit Marketing*, *2*(1), 73-84.

Shantz, P., Rollins, K., Johnson, L., & Wistowsky, W. (2004). *Study of the economic and social benefits of the nine Ontario living legacy signature sites*. Retrieved from https://dr6j45jk9xcmk.cloudfront.net/documents/2892/social-and-economic-benefit-study.pdf

Yeh, C. (2002). *Three economic applications of non-market valuation* (Doctoral dissertation). Retrieved from Ohio Sea Grant College Program. (Accession No. OHSU-TD-1000)

Yeh, C., Haab, C. T., & Sohngen, B. L. (2006). Modeling multiple-objective recreation trips with choices over trip duration and alternative sites. *Environmental & Resource Economics*, *34*, 189-209.

Water-Based Recreation

Connelly, N. A., Brown, T. L., & Brown, J. W. (2007). Measuring the net economic value of recreational boating as water levels fluctuate. *Journal of American Water Resources Association*, *43*(4), 1016-1023.

Englin, J., & Shonkwiler, J. S. (1995). Modeling recreation demand in the presence of unobservable travel costs: toward a travel price model. *Journal of Environmental Economics and Management*, *29*(3), 368-377.

Feather, F. & Shaw, W. D. (1999). Estimating the cost of leisure time for recreation demand models. *Journal of Environmental Economics and Management*, *38*(1), 49-65.

Schaefer, E. L., Upneja, A., Seo, W., & Yoon, J. (2000). Environmental auditing economic values of recreational power boating resources in Pennsylvania. *Environmental Management*, *26*(3), 339-348.

Smith, V. K. (1988). Selection and recreation demand. *Journal of Agricultural Economics*, *70*(1), 29-36.

Smith, V. K. (1993). Welfare effects, omitted variables, and the extent of the market. *Land Economics*, *69*(2), 121-131.

Beach Recreation

Sohngen, B., Lichtkoppler, F., & Bielen, M. (1999). *The value of Lake Erie beaches* [Brochure]. Columbus, OH: the Ohio State University.

Song, F., Lupi, F., & Kaplowitz, M. (2010, July 25-27). *Valuing Great Lakes beaches*. Paper presented at the AAEA, CAES, & WAEA Joint Annual Meeting, Denver, Colorado.

Wildlife Recreation

Hushak, J. L, Kelch, D. O., & Glenn, S. J. (1999). The economic value of the Lorain County, Ohio artificial reef. *American Fisheries Society Symposium*, *22*, 348-361.

Hvenegaard, G. T. & Butler, J. R. (1989). Economic values of bird watching at Point Pelee National Park, Canada. *Wildlife Society Bulletin*, *17*(4), 526-531.

Shafer, E. L., Carline, R., Guldin, R. W., & Cordell, H. K. (1993). Economic amenity values of wildlife: six case studies of Pennsylvania. *Environmental Management*, *17*(2), 669-682.

Upneja, A., Shafer, E. L., Seo, W., & Yoon, J. (2001). Economic benefits of sport fishing and angler wildlife in Pennsylvania. *Journal of Travel Research*, *40*, 68-78.

Waddington, D. G., Boyle, K. J., & Cooper, J. (1991). *Net economic values for bass and trout fishing, deer hunting and wildlife watching*. Washington, DC: USFWS Division of Federal Aid, U.S. Fish and Wildlife Service.

Land Protection for Recreation

Sverrisson, D. (2008). *Estimation of passive use values associated with future expansion of provincial parks and protected areas in southern Ontario* (Doctoral dissertation). Retrieved from The Ontario Network on Ecosystem Services.

Whitehead, J. C., Groothuis, P. A., Southwick, R., & Foster-Turley, P. (2009). Measuring the economic benefits of Saginaw Bay coastal marsh with revealed and stated preference methods. *Journal of Great Lakes Research*, *35*, 430-437.

Scenic Views

Blomquist, G. (1987). Valuing urban lakeview amenities using implicit and contingent markets. *Urban Studies*, *25*(4), 333-340.

Boyle, K. J., & Bishop, R. C. (1988). Welfare measurements using contingent valuation: a comparison of techniques. *American Journal of Agricultural Economics*, *70*(1), 20-28.

DSS Management Consultants Inc. (2009). The Impact of Natural Features on Property Values [Fact sheet]. Retrieved from http://www.creditvalleyca.ca/wp-content/uploads/2011/07/EGS_FACTSHEET_PROPERTY_VALUES.pdf

Kapper, T. (2000). *The economic value of landscape aesthetics: integrating contingent valuation and aesthetic assessment in a Wisconsin highway project* (Doctoral dissertation). Retrieved from WorldCat. (Accession No. 70950605)

Lake, M. B., & Easter, K. W. (2002). Hedonic valuation of proximity to natural areas and farmland in Dakota County, Minnesota (Staff Paper P02-12). Retrieved from Research in Agricultural & Applied Economics website: http://ageconsearch.umn.edu/handle/13407

Sander, H. A., & Haight, R. G. (2012). Estimating the economic value of cultural ecosystem services in an urbanizing area using hedonic pricing. *Journal of Environmental Management*, *113*, 194-205.

Sander, H. A., & Polasky, S. (2008). The value of views and open space: estimates from a hedonic pricing model for Ramsey County, Minnesota, USA. *Land Use Policy*, *26*, 837-845.

