Spatial Valuation of Ecosystem Services in the Chicago Metropolitan Region, USA

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THE CONSERVATION FUND

Project Team

THE CONSERVATION FUND

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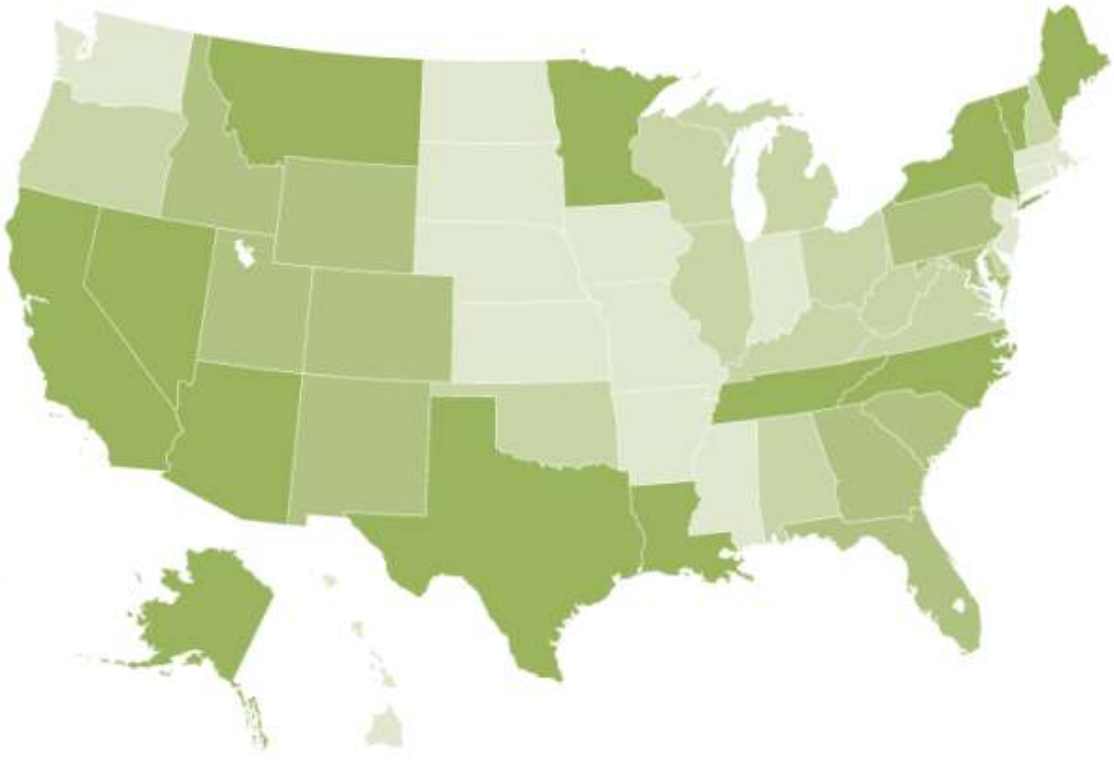
About The Conservation Fund

The Conservation Fund works at the intersection of conservation and community—we believe that environmental protection and economic vitality are inseparable.



Conservation Acquisition
Land, Water & Wildlife Protection

Mitigation Solutions
Infrastructure Mitigation

Conservation Leadership Network
Collaborative Solutions

Natural Capital Investment Fund
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Freshwater Institute
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Resourceful Communities
People, Places, Opportunities

Go Zero
Carbon & Climate

Strategic Conservation Planning
Green Infrastructure

Land Conservation Loans
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Working Forest Fund
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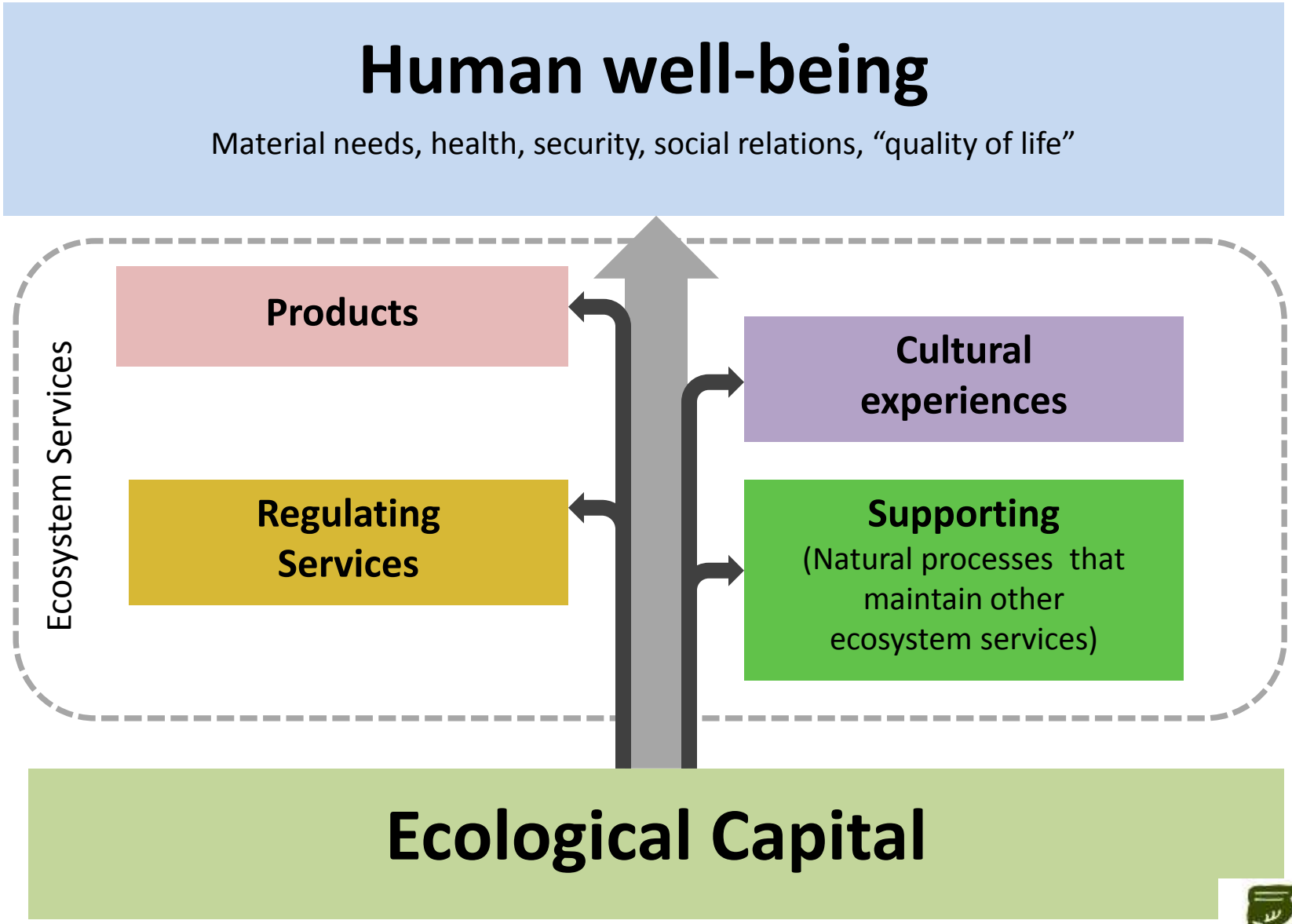
What are Ecosystem Services?



Adapted from 2010 Ecological Footprint Atlas

HOUSTON WILDERNESS

Chicago Wilderness Biodiversity Recovery Plan

Chapter 1

Executive Summary

Chicago Wilderness and Its Biodiversity Recovery Plan

1.1 Introduction

1.1.1 Chicago Wilderness: who we are, what we are accomplishing.

"Chicago Wilderness" refers to nature and to the people and institutions that protect it. Chicago Wilderness is 200,000 acres of protected conservation land—some of the largest and best surviving woodlands, wetlands, and prairies in the Midwest. It is also the much larger matrix of public and private lands of many kinds that support nature in the region along with the people who protect and live compatibly with it.

Many of the surviving natural communities of the Chicago region are of national and global significance for conservation. The region is blessed with both richness and opportunity for its conservation. Yet research indicates that we are experiencing a steady decline in both native species and communities. For example:

- In a review for this plan, the Chicago Wilderness Science and Land Management Teams found that more than half of the major community types of the region were at the highest level of conservation concern due either to the small amount remaining or to the poor ecological health of the remaining examples.
- A 1986 survey of DuPage County forest preserves revealed that 80% of its natural areas had declined to poor health (Applied Ecological Services 1993).

