Rapid Assessment of the Economic Value of Wisconsin's Wetlands

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Cover photo

Milwaukee Metropolitan Sewerage District

Introduction

Economic sustainability and resiliency both rely upon environmental sustainability and resiliency. The loss of natural infrastructure has real economic costs. Safeguarding the health of a wetland area, like keeping a house in good condition, provides value for everyone who utilizes or benefits from it, directly or indirectly. Unlike houses, levees, roads and other man-made infrastructure, wetlands are largely self-maintaining. Wetlands provide valuable goods and services across vast spans of time, and even well beyond their boundaries. Protecting and restoring Wisconsin's wetlands is critical to improving quality of life and to securing sustainability, public health and safety, and economic progress in the region.

This rapid assessment was commissioned by the Wisconsin Wetlands Association to provide initial baseline economic values for Wisconsin's 5.3 million acres of wetlands. Economic value is assessed using ecosystem service analysis which calculates the dollar value of resources and processes that are supplied by natural ecosystems to the benefit of humankind. Ecosystem services provided by wetlands include flood protection, ground water protection, water quality, recreation and biodiversity.

The dollar estimates in this report are very conservative and reflect baseline values of only 7 of the 22 ecosystem services. Similar in concept to a business or home appraisal, this assessment provides initial answers to questions such as:

- Can the wetlands be considered an economic asset?
- If wetlands are an economic asset, what is the range of probable dollar values in various degraded, restored and high-functioning conditions?
- How do the wetlands impact the local and regional economy?
- What is the opportunity cost to reducing or degrading wetlands and their functions?

Geography

The landscape of the 65,503 square miles that now constitute the state of Wisconsin was shaped by glaciers thousands of years ago. Due to the melting process, these glaciers left a large complex of lake basins, wetlands, and extremely fertile plains. One hundred and fifty years ago, more than 10 million acres of wetlands were found in Wisconsin. Today, wetland drainage, filling, levee development, and other human activity have reduced the area of wetlands to roughly 5 million acres, much of which is now degraded.[1] Despite this, the area remains spectacularly beautiful and ecologically diverse.

Figure 1: State of Wisconsin highlighted in yellow.

[1] Hagen, C. Reversing the Loss: A Strategy to Protect, Restore and Explore Wisconsin Wetlands, 2008. Accessible at http://dnr.wi.gov/topic/wetlands/documents/ReversingLoss08_gs.pdf.

Approximately 75% of Wisconsin's wetlands are owned and stewarded privately. Figure 2 shows the ownership breakdown.

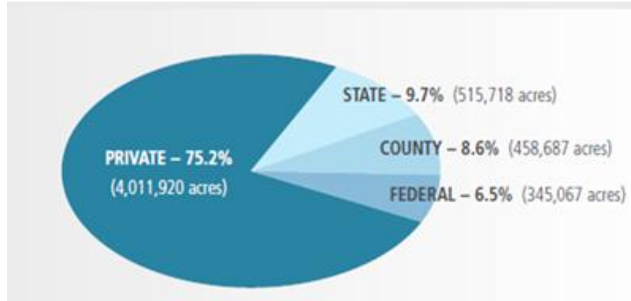


Figure 2: Wisconsin wetland ownership. Source: Hagen, C., 2008.

The Connection between Wetlands and the Economy

Wetlands house economies through their environmental assets. The natural environment provides many foundations that human beings need for survival, including breathable air, drinkable water, food for nourishment, and stable atmospheric conditions. These "ecosystem goods and services," are derived from ecosystems and provide essential benefits to humans. Ecosystems perform many functions, but only functions that provide human benefits are considered ecosystem goods or services. Every ecosystem produces a plethora of ecosystem services.

Healthy wetlands enable cities, communities, households and their residents to thrive. However, society has a tendency to under-invest in wetlands and take them for granted. For example, when flood protection provided for free by natural systems is lost, natural flood protection service must be replicated with levees, which can cause flooding in homes and businesses. When drinking water, storm water conveyance, local climate regulation, habitat and other benefits disappear, the economy suffers from both the direct damage and the imposition of expensive tax districts and construction costs that are needed to replace previously existing natural capital.