Simpson, S. N., & Hanna, B. G. (2010). Willingness to pay for a clear night sky: use of the contingent valuation method. *Applied Economics Letters*, *17*, 1095-1103.

Thornsnes, P. (2002). The value of a suburban forest preserve: estimates from sales of vacant residential building lots. *Land Economics*, *78*(3), 426-441.

Recreation – Spiritual and Aesthetic Meta-Analysis Valuation Studies[34]

Pendleton *et al.* (2007) analyzed the literature on non-market values of coastal and marine resources in the United States. This article looked at the eastern and western coasts, along with the Great Lakes, where they found that besides the topics of beaches and recreational fishing, the quality and quantity of literature was lacking, especially in watersheds, wildlife viewing, estuaries and private boating. They were able to identify a greater need of variety in peer-reviewed and grey literature to allow policy and decision makers to have accurate and comprehensive information to help coastal management efforts. From the original 150 studies used in this analysis, Atiyah used 35, which provided 98 beach value estimates. Through conducting a meta-analysis, the following values were looked at: methodology (travel cost and contingent valuation), the type of valuations (average or marginal), beach location (California, Florida or other), and author/year. The results showed that the travel cost method averaged $21 higher than contingent valuation estimates; the average values – measuring the value of an average beach day – had values $31 higher than marginal values, which measured values of lost beach days; and beach values were increasing by an average of $1.50/year possibly due to an increase in access, demographics, and/or improvement in valuation methods ($2007). The conclusions from this meta-analysis suggested having minimum criteria to unify literature and to include data on water quality, beach width, and the demographics of respondents to help better inform decision and policy makers.

Poe *et al*. (2012) conducted a review of the current literature on fishing, beach going, and boating. The purpose of this review was to calculate current net estimates and the estimated would-be impacts of aquatic nuisance species. But it turns out that recreational fishing was the only category that had enough available literature to calculate a new value of between $20 and $75 per day ($2012). This creates aggregate values of about $360 million to $1.35 billion in the Great Lakes region. Even though this net value was calculated, seeing the possible impacts by aquatic nuisance species was not accomplished because of lack of data.

Loomis created this report to explain updates to the current Forest Service database that reviews all economic studies in the U.S. on recreational use values and to provide guidance on performing benefit transfers. 470 new observations were added to the database creating a total of 1,239 observations from 1967 to 2003 that cover 30 different recreational activities. The top four activities across the country were found to be camping, fishing, hunting, and wildlife viewing with an estimated consumer surplus of $47.64/person/day ($2004). In comparison, the northeast region, which includes the Great Lakes, had fishing, going to the beach, hunting, and wildlife viewing as the top area activities. The mean per person per day values for each of these activities were $32.60, $42.60, $47.45 and $31.30, respectively. Because the valuation of non-market recreation is so important to local economies, the remainder of the report provided guidance and helpful tips on benefit-transfer methods; with the two types being single-point estimates and average values.

[34] All dollar values are in US unless otherwise stated. Values have not been converted to a common/base year.

Riganti and Nijkamp (2005) wrote about the controversial idea of using benefit transfers to help place economic values of cultural heritage sites. By reviewing different articles, they conducted a literature view on current efforts to use GIS techniques and possibly create a cultural sites taxonomic system to help place these resources into a spatial dimension. This, in turn, would help reduce sources of bias when transferring benefits from one site to a new one. Riganti and Nijkamp suggested four major categories for the taxonomy of cultural heritage site; these included historic landscapes, historic cities, urban neighborhoods of historic relevance, and outstanding buildings. With this in mind, they suggest that “the feasibility of cultural values transfer should not be dismissed without further research.”

Recreation – Spiritual and Aesthetic Meta-Analysis Valuation Studies References

Pendleton, L., Atiyah, P., & Moorthy, A. (2007). Is the non-market literature adequate to support coastal and marine management? *Ocean & Coastal Management, 50*, 363-378.

Atiyah, P. A. (2009). *Non-market valuation and marine management: using panel data analysis to measure policy impacts on coastal resources*. (Unpublished doctoral dissertation). University of California, Los Angeles.

Poe, G. L., Lauber, B., Connellyn, N. A., Creamer, S., Ready, R.C., & Stedman, R. C. (2012). *Net benefits of recreational fishing, beach going, and boating in the Great Lakes, upper Mississippi River, and Ohio River basins: a review of the literature*. Retrieved from https://ecommons.cornell.edu/bitstream/handle/1813/40456/HDRUReport12-2.pdf?sequence=1&isAllowed=y

Loomis, J. (2005). *Updated outdoor recreation use values on national forests and other public lands* (General Technical Report PNW-GTR-658). Retrieved from http://www.fs.fed.us/pnw/pubs/pnw_gtr658.pdf

Riganti, P. & Nijkamp, P. (2005). *Benefit transfers of cultural heritage values: how far can we go?* Retrieved from http://www-sre.wu-wien.ac.at/ersa/ersaconfs/ersa05/papers/186.pdf

Erosion, Sedimentation, Flood Control Estimates

Before modern development, the Lake Michigan coastline consisted of habitats supporting natural processes that have been impacted by shoreline hardening. The lake's coast is constantly susceptible to changing lake levels, coastal storms, erosion, and sedimentation processes due to wind, wave energy, currents and tides. By altering the littoral drift, this has led to beach and dune erosion. These coastal hazards, along with flooding, are now posing risks to property and other infrastructure assets. In simple terms, erosion is a cost to property owners, by losing private land, and accretion is a benefit, by gaining or retaining private land. Erosion, the process of water, wind and/or ice wearing away at rocks and soil, is constantly occurring. This eroded material enters local water systems in large quantities through flooding events and settles out to create new soil profiles through sedimentation.