Figure 2.1 Ecosystem health and human activity

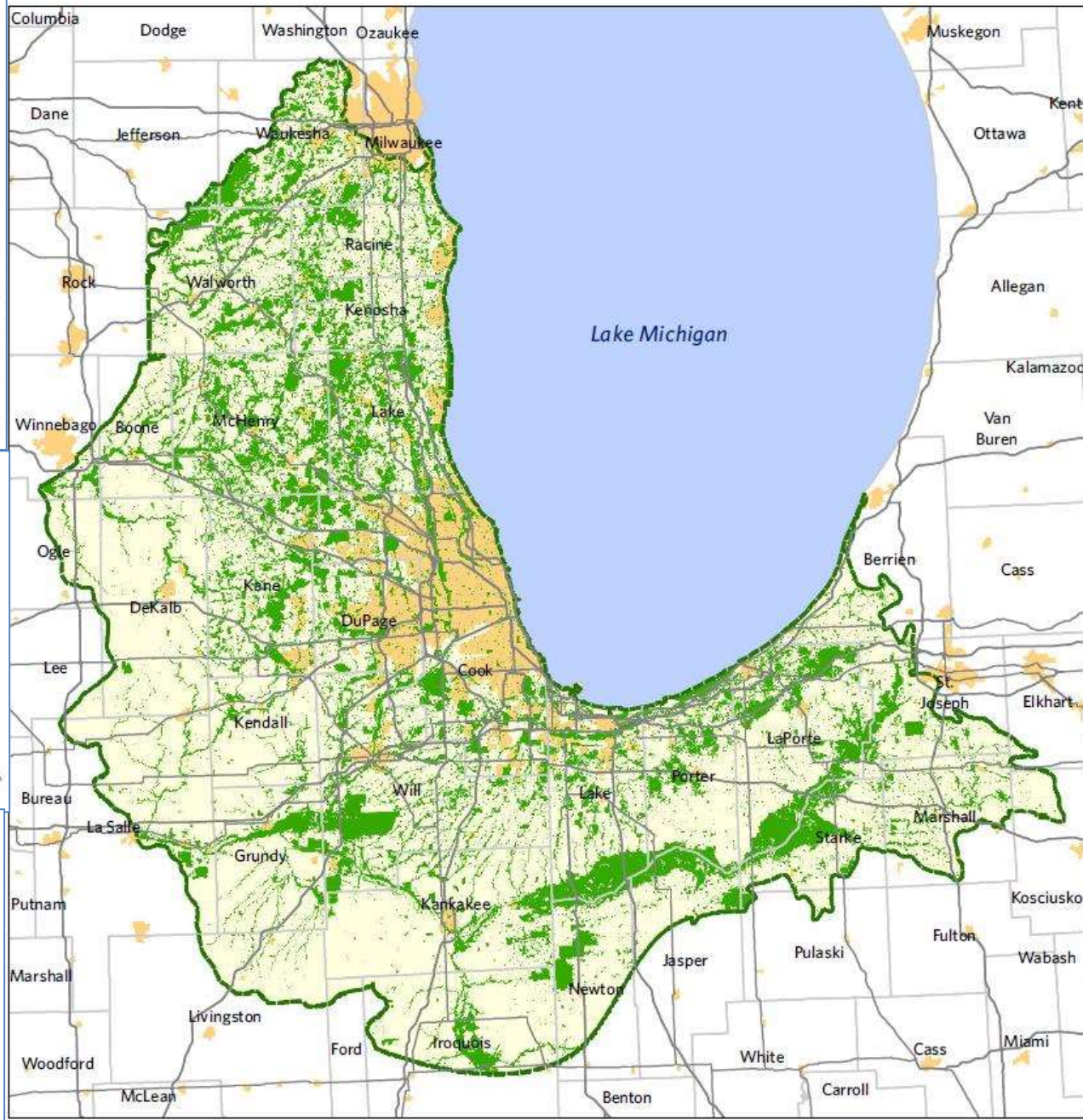
Chapter 8

Preserving Land and Water Resources for Biodiversity

8.1 Introduction

The previous chapters reviewed the types of natural communities found in the Chicago Wilderness area and the goals and actions needed to sustain them. As noted in Chapter 1, the natural areas of the region can be seen as

Ownership of natural areas in the Chicago Wilderness region is a mix of public and private. The core of Chicago Wilderness consists of public land permanently dedicated to the conservation of nature. However, as human use of the land intensifies, the choices made by private landowners become increasingly important. Land management by private owners can strongly affect the course of events in nearby public natural areas. Fortunately,



GREEN INFRASTRUCTURE VISION

VERSION 2.3 ECOSYSTEM SERVICE VALUATION

✓Given existing peer reviewed science, GIV Version 2.2 can help estimate the monetized social benefit of conservation in comparison with the investments required to protect land.

✓ Balmford et al. (2002) found that if the values of ecological services are considered, the benefits from conserving natural land gives a return on investment of at least 100 to 1.

✓GIV 2.3 will be useful in identifying the most strategic locations for CMAP and its partners to implement the land conservation goals of the GO TO 2040 metropolitan Chicago comprehensive regional plan.

Selecting ecosystem services to map

Ecosystem Service	Description
REGULATING & SUPPORTING	
Hazard Amelioration	
Water Flow Regulation / Flood Control	Maintain water flow stability and protect areas against flooding (e.g., from storms).
Water Purification	Maintain water quality sufficient for human consumption, recreational uses like swimming and fishing, and aquatic life.
Erosion Control and Sediment Retention	Maintain soil and slope stability, and retain soil and sediment on site.
Groundwater Recharge	Maintain natural rates of groundwater recharge and aquifer replenishment
Air Purification	Remove 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 and global climate change
Biological	
Support Native Flora and Fauna	Maintain species diversity and biomass
Pollination	Provide pollinators for crops and other vegetation important to humans
Pest and Disease Control	Provide biota which consume pests and control diseases
Provisioning	
Food Production	Production of plant or fungal-based food for human consumption
Game and Fish Production	Production of wild game and fish for human consumption
Fiber Production	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	Provision of biochemicals, natural medicines, pharmaceuticals, etc.
Genetic Information	Genetic resources for medical and other uses, including those not yet realized

Selecting ecosystem services to map

Ecosystem Service	Description
Cultural	
Recreation and Ecotourism	Outdoor, nature-based experiences like hiking, birding, hunting, camping, etc.
Savings in Community Services	Savings in community services from not converting natural land to houses
Increase in Property Values	Provide attractive location for homes and businesses
Science and Education	Existence of natural systems and areas for school excursions, advancement of scientific knowledge, etc.
Spiritual and Aesthetic	Aesthetic enjoyment or spiritual or religious fulfillment
Bequest value	The value placed on knowing that future generations will have the option to utilize the resource.
Existence value	The non-use value of simply knowing that particular resources exist, even if they are not used.

Valuation Methods

Avoided cost: Services allow society to avoid costs that would have been incurred in the absence of those services (e.g., natural flood control preventing property damages or natural waste treatment preventing health costs)

Replacement cost: Services could be replaced with man-made systems (e.g., natural waste treatment having to be replaced by costly engineered systems)

Factor income: Services provide for the enhancement of incomes (e.g., water quality increasing commercial fisheries catches and fishermen incomes)

Travel cost: Service demand may require travel, whose costs can reflect the implied value of the service (e.g., value of ecotourism or recreation is at least what a visitor is willing to pay to get there)

Hedonic pricing: Service demand may be reflected in the prices people will pay for associated goods (e.g., increase in housing prices due to water views or access to parks)

Contingent valuation: Service demand may be elicited by posing hypothetical scenarios that involve some valuation of alternatives (e.g., how much people are willing to pay for increased availability of fish or wildlife).

Metrics and valuation methods

Ecosystem Service	Metrics	Types of economic analyses
Water Flow Regulation / Flood Control	Reduction of flood damage, Reduction of stormwater flows, Reduction of peak discharges, Reduction of combined sewer system costs, Reduction of soil erosion	Avoided cost, Replacement cost
Water Purification	Reduction of N, P, Cl^-, sediment, bacteria, and other pollutants for drinking water, swimming, fishing, aquatic life, and other uses.	Avoided cost, Replacement cost
Groundwater Recharge	Supply of water to groundwater rather than surface runoff	Avoided cost, Replacement cost, Price of public water supply
Carbon Storage	Reduction of atmospheric CO_2 and associated climate effects	Avoided cost, Market price of carbon
Support Native Flora and Fauna	Protection of wildlife habitat Maintenance of ecosystem functions and resilience	Willingness to pay (contingent valuation)
Recreation and Ecotourism	Money spent on nature-based recreation (hunting, fishing, birding, hiking, etc.)	Surveys of money expended on nature-based recreation

Literature review

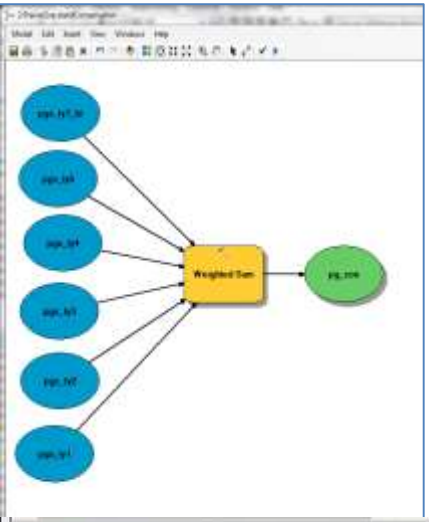
- A large tree can reduce 5,400 gallons of stormwater runoff per year.
- An acre of forest can avoid $21 per acre per year of stormwater treatment costs and over $9,000 per acre per year in gray infrastructure investment costs.
- An acre of wetlands can typically store 1-1.5 million gallons of floodwater.
- In Wisconsin, watersheds with 30% wetland or lake area had flood peaks 60-80% lower than watersheds with no wetland or lake area.
- Not building in floodplains could save an average $900 per acre per year in flood damages.