The economy of Wisconsin cannot be adequately understood without examining the contribution of wetlands and the associated value benefits of ecosystem services to the economy and well-being of people. To improve economic decision-making and better understand the explicit contribution of properly functioning ecosystems to economic activity and output, interest in identifying, describing, and quantifying the value of ecosystem services has grown tremendously over the past 20 years.[2]

Ecosystem Services

Ecosystem services can be categorized into four major types: regulating services, habitat services, provisioning services and information services (see Table 1). Ecosystem services in each of these categories provide economic value that can be measured in dollar terms. Specific ecosystems services exist within each category, as identified in Table 2.

[2] Costanza, R., d'Arge, R., Groot, R.d., Farber, S., Grasso, M., Hannon, B., Naeem, S., Limburg, K., Paruelo, J., O'Neill, R.V., Raskin, R., Sutton, P., Belt, M.v.d., 1997. The value of the world's ecosystem services and natural capital. Nature 387, 253-260; Balmford, A., Bruner, A., Cooper, P., Costanza, R., Farber, S., Green, R.E., Jenkins, M., Jefferiss, P., Jessamy, V., Madden, J., Munro, K., Myers, N., Naeem, S., Paavola, J., Rayment, M., Rosendo, S., Roughgarden, J., Trumper, K., Turner, R.K., 2002. Ecology - Economic reasons for conserving wild nature. Science 297, 950-953.

Table 1: Categories of ecosystem services

Regulating services are benefits obtained from the natural control of ecosystem processes. Intact ecosystems can provide regulation of climate, water, soil, flood and storms, and/or keep disease organisms in check.

Habitat services provide refuge and reproduction habitat to wild plants and animals and thereby contribute to the (in situ) conservation of biological and genetic diversity and evolutionary processes.

Provisioning services provide basic goods including food, water and materials. Forests grow trees that can be used for lumber and paper, wild and cultivated crops provide food, and other plants may be used for medicinal purposes. Groundwater provides fresh water for drinking or industrial activities. Lakes and rivers provide fish for food and recreation. Groundwater and lakes provide freshwater for drinking.

Information services provide humans with meaningful interaction with nature. These services include spiritually significant species and natural areas, places for recreation, and educational opportunities through science.

Table 2: List of ecosystem services

Services		Ecosystem Infrastructure and Processes	Goods and Services (examples)
Regulating Services		*Maintenance of essential ecological processes and life support systems*	
1	**Gas regulation**	Role of ecosystems in bio-geochemical cycles	Provides clean, breathable air, disease prevention, and a habitable planet
2	**Climate regulation**	Influence of land cover and biological mediated processes on climate	Maintenance of a favorable climate promotes human health, crop productivity, recreation, and other services
3	**Disturbance prevention**	Influence of ecosystem structure on dampening environmental disturbances	Prevents and mitigates natural hazards and natural events, generally associated with storms and other severe weather
4	**Water regulation**	Role of land cover in regulating runoff and river discharge	Provides natural irrigation, drainage, channel flow regulation, and navigable transportation
5	**Soil retention**	Role of vegetation root matrix and soil biota in soil retention	Maintains arable land and prevents damage from erosion, and promotes agricultural productivity
6	**Soil formation**	Weathering of rock, accumulation of organic matter	Promotes agricultural productivity, and the integrity of natural ecosystems
7	**Nutrient regulation**	Role of biota in storage and re-cycling of nutrients	Promotes health and productive soils, and gas, climate, and water regulations
8	**Water Quality and Waste Treatment**	Role of vegetation & biota in removal or breakdown of xenic nutrients and compounds	Pollution control/ detoxification; Filtering of dust particles through canopy services