The bed of Lake Michigan is collectively owned by the four states surrounding the lake (WI, IL, IN, MI). But coastal development in these areas can alter natural sedimentation dynamics. The Great Lakes Commission (2008) found a lack of comprehensive economic studies effectively linking the environmental impacts to erosion and sedimentation and associated economic values; making the total economic damages unknown[35]. By using proper management, these impacts can be reduced. The types of best practices include but are not limited to: prevention through zoning setbacks, plans and/or management for appropriate retreat strategies, natural vegetation buffers, reduced impermeable surfaces, dam removal, beach nourishment, and breakwaters.

Economic valuation articles on erosion, sedimentation, and flood control are presented in Table 5, organized as follows:

- ***Halting Erosion*** – The impacts of sediment erosion and the possible benefits obtained through different types of prevention efforts.
- ***Built Environment*** – Human-made structures impacted by erosion, sedimentation or flooding.
- ***Toxic Contamination/Sediment Remediation*** – Evaluating the impacts of harmful substance exposure and the benefits of future removal projects and regulations.

The methods used to evaluate the values of sedimentation, erosion, or flood control include: revealed preference (hedonic), stated preference (contingent valuation/choice), actual expenditure, and replacement costs[36]. These are represented in the last column of the tables. The remaining data for each article is organized by the publication information, geographic location, changing value being studied, and the final value estimate by dollar year.

Halting erosion is the only topic that uses all four types of valuation methods. Hansen and Hellerstein (2007) used replacement costs to see the benefits of reducing soil erosion on a per ton scale. Yang and

[35] Great Lakes Commission. (2008). *The economics of soil erosion and sedimentation in the Great Lakes Basin*. Great Lakes Region: U.S. Army Corp of Engineers Great Lakes and Ohio River Division.
[36] For brief descriptions of the economic valuation methods, see Appendix A.

Weersink (2004) determined the average costs of sediment reduction targets through actual expenditure methods using hectares as their scale of reference. The contingent valuation method is used in half of all the erosion studies. These included looking at willingness-to-pay (WTP) to maintain the condition of a nature preserve through the use of off-shore break walls; the use of hay-cutting based or non-hay-cutting based filter strips and the annual payment needed to have farmers install these strips; the reduction of dredging costs through an increase in erosion reduction efforts and the modeling of environmental changes and their impacts on household values. The final two articles used hedonic property valuation to determine changes in property and household values through erosion control and protection. Due to the many different methods of valuation, it is hard to compare the articles together, but household value changes can be an estimate that can help to compare results.

Three out of four articles take a stated preference approach when evaluating the built environment. While two use choice experimental methods to evaluate the restoration of wetlands and stormwater management projects, Mullarkey and Bishop (1999) use a contingent valuation to determine the economic impacts of draining a wetland to expand a highway. These studies created WTP values for the choice experiments, and values of creating an alternative route were created for the contingent valuation. The final article, which was by Daniel *et al*. (2007), used hedonic property methods to value price changes in households built in flood areas. The value estimates of these articles change in types of valuations, which make comparison between data hard.

The study methods of the articles focused on how toxic contamination can be split between actual expenditure and revealed preference. Braden *et al*. (2004) used hedonic property to value the cleanup of polychlorinated biphenyls (PCBs) to understand the WTP for full-harbor clean ups. The Eastern Research Group, Inc. (1992) evaluated the benefits of reducing residual risk of contaminated sediment through revealed preferences. The remaining three articles all use actual expenditure methods in their research. These studies included examining the benefits from changes in current PCB regulations, the economic value and WTP for dredging contaminated soils in a waterway, and the reduction in property values due to industrial hazardous waste. Many of the estimated values in toxic contamination are on an aggregate scale, making the comparison between articles easier to accomplish. Braden *et al*. (2006) are identical studies using hedonic property methods valuating the impacts and benefits of cleaning up sites in New York and Wisconsin only partially or completely. The Lichtkoppler, F.R. and Blaine, T.W. (1999) article evaluates several problems from contaminated soil and the possible benefits from dredging through contingent valuation. The benefit here is that the WTP value can then be compared to the others in this section but the changes between individual and aggregate values can make this difficult.

Because studies contained multiple valuation estimates (stemming from multiple policy scenarios and/or model specifications) it was not possible to include the full range of value estimates in the table. In addition, the population characteristics varied across studies (for example, income). While these characteristics affected valuations, they were not included in the table. Of note was that the baseline resource state and the increment of resource change valued also varied across the studies, which limited the comparability of studies.