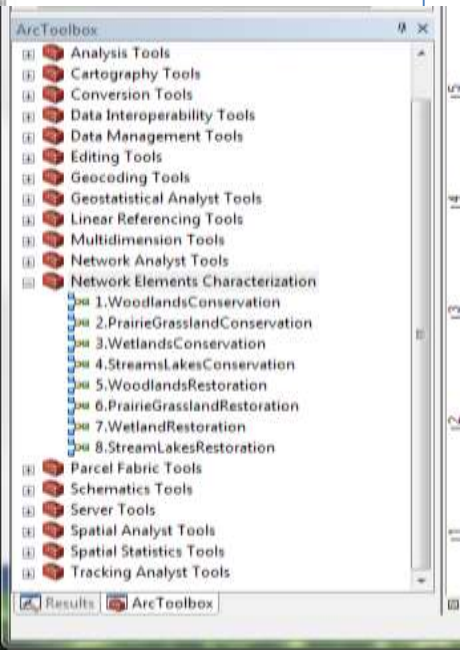
Assigning ecosystem service values to GIV

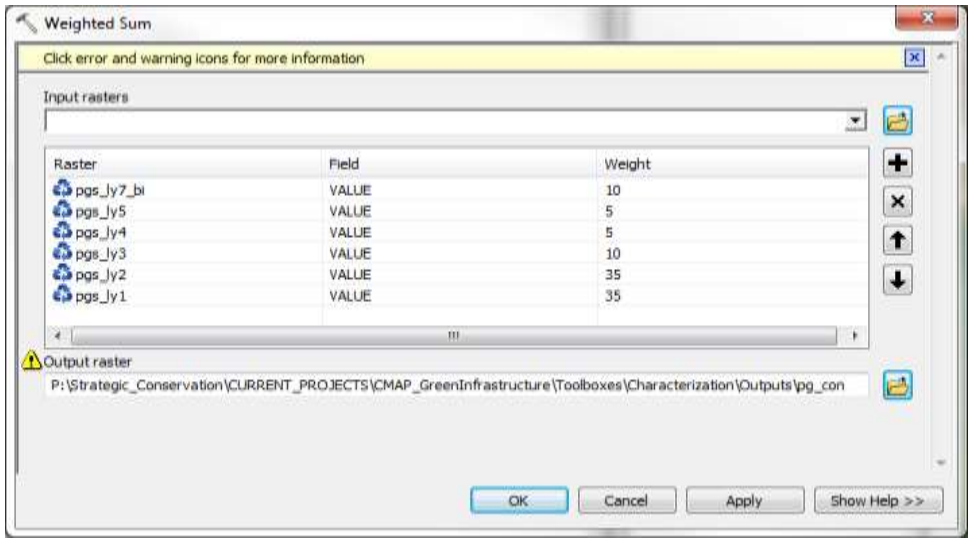
ECOSYSTEM SERVICE		LANDSCAPE TYPE			
		Woodlands / Forest	Prairie / Grassland / Savanna	Wetlands	Lakes/ Streams
Water Flow Regulation/ Flood control	Max.	$49,000	$13,900	$43,000	$31,740
	Median	$815	$6,951	$4,900	$900
	Min.	$11	$2	$1	$388
	# estimates	10	2	15	3
Water Purification	Max.	$1,300	$57	$79,800	
	Median	$1,025	$57	$3,429	
	Min.	$750	$57	$170	
	# estimates	2	1	12	N/A
Groundwater Recharge	Max.	$269		$37,120	$986
	Median	$269		$2,479	$669
	Min.	$269		$11	$38
	# estimates	1	0	14	5
Carbon Storage	Max.	$1,960	$184	$175	
	Median	$133	$82	$136	
	Min.	$32	$5	$100	
	# estimates	12	4	3	0
Support Native Flora and Fauna	Max.	$591		$14,819	$1,749
	Median	$535		$1,480	$20
	Min.	$319		$70	$1
	# estimates	3	0	7	3
Recreation and Ecotourism	Max.	$754	$1	$11,049	$23,284
	Median	$48	$1	$1,434	$2,229
	Min.	$6	$1	$37	$2
	# studies	13	1	15	8
TOTAL	Max.	$53,874	$14,142	$185,963	$57,760
	Median	$2,825	$7,091	$13,857	$3,818
	Min.	$1,387	$65	$389	$429