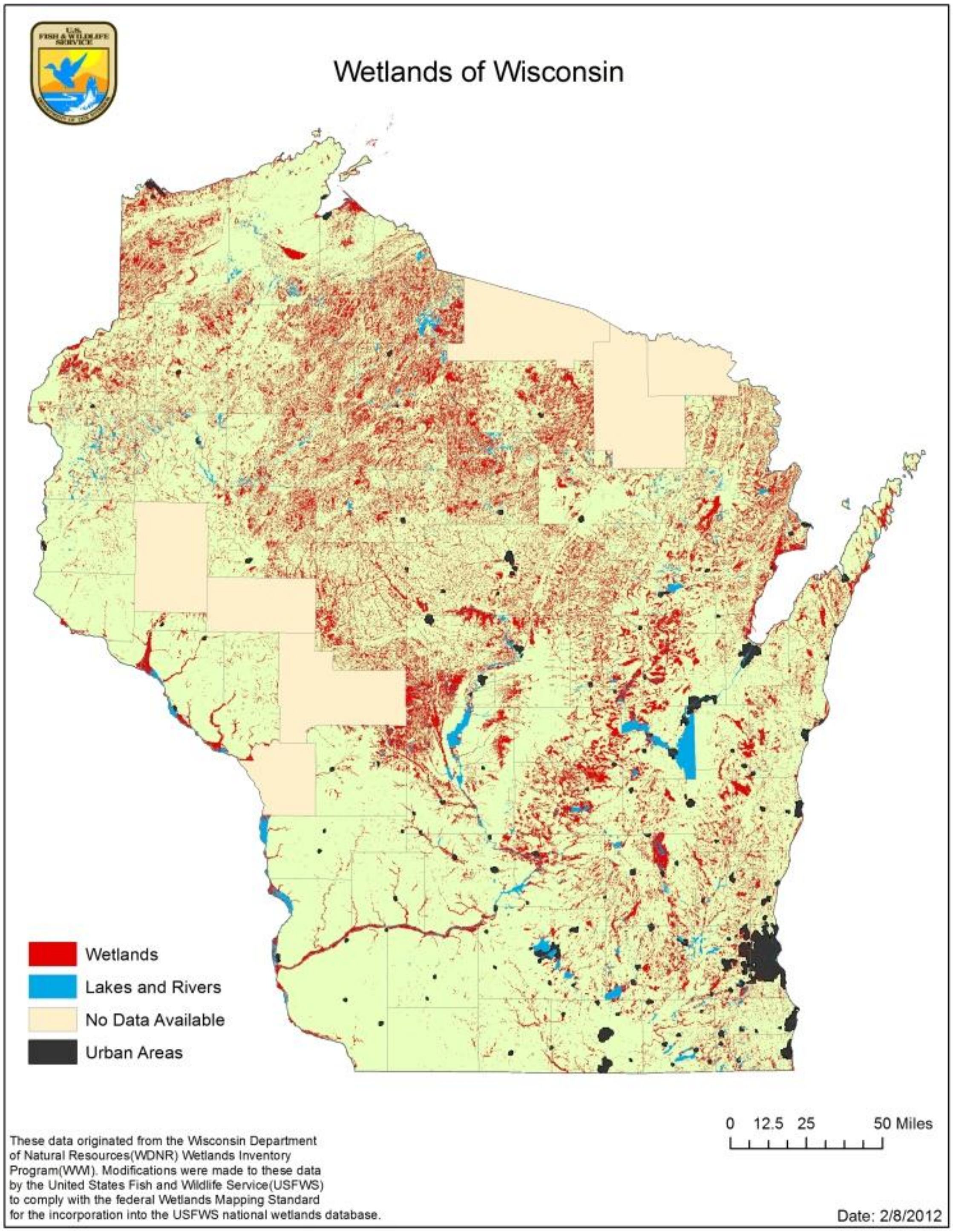
9	**Pollination**	Role of biota in movement of floral gametes	Pollination of wild plant species and harvested crops
10	**Biological control**	Population control through trophic-dynamic relations	Provides pest and disease control, reduces crop damage
Habitat Services		*Providing habitat (suitable living space) for wild plant and animal species*	
11	**Habitat and Biodiversity**	Suitable living space for wild plants and animals	Maintenance of biological and genetic diversity (and thus the basis for most other functions)
12	**Nursery**	Suitable reproduction habitat	Maintenance of commercially and recreationally harvested species
Provisioning Services		*Provision of Natural Resources*	
13	**Food**	Conversion of solar energy into edible plants and animals	Hunting, gathering of fish, game, fruits, etc.; small scale subsistence farming & aquaculture
14	**Water supply**	Filtering, retention and storage of fresh water (e.g. in groundwater aquifers)	Provision of water for consumptive or other use, includes both quality & quantity
15	**Raw materials**	Conversion of solar energy into biomass for human construction and other uses	Building and manufacturing; fuel and energy; fodder and fertilizer
16	**Genetic resources**	Genetic material and evolution in wild plants and animals	Improve crop resistance to pathogens & pests
17	**Medicinal resources**	Variety in (bio)chemical substances in, and other medicinal uses of, natural biota	Drugs, pharmaceuticals, chemical models, tools, test and essay organisms
18	**Ornamental resources**	Variety of biota in natural ecosystems with (potential) ornamental use	Resources for fashion, handicraft, jewelry, pets, worship, decoration & souvenirs
Information Services		*Providing opportunities for cognitive development*	
19	**Aesthetic information**	Attractive landscape features	Enjoyment of scenery
20	**Recreation**	Variety in landscapes with (potential) recreational uses	Travel to natural ecosystems for eco-tourism, outdoor sports, etc.
21	**Cultural and artistic information**	Variety in natural features with cultural and artistic value	Use of nature as motive in books, film, painting, folklore, national symbols, architecture, advertising, etc.
22	**Spiritual and historic information**	Variety in natural features with spiritual and historic value	Use of nature for religious or historic purposes (i.e., heritage value of natural ecosystems and features)
23	**Science and education**	Variety in nature with scientific and educational value	Use of natural systems for school excursions, etc. Use of nature for scientific research