Table 5: Summary of Erosion, Sedimentation, and Flood Control Valuation Studies[37]

Halting Erosion				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Bishop, R.C. and K.J. Boyle (1985)	IL, MI, WI	Ensuring the nature preserve is maintained in its current condition through an off-shore breakwater to halt erosion.	The estimated annual WTP to preserve the area is $27.55 for an individual. Aggregate values are available ($1985).	Contingent valuation
Cangelosi, A., R. Wiher, J. Taverna, and P. Cicero (2001)	OH	A $1.3 million decrease in dredging and confining expenditures associated with 15 percent reduction in sediments entering the Toledo harbor.	Reduced soil erosion in the Maumee River basin could cut dredging costs by up to $1.3 million ($1995).	Price
Croke, K., R. Fabian, and G. Brenniman (1987)	IL, MI	Three changes in the environment were modeled using contingent markets	The total annual household value per year was estimated at $33.35 for prevention of 30 percent erosion.	Contingent valuation
Hansen, L. and D. Hellerstein (2007)	US[38]	Reduction in soil erosion for more than 70,000 reservoirs in the U.S. Army Corps of Engineers National Inventory of Dams (NID)	Across watersheds, marginal reductions in soil erosion provide benefits ranging from $0 to $1.38/ton. Aggregate values are available.	Replacement costs
Kim, K.T (1992)	OH	The three baseline levels for erosion control were 5, 30, and 50 years until a property's setback distance is zero.	Estimated annual household value of erosion delay ranged from $64 to $280 ($1982–1984)	Hedonic property
Kriesel, W.P. (1988)	OH	Incremental increases in the number of years before the property setback distance is equal to zero.	Estimated change in property price from erosion protection varies from $1,787 to $74,099 depending on how much initial time is left before total erosion occurs and the amount of erosion prevention (in years) gained ($1988).	Hedonic property
Purvis, Amy, John P. Hoehn, Vernon L. Sorenson, and Francis J. Pierce (1989)	MI	Farmers agree to develop and maintain filter strips in exchange for payment.	An annual payment of $40/acre encourages average enrollment of 67 percent of eligible lands for the hay-cutting option. Without hay-cutting values are available ($1988).	Contingent valuation
Yang, W. and A. Weersink (2004)	ON	Sediment reduction targets of 10, 20, 30, 40, and 50 percent were considered in the study.	The average cost estimates were $175.4, $202.5, $227.2, $264.3, and $306.3 per hectare for the abatement goals. Marginal cost values are available ($CAN).	Actual expenditure

Built Environment				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Cadavid, C. L. and A. W. Ando (2013)	IL	Six attributes to determine the implementation of stormwater management projects	WTP to avoid the scenario where flooding frequency reduced by 25 percent ranged from $585,000 to $1,305,000.	Choice experiment
Daniel, V. E., R. J. Florax and P. Rietveld (2007)	CA, TX, ND, MN, WI, KY, NC, FL, LA, AL	Households built in flood areas that have changes to their prices	The marginal risk associated with living in a 100-year flood plain is negative and it amounts to between 0.6–0.8 percent of housing prices.	Hedonic property
Mullarkey, D. J. and R. C. Bishop (1999)	WI	Draining of the wetland area in question for the expansion of a 44-mile stretch of highway.	Sample means for the base group were $13.68–$37.38 for the three certainty levels. Sample means for the scope group were $20.77–$57.83.	Contingent valuation
Trenholm, R., T. Anderson, V. Lantz and W. Haider (2013)	ON	For farmers to restore wetlands by converting 1, 3, or 5 acres. For non-farm landowners to restore wetlands by converting 0.5, 1, or 1.5 acres.	For non-farm landowners, the WTP for one class of individuals was $0 and the WTA for a second class ranged from $23.46 to $617.95. For farmers, the WTA was $171.86–$655.57/acre/ year ($CAN).	Choice experiment

[37] Values are in U.S. dollars unless otherwise indicated. When year of values is not indicated, this information was not available. Values have not been converted to a common/base year When individual estimate values are available, they are reported. When they are not present, aggregate estimate values are stated.

[38] The geography for this article says U.S. in table but actually has a geography of AL, FL, GA, IA, IL, IN, MA, MI, MN, MO, ND, NE, NJ, OH, OK, OR, PA, SD, TN, TX, WI, WV