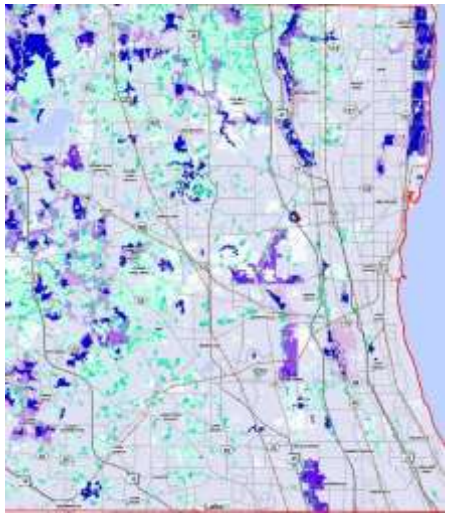
Technical Approach

Apply the ecosystem service values spatially on the map layers



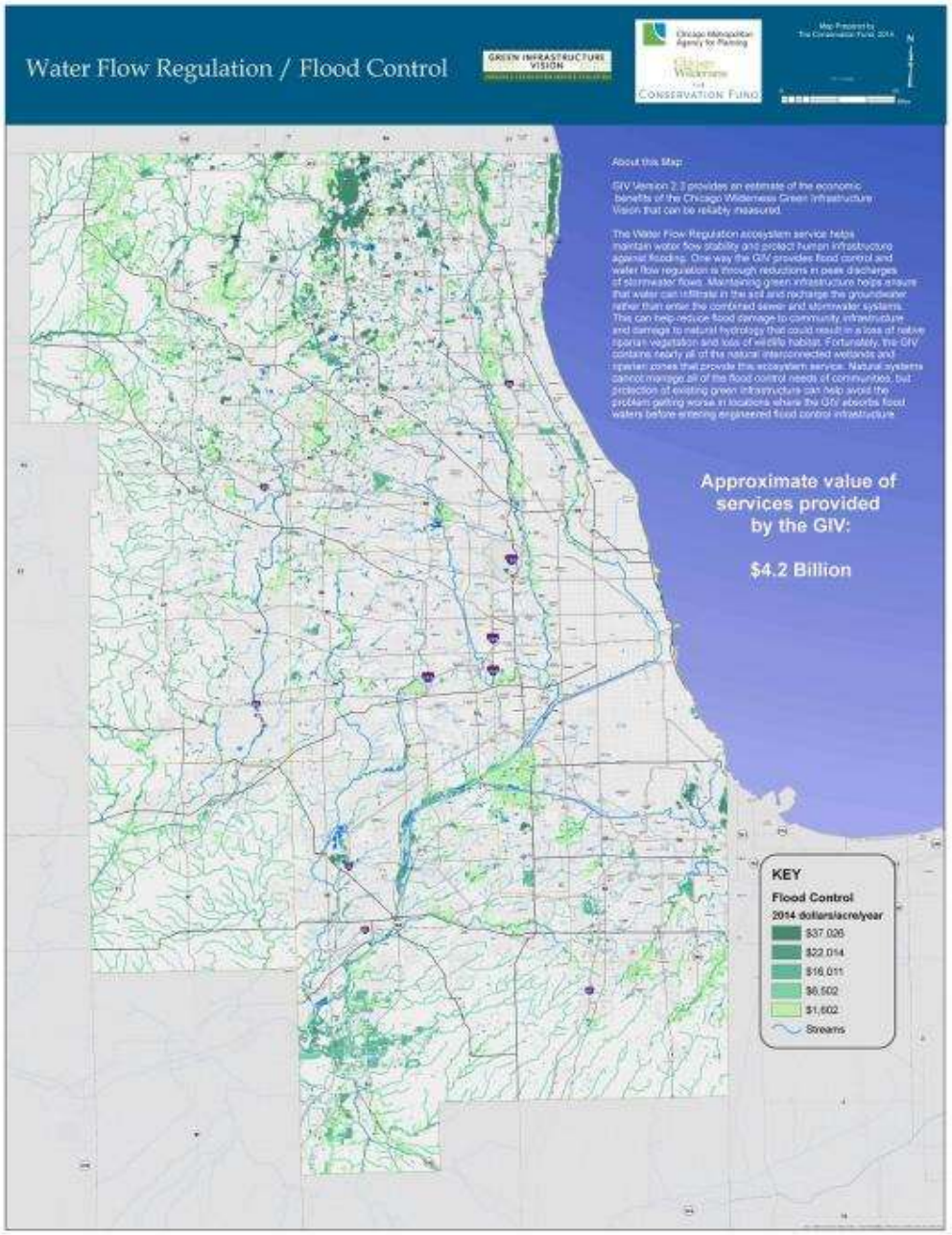






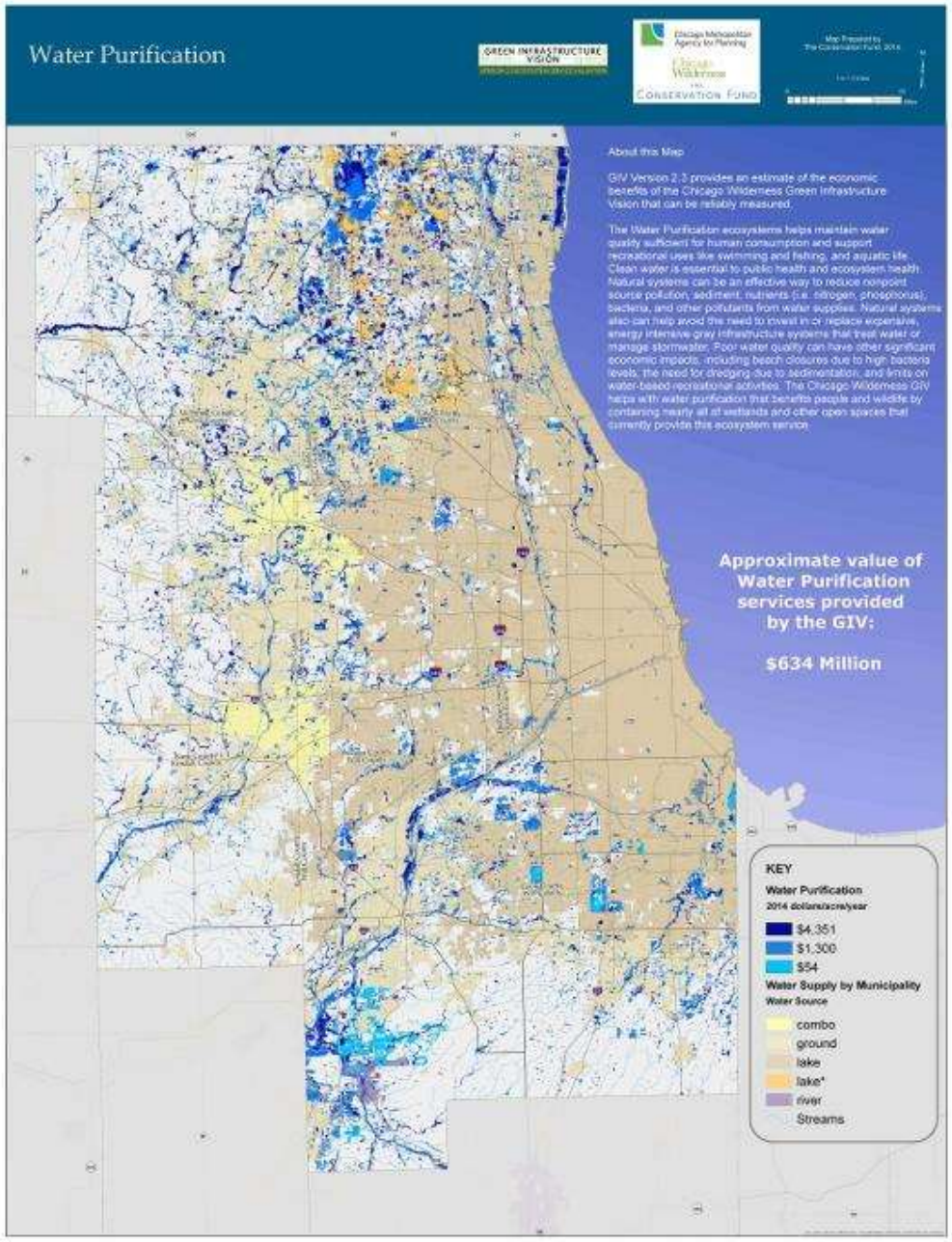
Water Flow Regulation / Flood control

	Median ($2014/ac)	Selected ($2014/ac)
Woodlands / Forest	$1,415	$1,603
Prairie / Grassland / Savanna	$16,000	$16,000
Wetlands	$4,900	$22,000
Natural Floodplains	$3,700	$6,500
Lakes	$43,000	$37,000



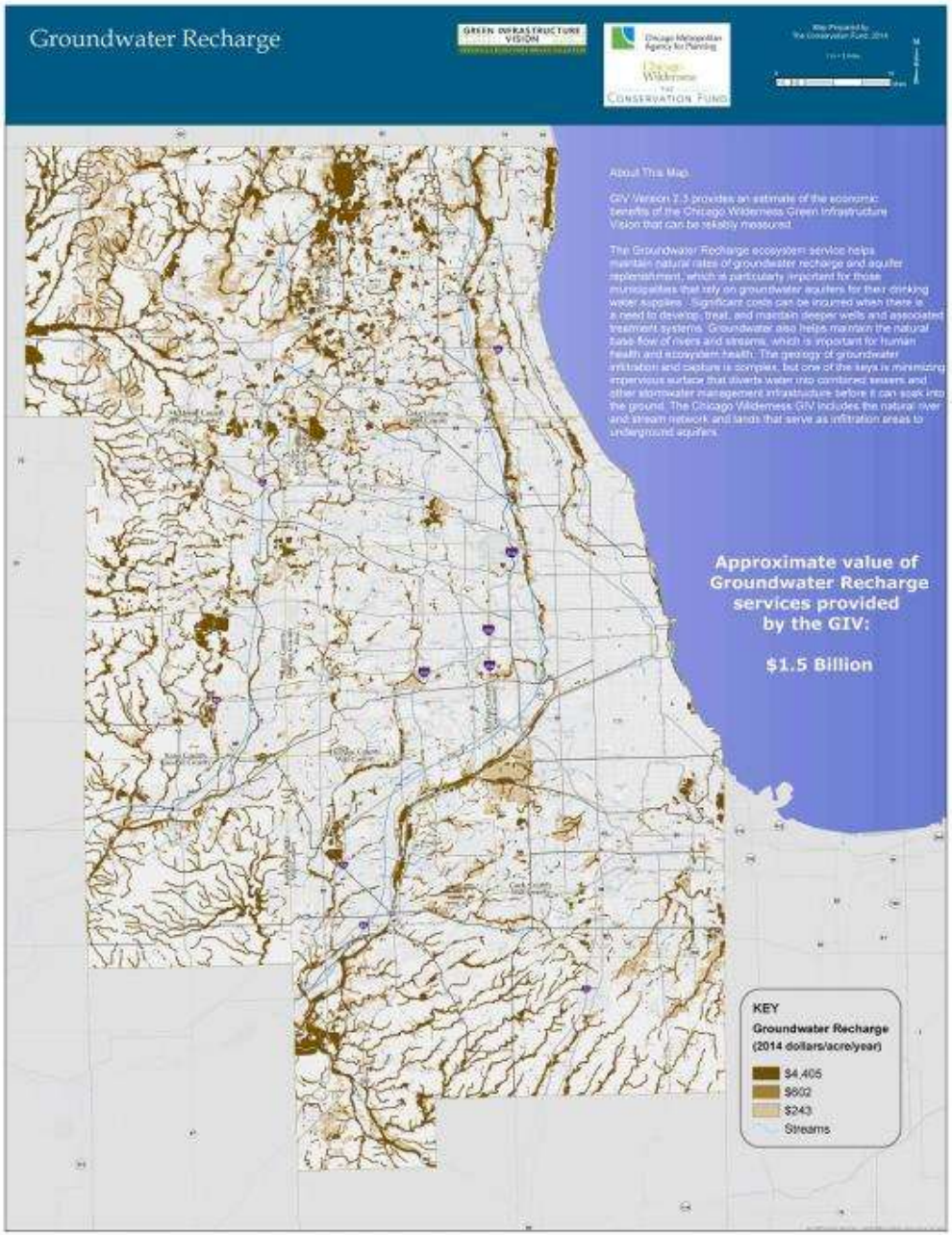
Water Purification

	Median ($2014/ac)	Selected ($2014/ac)
Woodlands / Forest	$1,060	$1,300
Prairie / Grassland / Savanna	$57	$57
Wetlands	$3,429	$4,350



Groundwater Recharge

	Median ($2014/ac)	Selected ($2014/ac)
Woodlands / Forest	$269	$269
Prairie / Grassland / Savanna	$269	$269
Wetlands	$2,479	$660
Natural Floodplains	$4,806	$4,806
Lakes	$566	$566



