GREEN INFRASTRUCTURE VISION

VERSION 2.3 ECOSYSTEM SERVICE VALUATION

FOR VALUATION OF ECOSYSTEM SERVICES PROVIDED BY THE NATURAL RESOURCES INCLUDED IN THE CHICAGO WILDERNESS GREEN INFRASTRUCTURE VISION

Final Report

Prepared by The Conservation Fund

Will Allen, Ted Weber, Jazmin Varela, CMAP Technical Committee
November 2014

Prepared for the Chicago Metropolitan Agency for Planning
CMAP CONTRACT #C-14-0041

Point of Contact:
Will Allen
Director of Strategic Conservation Planning
The Conservation Fund
410 Market Street, Suite 360
Chapel Hill, NC, 27516

Phone: 919-967-2248
wallen@conservationfund.org
http://www.conservationfund.org/strategic-conservation

FINAL REPORT - TABLE OF CONTENTS

Executive Summary……..2

1. GIV 2.3 Project Summary……3

   - What are Ecosystem Services?
   - What is Green Infrastructure?
   - What is the Chicago Wilderness Green Infrastructure Vision?
   - What is GIV 2.3?
   - How does GIV 2.3 support land use planning and decision making?
   - GIV 2.3 Technical Products

2. Ecosystem Services in the Chicago Wilderness Region……..7

   - Comprehensive List
   - Valuation Methods
   - GIV Landscapes
   - Ecosystem Service Value Estimates

3. GIS Layers and Models for GIV Ecosystem Services……13

   - Water Flow Regulation / Flood Control
   - Water Purification
   - Groundwater Recharge
   - Carbon Storage
   - Map of Four Combined Services
   - Native Flora and Fauna
   - Recreation and Ecotourism

Appendices (Under separate cover)

List of Figures

1 – Ecosystem services and their relationship to ecology and human well being
2 – Green infrastructure at multiple geographic scales

List of Tables

1 – Ecosystem services mapped for Chicago Wilderness GIV 2.3
2 – Comprehensive list of ecosystem services and descriptions
3 – Ecosystem services metrics and economic analyses
4 – GIV layers used in ecosystem service valuation estimates
5 – Ecosystem service valuation estimates used on maps
6 – GIV layers and model references for ecosystem service valuation

EXECUTIVE SUMMARY

Ecosystem services are the collective benefits from an array of resources and processes that are supplied by nature. Forests, wetlands, prairies, water bodies, and other natural ecosystems support our existence. Green infrastructure is the interconnected network of forests, wetlands, waterways, grasslands, and other natural areas that support native species, maintain natural ecological resources and processes, and contribute heavily to human health and quality of life. Since 2004, the Chicago Wilderness Green Infrastructure Vision has served as a visual representation of the Chicago Wilderness Biodiversity Recovery Plan, but it also served as a spatial representation of the region's ecosystem services. Only recently has it become possible to reliably estimate the contributions the GIV makes to human well being and to measure the benefits that nature provides us for free.

This project constitutes a new release of the GIV – Version 2.3. GIV 2.3 now includes an extensive review and visualization of ecosystem service values for six services within the CMAP 7-county region: water flow regulation/flood control, water purification, groundwater recharge, carbon storage, native flora and fauna, and recreation and ecotourism. In addition, three additional services were researched but did not have sufficient information to support visualization at the CMAP regional scale: air purification, microclimate moderation, and increases in property values.

According to analysis completed for this project, natural ecosystems contribute well more than $6 billion per year in economic value to the 7-county CMAP region. In comparison, the GDP of the Chicago Metropolitan Statistical Area (which mostly overlaps the 7 counties) was $586 billion in 2013. And this may undercount the total value since this estimate is only from ecosystem services that could be reliably measured, and this total does not include any of the economic activity supported by the region's recreation and ecotourism infrastructure.