Toxic Contamination/Sediment Remediation				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Braden, J. B., X. Feng, L. Freitas and D. Won (2010)	IN, IL, MI, MN, NY, OH, PA, WI	Hazardous waste from former industrial sites.	The average reduction value in home prices was $8,312. Aggregate values are available ($2000).	Actual expenditure
Braden, J.B., A.A. Patunru, S. Chattopdhyay and N. Mays (2004)	IL	PCB cleanup of Waukegan Harbor area.	Homeowners' WTP for full harbor cleanup was approximately $400 million in Waukegan and $7 billion to $12 billion elsewhere in Lake County.	Hedonic property
Braden, J. B., L. O. Taylor, D. Won, N. Mays, A. Cangelosi and A. Patunru (2006)	WI	The welfare impacts of a partial cleanup and a full cleanup of the Area of Concern in addition to the disbenefits due to additional pollution.	Estimated households in the middle and lower sections of the river were $56–$90 million. The WTP of full cleanup was $194 million ($2003).	Hedonic property
Braden, J. B., L. O. Taylor, D. Won, N. Mays, A. Cangelosi and A. A. Patunru (2006)	NY	The welfare impacts of a partial cleanup and a full cleanup of the AOC in addition to the disbenefits due to additional pollution.	Estimated single-family homes had capital loss of $83.8–$118 million and an estimated total WTP for full cleanup to be $247–$304 million ($2004).	Hedonic property
Consulting and Audit Canada (1994)	CAN – Great Lakes Region	The change from the chlorobiphenyls regulations to the proposed PCB regulations.	The overall benefit was estimated at $100.78 million. The net benefits of the regulations are estimated to be $42 million ($1994 CAN).	Actual expenditure Replacement costs
Eastern Research Group, Inc., Arlington, Massachusetts (1992)	NY, OH	Evaluates the benefits with achieving a residual risk in the contaminated sediments of 1 in 1 million for the Fields Brook site and Massena site.	For both sites the benefits ranges were varied from $21.3 million to $70.5 million at the Fields Brook site and $8.1 million to $33.6 million for the Massena site.	Combined revealed and stated preference
Hushak, L. and M. Bielen (1999)	MI	Dredging of the Ottawa River for improved navigation and removal of contaminated sediments	The mean economic value of dredging for current boaters and businesses is $746,568 with an annual WTP of about $43 and $196, respectively ($1998).	Actual expenditure Contingent valuation
Lichtkoppler, F.R. and T.W. Blaine (1999)	OH	Dredging of the Ashtabula River will address six problems primarily caused by contaminated sediments and help restore many of its impaired beneficial uses.	The households' average annual WTP for dredging ranged from $25 –$50 ($1997).	Contingent valuation

Erosion, Sedimentation, Flood Control Estimate Valuation Studies, EVRI Database Great Lakes Region

Halting Erosion

Bishop, R. C., & Boyle, K. J. (1985). *The economic value of Illinois beach state nature preserve*.

Cangelosi, A., Wiher, R., Taverna, J., & Cicero, P. (2001). *Soil erosion in the Maumee River Basin in revealing the economic value of protecting the Great Lakes*.

Croke, K., Fabian, R., & Brenniman, G. (1987). Estimating the value of beach preservation in an urban area. *The Environmental Professional*, *9*, 42-48.

Hansen, L., & Hellerstein, D. (2007). The value of the reservoir services gained with soil conservation. *Land Economics*, *83*(3), 285-301.

Kim, K. T. (1992). *An assessment of the economic effects of shoreline erosion control in the Lake Erie zone's residential housing market* (Doctoral dissertation). Retrieved from OhioLINK. (Accession No. osu1248794606)

Kriesel, W. P. (1988). *An economic analysis of the role of shoreline erosion in Ohio's residential housing market* (Doctoral dissertation). Retrieved from WorldCat. (Accession No. 20325698)

Purvis, A., Hoehn, J. P., Sorenson, V. L., & Pierce, F. J. (1989). Farmers' response to a filter strip program: results from a contingent valuation survey. *Journal of Soil and Water Conservation*, *44*(5), 501-504.

Yang, W., & Weersink, A. (2004). Cost-effective targeting of riparian buffers. *Canadian Journal of Agricultural Economics*, *52*, 17-34.

Toxic Contamination

Braden, J. B., Patunru, A. A., Chattopdhyay, S., & Mays, N. (2004). Contaminant cleanup in the Waukegan Harbor Area of Concern: homeowner attitudes and economic benefits. *Journal of Great Lakes Research*, *30*(4), 474-491.

Braden, J. B., Taylor, L. O., Won, D., Mays, N., Cangelosi, A., & Patunru, A. A. (2006). *Economic benefits of sediment remediation (1/2)* (GL- 96553601). Retrieved from http://www.sehn.org/tccpdf/property%20value%20benefits%20of%20cleanup.pdf

Braden, J. B., Taylor, L. O., Won, D., Mays, N., Cangelosi, A., & Patunru, A. A. (2006). *Economic benefits of sediment remediation (2/2)* (GL- 96553601). Retrieved from http://www.sehn.org/tccpdf/property%20value%20benefits%20of%20cleanup.pdf

Braden, J. B., Feng, X., Freitas, L., & Won, D. (2010). Meta-functional transfer of hedonic property values: application to Great Lakes Area of Concern. *Agricultural and Resource Economics Review*, *39*(1), 101-113.

Consulting and Audit Canada. (1994). *Valuing the benefits of the proposed PCB Regulations* (Project No. 570-0781).

Eastern Research Group, Inc. (1992). *Clean water reauthorization study: analysis of the costs and benefits of remediating contaminated sediment*. Washington, DC: Office of Water, U.S. Environmental Protection Agency.

Hushak, L., & Bielen, M. (1999). *Valuing the Ottawa River: the economic values and impacts of recreational boating*. Retrieved from http://www.partnersforcleanstreams.org/ValuingtheOttawaRiverFinalReport.pdf

Lichtkoppler, F. R., & Blaine, T.W. (1999). Environmental awareness and attitudes of Ashtabula County voters concerning the Ashtabula River Area of Concern: 1996-1997. *J. Great Lakes Resources*, *25*(3), 500-514.

Built Environment

Cadavid, C. L, & Ando, A. W. (2013). Valuing preferences over stormwater management outcomes including improved hydrologic function. *Water Resources Research*, *49*(7), 4114-4125.