Carbon Storage

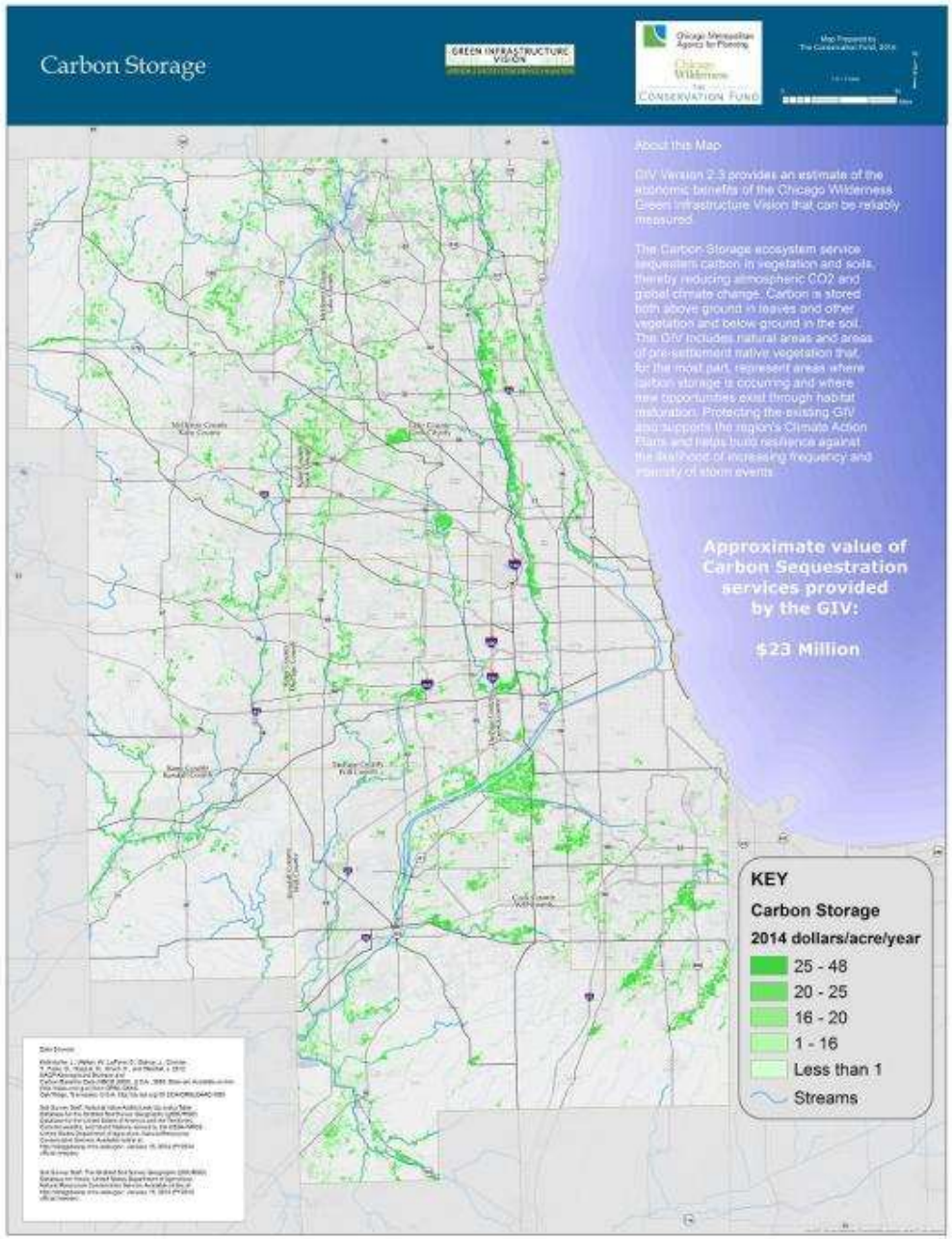
The carbon storage value per grid cell = (**C**above + **C**below) * $2/tonne/year

Cabove = Aboveground carbon storage (dry weight biomass * 0.5) from NBCD

Cbelow = Belowground carbon storage from gSSURGO

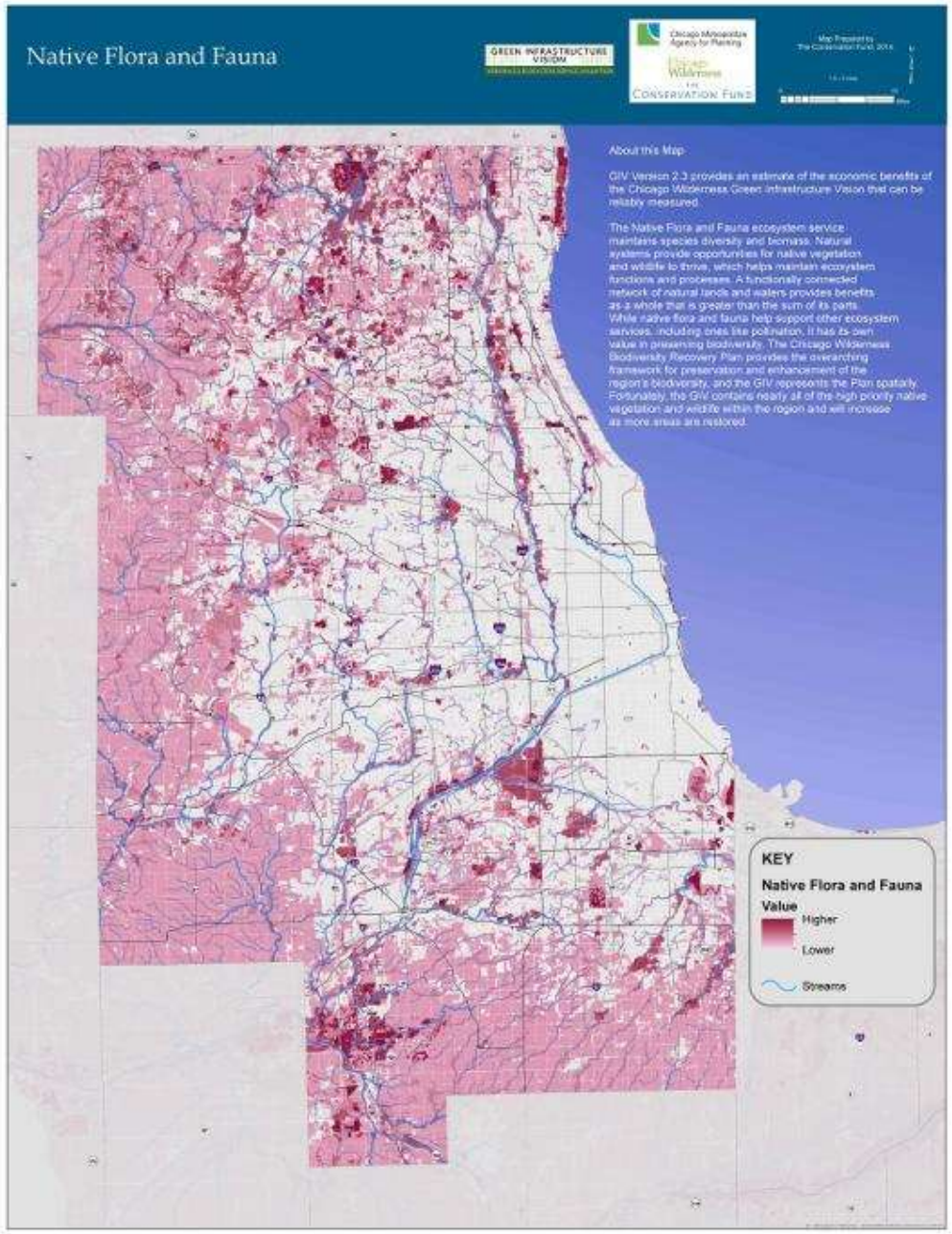
$2/tonne/year was estimated avoided future damage from the carbon being sequestered in vegetation and soil instead of in the atmosphere.

This is a snapshot in time. In the absence of disturbance, carbon storage will increase over time as forests and prairie reach maturity. Disturbances, especially fire, will release some of this carbon (primarily from the aboveground stock) into the atmosphere.