Based on: de Groot, R.S., Wilson, M.A., Boumans, R.M.J., 2002.

Valuation of the Wisconsin Wetlands

To provide a preliminary estimate the value of ecosystem services produced in Wisconsin's wetlands, Earth Economics first identified the ecosystem services present using Geographical Information Systems (GIS) data. The State of Wisconsin contains 5,331,392 acres of wetlands. Each acre of wetlands was assigned a total high and low annual per-acre dollar value for its ecosystem services.

Figure 3: Wisconsin wetlands in relation to urban areas



Valuation Methodology

Benefit Transfer Methodology (BTM) was used to estimate the approximate value of ecosystem services produced by the wetlands in Wisconsin. BTM is used when it is cost-prohibitive to conduct primary studies on every site in a study area for every vegetation type. BTM is a widely accepted economic methodology in which the estimated economic value of an ecological good or service is determined by examining previous valuation studies of similar goods or services in other comparable locations. The term “transfer” refers to the application of derived values and other information from the original study site to a new but sufficiently similar site, like a house or business “comp.”[3] As the “bedrock of practical policy analysis”,[4] BTM has gained popularity in the last several decades as decision-makers have sought timely and cost-effective ways to value ecosystem services and natural capital.[5]

Earth Economics maintains and continually expands a database of published, peer-reviewed ecosystem service valuation studies for use in benefit transfer studies. For example, Doss and Taff (1996) performed a study in Ramsey County Minnesota to examine the relationship between housing prices and wetland proximity. This study was used for the present valuation. The valuation methodologies used to derive the values in the database studies were primarily developed within the disciplines of Environmental and Natural Resource Economics. Table 3 describes the methodologies used in this rapid assessment.

Photo Credit: Steve Eggers

[3] Brookshire, D.S., Neill, H.R., 1992. Benefit Transfers: Conceptual and Empirical Issues. Water Resources Research 28, 651-655; Desvousges, W.H., Naughton, M.C., Parsons, G.R., 1992. Benefit transfer: conceptual problems estimating water quality benefits using existing studies. Water Resources Research 28.

[4] Desvousges, W.H., Johnson, F.R., Banzhaf, H.S., 1998. Environmental Policy Analysis with Limited Information: Principles and Applications of the Transfer Method. Edward Elgar, Northhampon, MA.

[5] Wilson, M., Hoehn, J., 2006. Valuing environmental goods and services using benefit-transfer: state-of-the-art and science. Ecological Economics 60, 335-342.

Table 3: Valuation methods used to value ecosystem services

Avoided Cost (AC): Services that allow society to avoid costs that would have been incurred in the absence of those services; for example, floodwater regulation provided by wetlands avoids property damages to urban and rural areas.
Replacement Cost (RC): Services that can be replaced with man-made systems; ex. nutrient cycling and waste treatment provided by wetlands can be replaced with expensive treatment systems whose replacement cost can be readily estimated.
Factor Income (FI): Services that provide for the enhancement of incomes; for example, water quality improvements increase commercial and recreational fisheries catch and the incomes of communities or economies dependent upon fishing retailers.
Travel Cost (TC): Service demand may require travel, which has costs that can reflect the implied value of the service; for example, recreation areas can be valued in part by the dollar amount that visitors are willing to pay to travel to it, including the imputed dollar value of their time.
Hedonic Pricing (HP): Service demand may be reflected in the prices people will pay for associated goods, for example, housing prices along shorelines generally exceed the prices of inland homes.
Contingent Valuation (CV): Service demand may be elicited by posing hypothetical scenarios that involve some valuation of alternatives; for example, when surveyed, people generally state that they are willing to pay for preservation of beaches and shoreline and will name a dollar amount they would be willing to pay per unit of time.
Group Valuation (GV): This approach is based on principles of deliberative democracy and the assumption that public decision making should result not from the aggregation of separately measured individual preferences but from open public debate.