Daniel, V. E., Florax, R. J., & Rietveld, P. (2007). Flooding risk and housing values: an economic assessment of environmental hazard. *Ecological Economics, 69*(2), 355-365.

Mullarkey, D. J., & Bishop, R. C. (1999, August 8-11). *Sensitivity to scope: evidence from a CVM study of wetlands.* Paper presented at the American Agricultural Economics Association Annual Meeting, Nashville, TN.

Trenholm, R., Anderson, T., Lantz, V., & Haider, W. (2013). *Landowner views on wetland enhancement and restoration in and adjacent to the credit river watershed*. Retrieved from http://www.watershedconnect.com/documents/files/landowner_views_on_wetland_enhancement_and_restoration_in_and_adjacent_to_the_credit_river_watershed_.pdf

Open Space and Habitat Types

Areas without buildings or large infrastructure are known as open space. Open space can include parks and playgrounds, seating areas, community spaces, farmland, and even cemeteries and vacant lots. These may all be considered part of an urban habitat. Several studies in the EVRI^{TM} database used different approaches, in addition to economic studies examining single ecosystem services (such as water purification) to determine habitat valuation including:

- ***Open Space***
- ***Forest***
- ***Wetlands***

The methods used to estimate the values of open space and habitat types are: revealed preference (travel cost) and stated preference (contingent valuation, conjoint analysis)[39]. These are represented in the last column of Table 6. The remaining data for each article is organized by the publication information, geographic location, change being studied, and the final value estimate by dollar year. Table 6 is arranged in the order of forest, open space, and wetlands.

More than half of the articles about wetlands used contingent valuation to determine value estimates. Of the two articles that didn't, Bishop *et al.* (2000) used a conjoint analysis to determine willingness-to-pay (WTP) for different types of restoration programs. The programs were PCB-caused losses, increasing wetlands, helping existing parks and creating new parks. Whitehead *et al*. (2009) used revealed and stated preferences when studying WTP for acreage protection. They evaluated estimated values of coastal marsh land for recreation users and nonusers. The study examined: value of wetland outputs; improved groundwater, surface water and wetland quality; retained and restored wetlands; WTP to prevent development of a bog and peat extraction; different restoration proposals for wetlands in Saginaw Bay; and evaluation of programs for nitrate and sediment reduction.

Two articles focused on forest habitats. Harrison and Hitzhusen (2010) determined WTP based on individual preferences for a proposed policy that would support responsible forestry. Mills *et al.* (1980) estimated the value of developing Minnesota's Voyageurs National Park. A travel cost method was used to create an aggregate value of costs versus benefits of development in the park. Blaine and Lichtkoppler (2004) looked at both regular citizens and conservation-focused citizens to see if there was a difference in the value of open space and their WTP for conservation easements.

Because studies contained multiple valuation estimates (stemming from multiple policy scenarios and/or model specifications) it was not possible to include the full range of value estimates in the table. In addition, population characteristics varied across studies (for example, income). While these characteristics affected valuations, these were not included in the table. Of note was that the baseline

[39] For brief descriptions of the economic valuation methods, see Appendix A.

resource state and the increment of resource change valued also varied across the studies, which limited the comparability of studies.

Table 6: Summary of Open Space and Habitat Types[40]

Forest				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Mills, A. S., J. G. Massey and H. M. Gregersen (1980)	MN	Value of the development of the Voyageurs National Park, Minnesota	Combining the values for the park, the rest of Minnesota, and the rest of U.S., the benefits of the park would add up to $637,454,157 and the costs would be $238,424,220 ($1974).	Travel cost method
Harrison, J. and Hitzhusen, F. (2010)	OH	Determine the WTP of students, faculty and staff at Ohio State University for a proposed environmentally-responsible forest policy.	Mean WTP is $5.09 per quarter, with 86.97 percent of respondents willing to pay for the forest resource policy. Aggregate values are available.	Contingent valuation

Open Space				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Blaine, T.W., and F.R. Lichtkoppler (2004)	OH	A valuation on the WTP of individuals to help fund the purchase of conservation easements	For registered voters, the WTP was $2.69/household/month. For members of the Soil and Water Conservation District, it was $3.04/household/month. Aggregate values are ($2001).	Contingent valuation

[40] Values are in U.S. dollars unless otherwise indicated. When year of values is not indicated, this information was not available. Values have not been converted to a common/base year Individual estimate values reported when available. When they are not present, aggregate estimate values are stated.