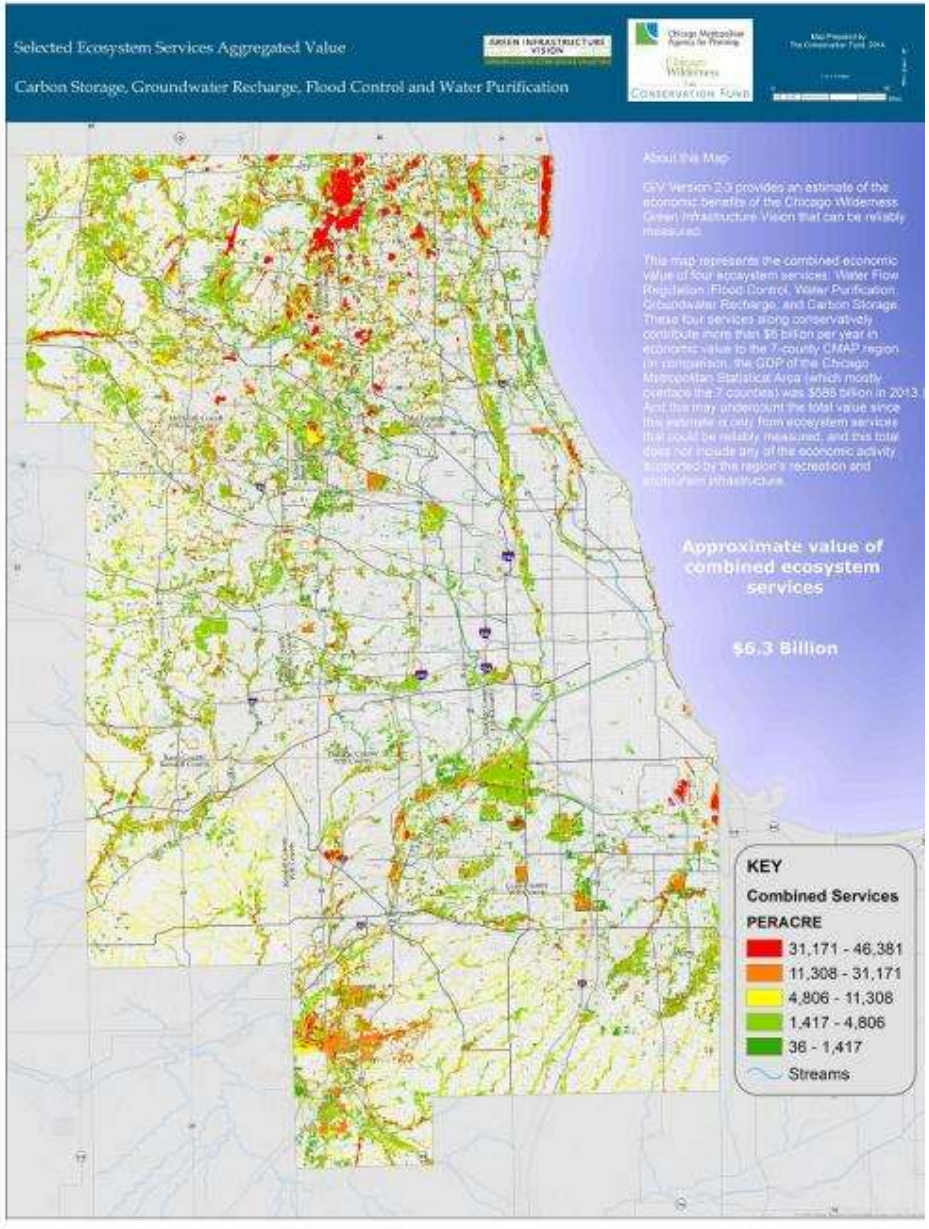


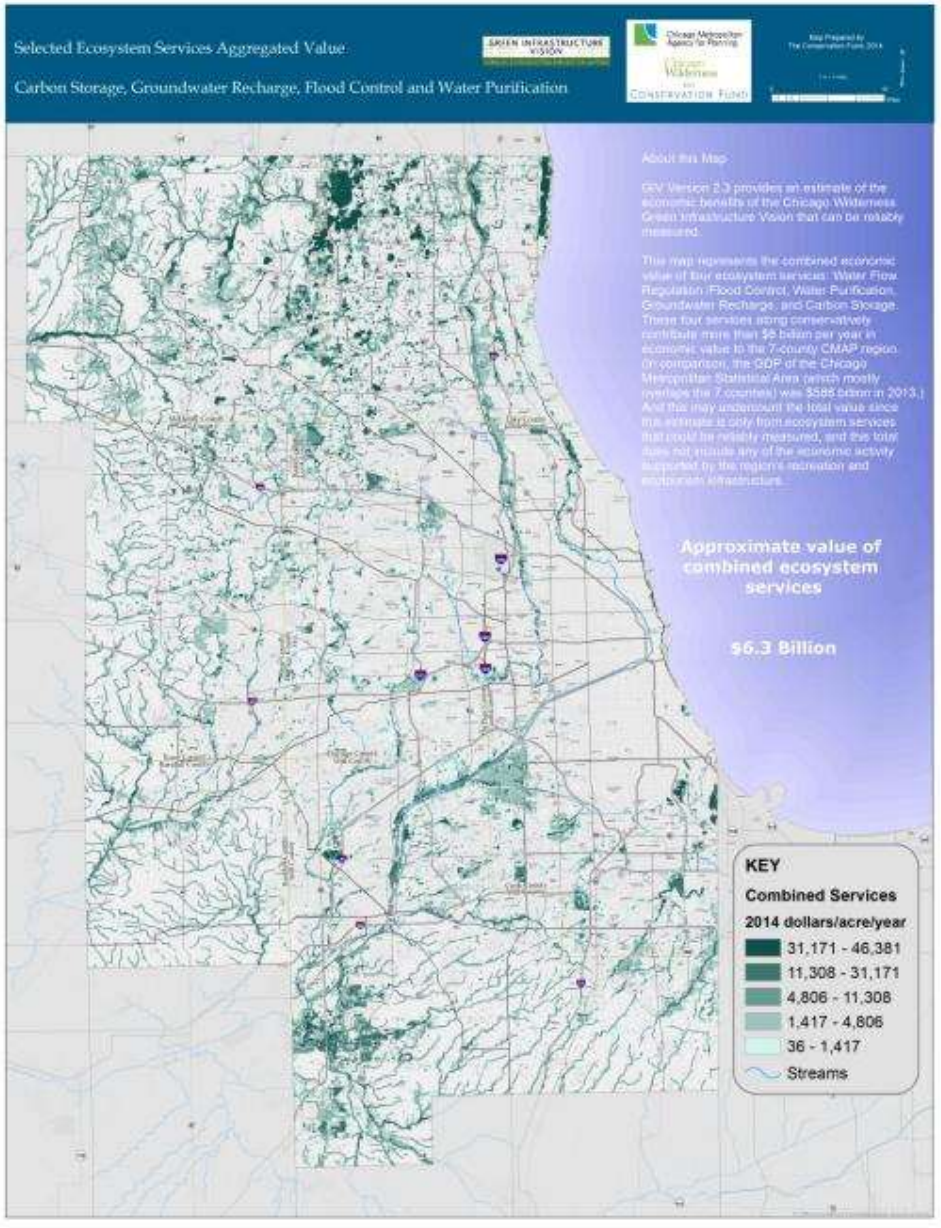
Native Flora and Fauna

Landscape feature	Value
Designated habitat (INAI, etc.), confirmed in field as important to biodiversity	10
Other core areas	5
Other functional connections (e.g., corridors)	3
Restoration building blocks	2



Combined value of Four Services





Action steps to maintain and enhance this service identified by workshop participants

Programs, Policies, and Projects

- ✓ Prioritize program strategies based on whether drinking water supply is coming from groundwater, rivers, or Lake Michigan.
- ✓ Explore dam removal on rivers for water quality improvements and fish passage (e.g. Fox River study group, Des Plaines River)
- ✓ Implement large scale tributary restoration and wetlands protection.
- ✓ Develop education program for landowners and land managers on strategies to reduce pollution from their properties.
- ✓ Construct wetlands, bioswales, and rain gardens in urban areas.
- ✓ Re-meander streams and restoring natural stream flow in rural areas.
- ✓ Reduce agricultural pollution, including nutrients that eventually travel to the Gulf of Mexico hypoxic zone.
- ✓ Develop incentives for nutrient reduction on agricultural lands that supplement existing best management practices and USDA cost share programs.
- ✓ Highlight how protection and enhancement of the GIV can serve as key elements of a compliance strategy that minimizes gray infrastructure investment costs. The Clean Water Act (CWA) and Total Maximum Daily Load (TMDL) program provide the framework to protect water quality through setting specific targets to be attained.
- ✓ Strengthen standards for nutrient reduction in agricultural and urban runoff.
- ✓ Incorporate pollution reduction into municipal Comprehensive Plans.

Water Flow Regulation / Flood control

	Median ($2014/ ac)	Selected ($2014/ ac)
Woodlands / Forest	$1,415	$1,603
Prairie / Grassland / Savanna	$16,000	$16,000
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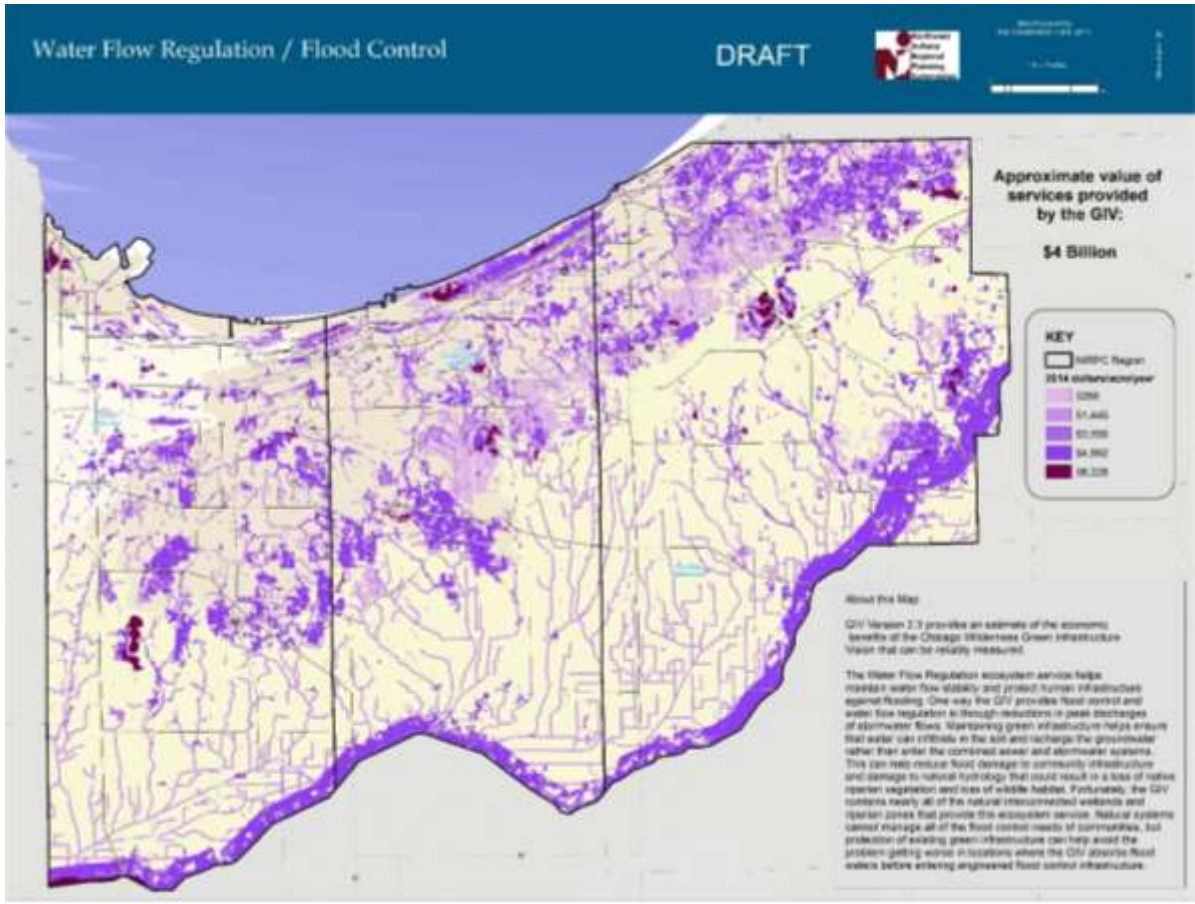