Adapted from Farber et al., 2006

Photo Credit: Steve Eggers

Table 4 provides a matrix that highlights ecosystem services identified for each land cover type in Wisconsin; those cells that were valued for this assessment are marked with an "X". Due to time constraints, not all ecosystem services that were identified for Wisconsin wetlands are assigned a value. Also, this assessment does not include valuation of non-wetland land cover classes, such as forest, pasture, riparian buffer, etc.

Table 4: Ecosystem services identified and valued for this assessment

	Agricultural Lands	Forest	Grasslands	Lakes/Rivers	Pasture	Riparian Buffer	Shrub/Scrub	Urban Green Space	Wetland
Provisioning Services									
Food									
Raw Materials									
Genetic Resources									
Medicinal Resources									
Ornamental Resources									
Regulating Services									
Gas Regulation									X
Climate Regulation									X
Disturbance Prevention									X
Soil Retention									
Water Regulation									X
Water Supply									X
Biological Control									
Waste Treatment									X
Soil Formation									
Nutrient Regulation									
Pollination									
Habitat Services									
Habitat and Biodiversity									X
Nursery									X
Information Services									
Aesthetic Information									X
Recreation									X
Cultural and Artistic Information									
Science and Education									
Spiritual and Historic Information									

Key:

	Ecosystem service produced by land cover but not valued in this report
X	Ecosystem service produced by land cover and valued in this report
	Ecosystem service not produced by land cover

Underestimated Value

A total of 22 ecosystem services were identified in Wisconsin's wetlands. Rapid assessment valuation was possible for 10 services. Table 4 suggests that, because a large number of ecosystem services and land covers have yet to be valued, this rapid assessment valuation provides a significant underestimate of the true value.

Annual Value of Wisconsin Wetlands

Transferred values were converted to 2010 dollars per acre per year, representing the annual flow of value generated by a single ecosystem service on a single land cover each year. Combining the available ecosystem service values (water regulation, habitat, recreation, etc.) for each wetland type yields a total value for that land cover in dollars per acre per year. Table 5 summarizes the range of ecosystem service values for wetlands in Wisconsin.

Table 5: Value of ecosystem services provided by each wetland sub-type in the State of Wisconsin

Ecosystem Service	Low Value ($/acre/year)	High Value ($/acre/year)
Disturbance Prevention	434	7,758
Waste Treatment	13	1,747
Water Regulation	148	6,877
Water Supply	10	4,289
Gas and Climate Regulation	5	534
Aesthetic and Recreation	2	4,985
Habitat and Nursery	6	2,242
Total ($/acre/year)	**617**	**28,432**

Table 6 summarizes the annual flow of value provided across all wetlands in Wisconsin. **Wisconsin wetlands provide over $3.3 billion dollars in economic benefits to the state *per year.***

Table 6: Annual value of ecosystem services provided by wetlands in Wisconsin

Low Value ($/acre/year)	High Value ($/acre/year)	Acreage of Wetlands in Wisconsin	Total Low ($/year)	Total High ($/year)
617	28,432	5,331,392	**3,291,961,752**	**151,580,506,001**

Value Discrepancies

The wide ranges of the estimates for the subset of ecosystems and services available for this study can be attributed to a number of factors including wetland health and ecosystem service function and year of primary study. In general, the more degraded the ecosystem, or the older the source study, the lower the value. A total of 22 ecosystem services were identified in Wisconsin's wetlands. Rapid assessment valuation was possible for 10 services. Table 4 suggests that, because a large number of ecosystem services and land covers have yet to be valued, this rapid assessment valuation provides a significant underestimate of the true value.