Wetlands				
Publication	**Geography**	**Change Valued**	**Value Estimate ($Year)**	**Valuation Method**
Roberts, L.A. and J.A. Leitch (1997)	MN, SD	The wetland outputs of Mud Lake, including flood control, fish and wildlife habitat, water supply, water quality, recreational use, and aesthetics.	The total estimated annual dollar value of Mud Lake was $2,216,000, or $440 per acre.	Contingent valuation
Whitehead, J. C., P. A. Groothuis, R. Southwick and P. Foster-Turley (2009)	MI	Determining the WTP for three different acreage amounts of further protection: 1,125, 2,500, and 4,500.	The value of coastal marsh is $1,870/acre for the purpose of recreation. The value to recreation nonusers adds $551/acre. Aggregate values are available ($2005).	Combined revealed and stated preference
De Zoysa, A.D.N (1995)	OH	The alternate levels of provision: reduction of nitrate concentrations, reduction in soil erosion, and protection and restoration of wetlands	Mean WTP values for improved groundwater, surface water and wetland quality are $52.78, $78.38, and $62.57. Aggregate values are available ($1994).	Contingent valuation
Lantz, V., P. Boxall, M. Kennedy and J. Wilson (2010)	ON	To estimate the value of retaining and restoring wetland service.	The household WTP was estimated to be $228.28 and $258.78. Aggregate values are available ($CAN).	Contingent valuation
Tkac, J.M (2002)	ON	WTP to prevent the conversion of a bog for development and peat extraction	Mean WTP was $79.22. Aggregate values are available ($CAN).	Contingent valuation
Bishop,R.C., W.S. Breffle, J.K. Lazo, R.D. Rowe and S.M. Wytinck (2000)	WI	Focuses on four groups of natural resource restoration programs for the Green Bay area.	The WTP value per household for PCB-caused losses is $83.42. The WTP value per household for increasing wetlands is $30.12. The WTP value per household for existing parks is $7.73. The WTP value per household for an increase in new parks is $0 ($1999).	Conjoint analysis
Cangelosi, A., R. Wiher, J. Taverna, and P. Cicero (2001)	MI, OH	Restoration proposals to protect and restore wetlands, improve existing wetlands, provide wildlife habitat, and develop improved nesting cover.	Estimated wetland benefits for Saginaw Bay range from $500 to $9,000 per acre for residents of the drainage basin. Aggregate state values are available ($1997).	Contingent valuation
Randall, A. and D. DeZoysa (1996)	OH	Three programs were evaluated: reduction in nitrate levels for groundwater, reduction of sediments due to soil erosion, and for wetlands improvement.	The WTP for the single component groundwater, surface water, and wetland improvement programs in a one-time payment were, respectively, $20.80, $50.27, and $29.56 per household.	Contingent valuation

Wetlands

Bishop, R. C., Breffle, W. S., Lazo, J. K., Rowe, R. D., & Wytinck, S. M. (2000). *Restoration Scaling Based on Total Value Equivalency: Green Bay Natural Resource Damage Assessment*. Boulder, Colorado: Stratus Consulting Inc.

Cangelosi, A., Wiher, R., Taverna, J., & Cicero, P. (2001). *Wetlands restoration in Saginaw Bay in the revealing the economic value of protecting the Great Lakes*.

De Zoysa, A.D.N. (1995). *A benefit evaluation of programs to enhance groundwater quality, surface water quality and wetland habitat in Northwest Ohio* (Doctoral dissertation). Retrieved from WorldCat. (Accession No. 34727047)

Lantz, V., Boxall, P., Kennedy, M., & Wilson, J. (2010). *Valuing wetlands in southern Ontario's Credit River watershed: a contingent valuation analysis*. Retrieved from http://www.creditvalleyca.ca/wp-content/uploads/2011/01/ValuingWetlandsPhase2-final.pdf

Randall, A. & DeZoysa, D. (1996). Groundwater, Surface Water, and Wetlands Valuation for Benefits Transfer: A Progress Report (W-133). Retrieved from http://fes.forestry.oregonstate.edu/sites/fes.forestry.oregonstate.edu/files/PDFs/W133%209th%20Interim%20Report%201996.pdf

Roberts, L. A. & Leitch, J. A. (1997). *Economic valuation of some wetland outputs of Mud Lake, Minnesota-South Dakota*. Retrieved from http://ageconsearch.umn.edu/bitstream/23406/1/aer381.pdf

Tkac, J. M. (2002). *Estimating willingness to pay for the preservation of the Alfred Bog wetland in Ontario: a multiple bounded discrete choice approach* (Master's thesis). Retrieved from McGill Library and Collections. (Accession No. 29480)

Whitehead, J. C., Groothuis, P. A., Southwick, R., & Foster-Turley, P. (2009). Measuring the economic benefits of Saginaw Bay coastal marsh with revealed and stated preference methods. *Journal of Great Lakes Research*, *35*, 430-437.

Forest

Harrison, J., & Hitzhusen, F. (2010). Contingent valuation study of willingness-to-pay for sustainable forest products. *Journal of Environmental Assessment Policy and Management*, *12*(4), 469-489.

Mills, A. S., Massey, J. G., & Gregersen, H. M. (1980). Benefit-cost analysis of Voyageurs National Park. *Evaluation Review*, *4*(6), 715-738.

Open Space

Blaine, T. W., & Lichtkoppler, F. R. (2004). Willingness to pay for green space preservation: a comparison of soil and water conservation district clientele and general public using the contingent valuation method. *Journal of Soil and Water Conservation*, *59*(5), 203-20

Open Space Meta-Analysis Valuation Study[41]

Brander and Koetse (2010) conducted a meta-analysis on the current literature about open space because of its growing importance across the country. Having 20 studies and 73 value observations, contingent valuation meta-regression and hedonic pricing methods were used to see changes in housing prices. Having open space per hectare per year as the dependent variable, a percent change in converted $2003 prices was determined when the distance to open space was reduced by 10 meters. They found that urban parks have a higher value compared to undeveloped and agricultural lands and showed that region played an important role in the valuation process. They found that the contingent valuation method could be used to help determine the estimated value per unit area; compared to hedonic pricing, which estimated the value for the change in distance to urban open space locations. The authors commented that value transfers should not be used when determining the estimated value of urban open space because of how large a role region or location played in the final value.