Lake County Ecosystem Service Valuation Maps

- Water Flow Regulation / Flood Control

- $1.85 billion per year

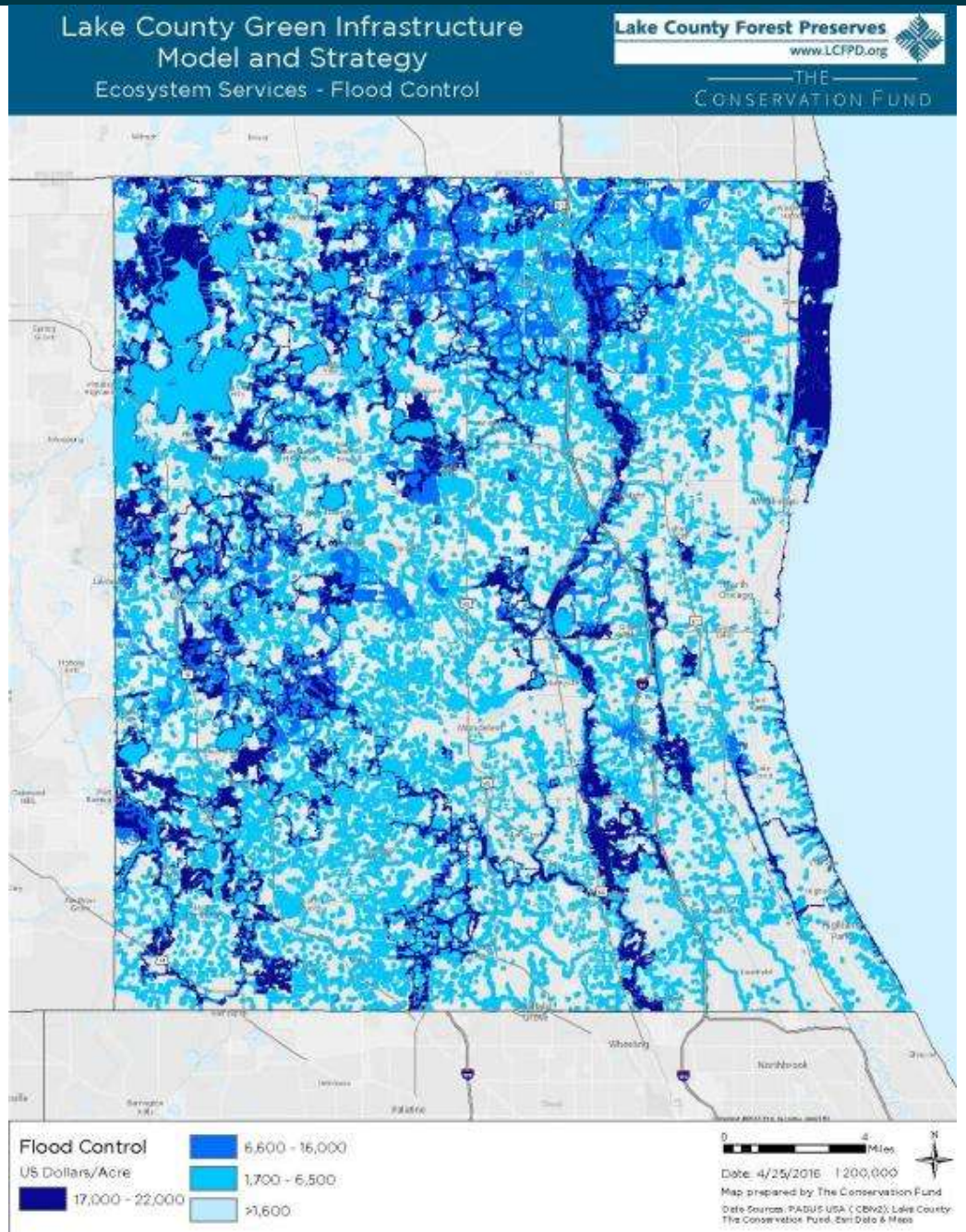
The Water Flow Regulation ecosystem service helps maintain water flow stability and protect human infrastructure against flooding.

One way is through reductions in peak discharges of stormwater flows.

Maintaining green infrastructure helps ensure that water can infiltrate in the soil and recharge the groundwater rather than enter the combined sewer and stormwater systems.

This can help reduce flood damage to community infrastructure and damage to natural hydrology that could result in a loss of native riparian vegetation and loss of wildlife habitat.

Natural systems cannot manage all of the flood control needs of communities, but protection of existing green infrastructure can help avoid the problem getting worse in locations where the network absorbs flood waters before entering engineered flood control infrastructure.



Ecosystem Service Valuation by GIV Landscape Type

Estimated recreation economic value per park in Lake County, IL. - Examples

Preserve	Annual Visitors	Est. direct spending	Est. secondary effects	Est. consumer surplus	Est. total recreation value
Almond Marsh	5,689	$170,670	$99,159	$287,465	$557,294
Berkeley Prairie	2,346	$70,380	$40,891	$118,543	$229,814
Black Crown	200	$6,000	$3,486	$10,106	$19,592
Bluebird Meadow	200	$6,000	$3,486	$10,106	$19,592
Brae Loch Golf Club	21,876	$656,280	$381,299	$1,105,394	$2,142,973
Buffalo Creek	129,402	$3,882,060	$2,255,477	$6,538,683	$12,676,220
Cahokia Flatwoods	367,324	$11,019,720	$6,402,457	$18,560,882	$35,983,059
Cptn Daniel Wright Woods	568,126	$17,043,780	$9,902,436	$28,707,407	$55,653,623
Many others…	----------	----------	----------	----------	----------
TOTAL	**8,287,195**	**$248,615,850**	**$144,445,809**	**$418,751,963**	**$811,813,622**

Estimated recreation economic value per state park in Lake County, IL.

Preserve	Annual Visitors	Est. direct spending	Est. secondary effects	Est. consumer surplus	Est. total recreation value
Chain "O" Lakes State Park	502,186	$15,065,580	$8,753,102	$25,375,459	$49,194,141
Volo Bog	95,544	$2,866,320	$1,665,332	$4,827,838	$9,359,490
Illinois Beach State Park	1,061,061	$31,831,830	$18,494,293	$53,615,412	$103,941,536
Moraine Hills State Park	615,298	$18,458,940	$10,724,644	$31,091,008	$60,274,592
North Point Marina	834,055	$25,021,650	$14,537,579	$42,144,799	$81,704,028
TOTAL	**3,108,144**	**$93,244,320**	**$54,174,950**	**$157,054,516**	**$304,473,786**

Estimated recreation economic value per bike trail in Lake County, IL.