Asset Value of Wisconsin's Wetlands

Like a traditional capital asset, an ecosystem produces a flow of valuable services across time. As long as the natural infrastructure of the wetlands are not degraded or depleted, this flow of value will likely continue into the future. In fact, it will become even more valuable as such natural infrastructure becomes scarcer or degraded elsewhere. This analogy can be extended by calculating the net present value of the future flows of ecosystem services, just as the asset value of a capital asset (such as a bridge or a building) can be calculated as the net present value of its future benefits. This calculation is no more than an economic exercise however, because ecosystems are not generally bought and sold in this manner; the usefulness of this exercise is to demonstrate their long-term economic value.

Calculating the net present value of an asset requires the use of a discount rate. Table 7 shows the net present value of the wetlands calculated using different discount rates. Using a 0% discount rate recognizes the renewable nature of natural capital and that people 100 years from now will enjoy the same level of benefits we enjoy today. In contrast, the federal discount rate for water resource projects in FY2012 is 4%, and lowers the value of the benefits by 4% each year into the future.

Table 7: Asset Value of Wetlands in Wisconsin

Discount Rate	Value for State of Wisconsin (low)	Value for State of Wisconsin (high)	Per-Acre Value (low)	Per-Acre Value (high)
0% (100 years)	$329,196,175,226	$15,158,050,600,129	$61,747	$2,843,169
4% (100 years)	$80,669,519,438	$3,714,480,147,549	$15,131	$696,719

At the 4% federal discount rate, the asset value of Wisconsin's wetlands is estimated between $81 billion and $3.7 trillion, and at a zero discount rate, is estimated between $329 billion and $15.2 trillion. Even with the most conservative estimate, this means that each acre of wetland is worth at least $15,000, if treated as an economic asset.

Conclusion

This report provides a preliminary view of the value of Wisconsin's wetlands to the local community and the local, state and federal agencies that are responsible for serving the residents of the beautiful state of Wisconsin. The appraisal valuation of ecosystem services provided by wetlands in Wisconsin quantifies the economic value supplied by nature in the wetlands every year. By protecting against flooding, assuring water supply, buffering climate instability, maintaining critical habitat, providing waste treatment and other benefits, **Wisconsin's wetlands provide between $3.3 billion and $152 billion in economic value every year to the local, regional and national economy.** These wetlands provide tremendous benefits to the public over generations, at little or no cost.

Ecosystem services may also be treated like economic assets, as they provide a stream of benefits over time, similar to bridges, roads or other built infrastructure. Valued as such, a discount rate may be applied to these services, allowing for calculation of the present value (or asset value) of these systems. If treated like an asset with a lifespan of 100 years, the asset value of the Wisconsin's wetlands is between $81 billion and $3.7 trillion at a 4% discount rate. **Using a 0% discount rate, which recognizes the renewable nature of natural capital and that people 100 years from now will enjoy the same level of benefits, Wisconsin's wetlands have an asset value of between $329 billion and**

$15.2 trillion. Though a snapshot in time, these appraisal values are defensible underestimates and applicable to decision-making at every jurisdictional level.

The creation of macroeconomic measures in the 1930s, such as measures for the Gross Domestic Product, unemployment and inflation, transformed the United States because these measures enabled better economic decision-making. Built capital was scarce, and economic measures of built capital were essential to building a prosperous 20th century economy.

Today, scarcity has shifted from manufactured goods to ecosystem goods and services. To increase their production the value of ecosystems should be correctly measured and included in decision-making. Discovering and measuring the value of natural capital in Wisconsin is important, and ecosystem service valuations can aid effective and efficient natural resource management.

While this rapid assessment provides a valuation of ecosystem services provided by Wisconsin's wetlands, it is only a first step in the process of developing policies, measures and indicators that support discussions about the tradeoffs in investments of public and private money that ultimately shape the regional economy for generations to come.