Open Space Meta-Analysis Valuation Study Reference

Brander, L. M. & Koetse, M. J. (2010). The value of urban open space: meta-analyses of contingent valuation and hedonic pricing results. *Journal of Environmental Management*, *92*, 2763-2773.

[41] All dollar values are in US unless otherwise stated. Values have not been converted to a common/base year.

Appendix A – Valuation Method and Other Indicator Definitions

Hedonic Wage/Property – This is a way of using market pricing to estimate the economic value provided by ecosystem and environmental services. Through collecting residential property sale data or wage data, statistical analysis can be conducted to determine the influential value that certain factors can play towards the overall price of a house or the price of a person's time. These factors may include air quality or the distance to green space or a water source.

Travel Cost – A valuation method to determine a person's willingness-to-pay (WTP) for the use of an ecosystem or recreational good. The number of trips taken to a specific location is used to help determine the value of the good. At the location, visitors are surveyed about how many times they visit, how far away they live from the location, how long the visit was, and other information such as income, age, and education. The travel cost value is determined from respondents' answers. Examples of this type of method would be: determining the impact of raising the entrance fee to a specific national park, or the benefits of water quality at a popular beach location.

Contingent Valuation – A method used to determine a person's WTP/WTA for environmental and ecosystem services by surveying people directly about how much they would pay for the service or be compensated for losing the service. These surveys include detailed explanations of the service or good in question, demographics (age, income, etc.), and how much they would be willing to pay or accept for services. To help get a more realistic estimate, a description of how an individual would pay for the service would be included, such as tax, donation, or other types of fees. Examples of this method are: the economic value of non-game fish to people, or the WTP to help restore a beach front.

Conjoint Analysis – A technique used to see how people value certain products or services, provided by ecosystems and the environment, over others. Through surveying techniques, individuals are asked to respond to or rank different options about environmental and ecosystem services and products. Their answers reflect the preferences for certain products or services over others and reflect their economic value. This ranking process can help determine what types of recreational opportunities should be made available in a certain park.

Combined Revealed/Stated Preference – Looking at both an individual's trade-offs and WTP for environmental services. By using stated preference, data is collected about one's preferences about certain goods or services. These options are based off of the calculated values from revealed preferences that determined people's WTPs for a variety of environmental and ecosystem services. An example of this type of study is: looking at what type of management strategy for deer population is most favored by the local community and how much an individual would be willing to pay to have this strategy implemented.

Actual Expenditure/Actual Price – Evaluating the full cost paid for environmental and ecosystems goods and services. Market data can be collected to find how much people are paying for a certain good and using that information to determine the overall economic benefit to consumers whether it be positive or negative. This process helps to determine the economic value of things such as the impacts of sustainable versus non-sustainable commercial fisheries and timber harvest practices.

Averting Behavior – Looking at the benefits and/or costs to human health through different environmental actions. After determining the risk being evaluated, data is collected on the amount of products bought by individuals that would help prevent the impacts on individuals from the chosen risk. The WTP to prevent the possible risk is calculated from this market data. Possible impacts to human health can include ozone depletion and the impacts on human skin, or buying more water bottles because of poor water quality.

Replacement Cost – Determining how much replacing ecosystem services would cost an individual or community. This is done by looking at the service being supplied by the environment and determining the cost required for providing what would be lost. An example is: looking at possibly removing a wetland, identifying the services provided, such as flood control, and calculating the total cost of building new infrastructure to manage future needs of those lost services. The final amount would be how much the community would save by keeping the wetland compared to what they would gain by removing it. Other examples are: looking at the value of watersheds providing clean drinking water to a certain population, or forests controlling soil erosion.

Appendix B - Components of Economic Value

Use Value – How much an environmental or ecosystem good or service is valued by a person when it is used directly or indirectly

Direct Use Value – The value a person places on ecosystem services or products that they use or consume (such as using wood for a bonfire or catch and release fishing)

Consumptive Value – Values that reflect services or products bought or removed by individuals to be enjoyed (such as hunting or mushroom picking)

Non-consumptive Values – Values that reflect services or products that do not need to be consumed or removed to be enjoyed (such as hiking or bird watching)

Indirect Use Value – The benefit values that a person receives from environmental and ecosystem functions even though they do not directly use the service (such as water filtration and clean air production by trees)

Option Value – How much a person values the option to use an environmental or ecosystem service or product in the near or distant future even if they do not currently use it

Non-use Values – How much a person values an environmental or ecosystem service that they will not use (such as knowing that there are bald eagles because they have patriotic symbolism in the U.S.)

Bequest Value – How much a person from the current generation values knowing that an environmental or ecosystem service will be available for future generations even if they will not enjoy it themselves

Existence Value – How much a person values knowing a service or good exists even if they will never visit or use it (such as knowing the Great Barrier Reef exists even they are unable to visit it)

Altruist Value – How much a person values knowing that an environmental or ecosystem good is used by other people but they might never use it.