Preserve	Annual Visitors	Est. direct spending	Est. secondary effects	Est. consumer surplus	Est. total recreation value
Northshore Bike Path	73,730	$1,548,330	$908,870	$6,817,076	$9,274,276
McClory Bike Path	75,214	$1,579,494	$927,163	$6,954,286	$9,460,943
Skokie River Bike Path	142,228	$2,986,788	$1,753,245	$13,150,401	$17,890,433
TOTAL	**291,172**	**$6,114,612**	**$3,589,277**	**$26,921,763**	**$36,625,652**

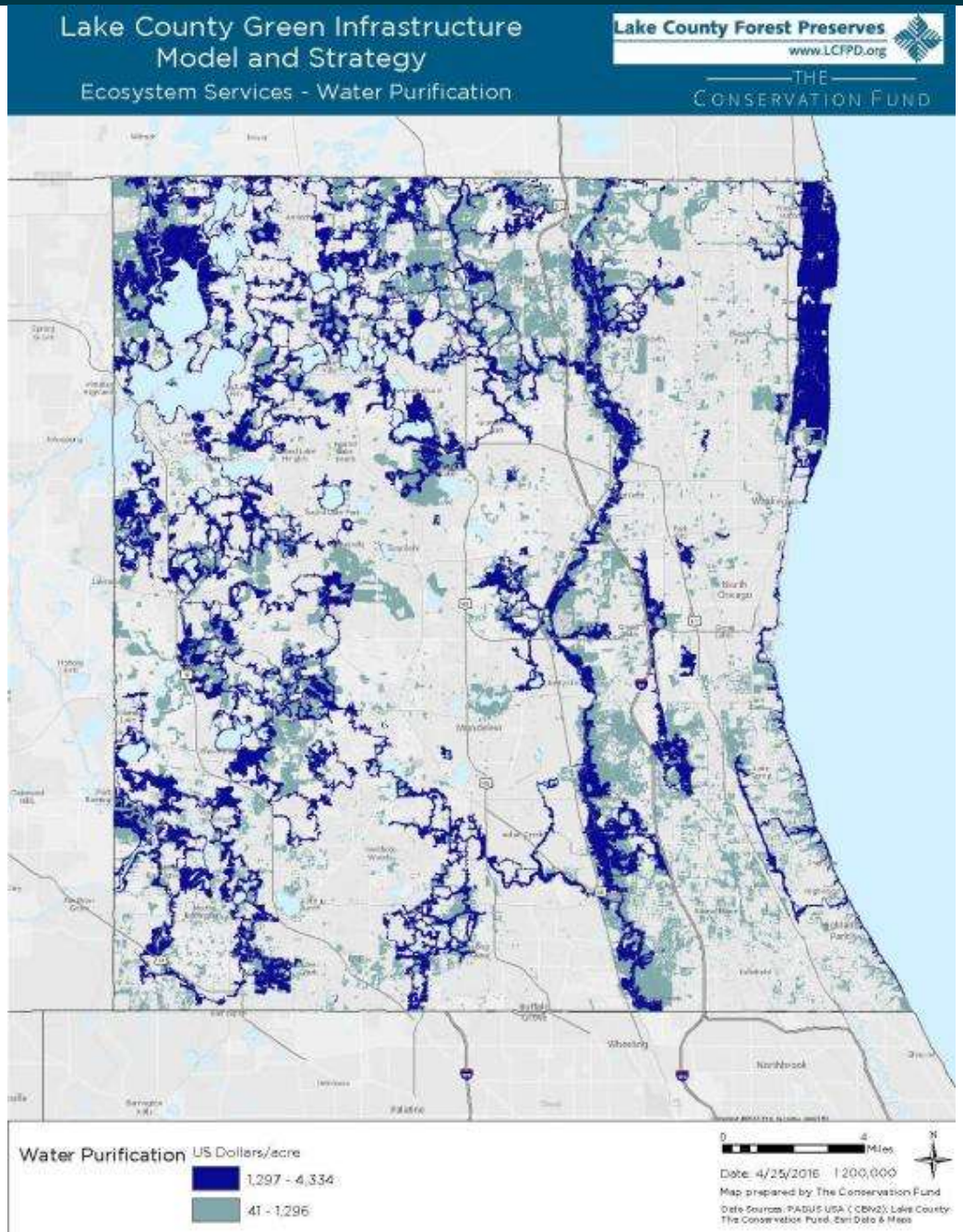
Lake County Ecosystem Service Valuation Maps

- Water Purification
- $210 million per year

Clean water is essential to public health and ecosystem health. Natural systems can be an effective way to reduce nonpoint source pollution, sediment, nutrients (i.e. nitrogen, phosphorus), bacteria, and other pollutants from water supplies.

Natural systems also can help avoid the need to invest in or replace expensive, energy intensive gray infrastructure systems that treat water or manage stormwater.

Lake County's Green Infrastructure helps with water purification that benefits people and wildlife by containing nearly all of wetlands and other open spaces that currently provide this ecosystem service.



Lake County Ecosystem Service Valuation Maps

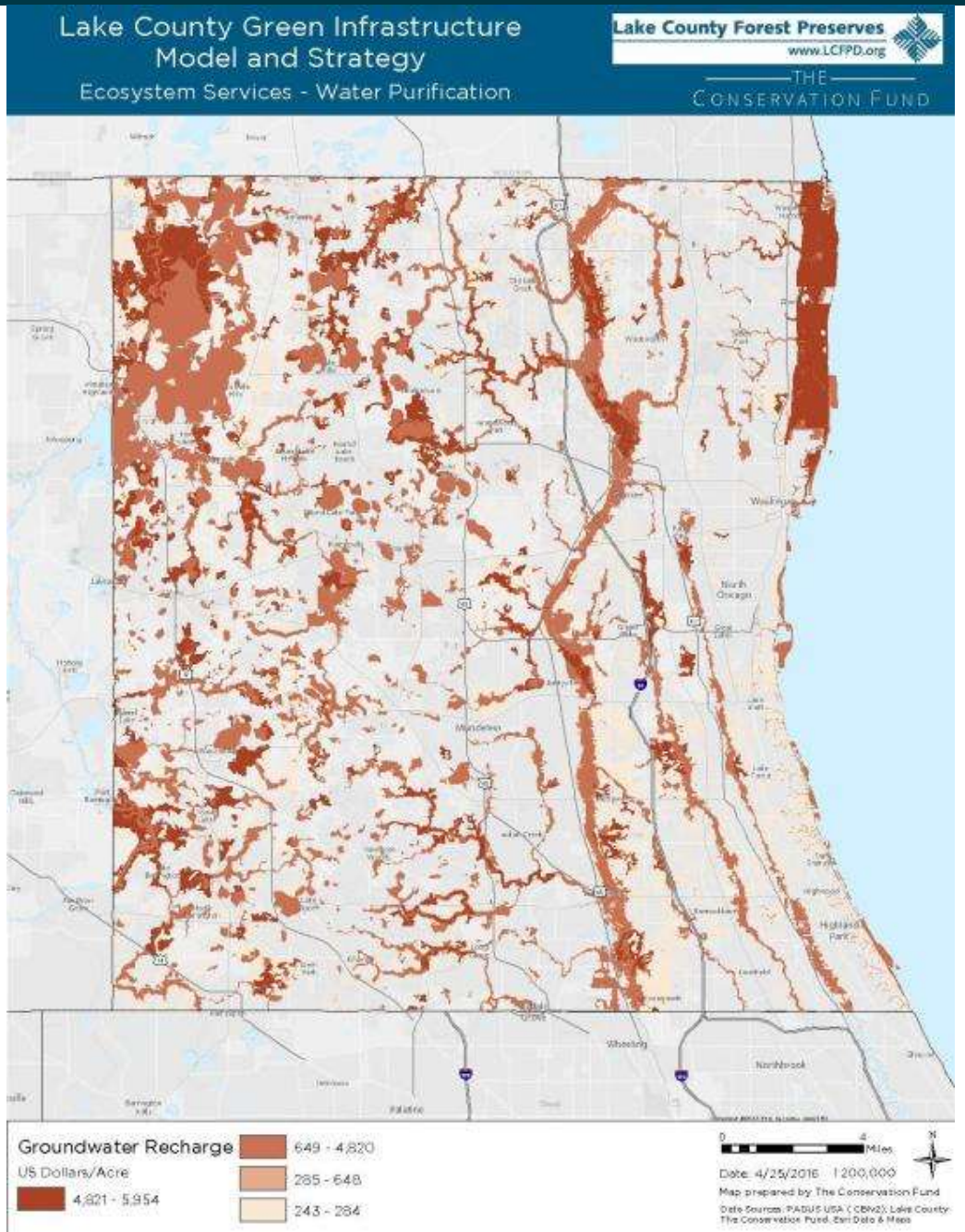
- Groundwater Recharge
- $344 million per year

The Groundwater Recharge ecosystem service helps maintain natural rates of groundwater recharge and aquifer replenishment, which is particularly important for those municipalities that rely on groundwater aquifers for their drinking water supplies.

Significant costs can be incurred when there is a need to develop, treat, and maintain deeper wells and associated treatment systems.

Groundwater also helps maintain the natural base flow of rivers and streams, which is important for human health and ecosystem health.

The geology of groundwater infiltration and capture is complex, but one of the keys is minimizing impervious surface that diverts water into combined sewers and other stormwater management infrastructure before it can soak into the ground.



Lake County Ecosystem Service Valuation Maps

- Carbon Storage (based on 30-meter resolution Woods Hole Research Center data, above and below ground carbon)
- $2.2 million per year (GIV network only)
- $4.1 million (countywide)

The Carbon Storage ecosystem service sequesters carbon in vegetation and soils, thereby reducing atmospheric CO_2 and global climate change. Carbon is stored both above ground in leaves and other vegetation and below ground in the soil.

Protecting the existing green infrastructure network supports the region's Climate Action Plans and helps build resilience against the likelihood of increasing frequency and intensity of storm events.