Recommended next steps include:

- **Protect and Restore Natural Capital.** Consider both the conservation and the restoration of these Wisconsin ecosystems as a key investment in the future economy as supported by green infrastructure.
- **Apply Ecosystem Service Valuation to Support Funding Investment in Natural Assets.** Ecosystem service valuation can provide governments, organizations, and private owners with a way to calculate the rate of return on conservation and restoration investment. Beginning in late 2012, values in this report can be regularly updated and enhanced with information on more ecosystems and ecosystems services using Earth Economics' SERVES (Simple Effect Resource for Valuing Ecosystem Services), a web-based tool that can be accessed from www.eartheconomics.org.
- **Adopt an Ecosystem Services Approach to Rural Economic Development.** By including sustainable forestry, forest product development, agriculture, and access to quality outdoor recreation in economic development planning, long-term and sustainable jobs can be identified, quantified and secured. Restoration projects can and should be effectively linked to economic advancement, sustainability and long-term job creation.
- **Review Institutional Options for Planning and Management of Natural Assets.** Ecosystem services can be a guide for improvement by setting a context wherein alternative goals, such as flood control, storm water conveyance, habitat and water quality, can be simultaneously improved, thus avoiding infrastructure conflict. Wisconsin leaders should facilitate discussions about institutional improvements that facilitate the coordination of the leveraging of wetland benefits including the reduction of flood risk, provision of drinking water and water quality, resilience to changes in the climate, and ensuring the livelihood of forest and agricultural landowners. Earth Economics is working in Washington State to develop the first state Watershed Investment District as an example of a new institution to manage natural capital.

Such an institution would be positioned to take advantage in emerging ecosystem service markets to generate funding for investment in Wisconsin's natural capital, while also creating a mechanism for incentive funding for stewardship practices on private land through Payments for Ecosystem Services. Adopting an integrated approach will save money and provide greater economic benefits and higher quality of life for Wisconsin residents.

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Value Transfer Studies Used by Ecosystem Service

Ecosystem Service	Author(s)	Low	High
Disturbance Regulation	Allen, J. et al.	$433.78	$7,757.92
Waste Treatment	Pate, J. and Loomis, J.	$76.39	$344.14
	Olewiler, N.	$154.68	$434.60
	Wilson, S. J.	$12.86	$1,747.07
Water Regulation	Thibodeau, F. R. and Ostro, B. D.	$6,876.67	$6,876.67
	Wilson, S. J.	$1,552.65	$1,552.65
	Woodward, R., and Wui, Y.	$148.48	$2,914.64
Water Supply	Creel, M. and Loomis, J.	$533.70	$533.70
	Lant, C. L. and Tobin, G.	$189.14	$2,082.37
	Pate, J. and Loomis, J.	$3,538.95	$3,538.95
	Dodds, W.K., et al.	$1,379.95	$1,379.95
	Hayes, K. M., et al.	$1,915.63	$2,977.72
	Wilson, S. J.	$704.81	$704.81
	Brouwer, R., et al.	$21.77	$53.17
	Woodward, R., and Wui, Y.	$10.01	$4,289.38
Aesthetic and Recreational	Doss, C. R. and Taff, S. J.	$4,118.83	$4,984.78
	Kreutzwiser, R.	$195.28	$195.28
	Thibodeau, F. R. and Ostro, B. D.	$30.95	$645.51
	Whitehead, J. C.	$1,027.44	$2,065.76
	Dodds, W.K., et al.	$1,689.67	$1,689.67
	Allen, J. et al.	$111.78	$578.92
	Hayes, K. M., et al.	$1,804.08	$3,448.12
	Mahan, B.L.	$49.21	$49.21
	van Vuuren, W. and Roy, P.	$853.81	$853.81
	Wilson, S. J.	$47.36	$128.80
	Cooper J. and Loomis, J.	$327.16	$1,284.80
	Mahan, B. L., et al.	$37.44	$37.44
	Whitehead, J. C., et al.	$237.71	$237.71
	Woodward, R., and Wui, Y.	$1.67	$4,641.41
Gas and Climate Regulation	Dodds, W.K., et al.	$123.79	$123.79
	Wilson, S. J.	$4.85	$534.02
	Costanza, R., et al.	$176.30	$176.30
Habitat Refugium and Nursery	Pate, J. and Loomis, J.	$99.76	$317.15
	van Kooten, G. C. and Schmitz, A.	$5.82	$5.82
	Dodds, W.K., et al.	$179.38	$179.38
	Knowler, D. J. et al.	$10.91	$49.99
	Wilson, S. J.	$2,241.85	$2,241.85
	Woodward, R., and Wui, Y.	$158.50	$510.52
	Kazmierczak, R.F.	$273.67	$652.95
	Streiner, C., Loomis, J.	$274.09	$274.09