The Chicago Wilderness GIV is being used every day by planners and decision makers at the local, state, regional, and federal levels to guide existing planning efforts and evaluate conservation and restoration opportunities that support preserving and managing the GIV network. With the release of Version 2.3, the GIV can help identify 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. Specifically, GIV 2.3 will provide an estimate of return on investment for conservation capital in different locations within the CMAP service area. It is also important to note that the GIV 2.3 is a land-based network and does not take into account the ecosystem services provided by Lake Michigan. The shoreline, near shore submerged habitat, and the lake itself have abundant ecosystem service values for recreation and ecotourism, native flora and fauna, and, to some extent, carbon storage.

A recent study 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. Using the GIV 2.3 to estimate the monetized social benefit of conservation in comparison with the investments required to protect land is a scientifically valid and valuable product that will lead to increased awareness of decision makers and the general public regarding the importance and contribution of green infrastructure to the region's quality of life as well as a greater understanding of the relationship between the built environment and the region's ecological capital.

The final deliverables for the GIV 2.3 project include an extensive literature review of ecosystem services as well as GIS layers and models that facilitate ecosystem service valuation to be updated over time as new data and scientific literature become available.

1. GIV 2.3 PROJECT SUMMARY

What are Ecosystem Services?

Ecosystem services are the collective benefits from an array of resources and processes that are supplied by nature. Forests, wetlands, prairies, water bodies, and other natural ecosystems support our existence. They provide services like cleaning the air, filtering and cooling water, storing and cycling nutrients, conserving and generating soils, pollinating crops and other plants, regulating climate, sequestering carbon, protecting areas against storm and flood damage, and maintaining hydrology and water supplies. These resources also provide marketable goods and services like forest products, fish and wildlife, and recreation. They serve as vital habitat for wild species, maintain a vast genetic library, provide scenery, and contribute in many ways to human health and quality of life.

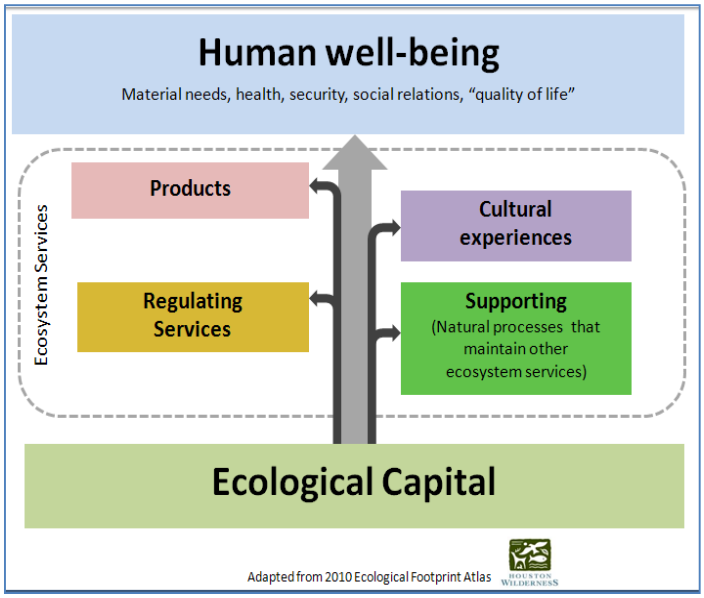


Figure 1. Ecosystem services and their relationship to ecology and human well being. Source: Houston Wilderness

What is Green Infrastructure?

Figure 2. Green infrastructure at multiple geographic scales. Source: The Conservation Fund

Green infrastructure is our natural life support system. At the landscape level, it is an interconnected network of forests, wetlands, waterways, grasslands, and other natural areas that support native species, maintain natural ecological resources and processes, and contribute heavily to human health and quality of life. At the regional scale, green space can help protect water quality and help ensure the availability of drinking water. Green infrastructure can also provide key recreational areas that link people to natural lands and facilitate the use of transportation modes other than automobiles to reach key community assets. At the site scale, green infrastructure enhances communities through environmentally-sensitive site design techniques, urban forestry, and stormwater management systems that

reduce the environmental impact of urban settlements. A recognized and delineated green infrastructure network serves as a shared vision that can lead to collaborative efforts. It can provide a systematic and strategic approach to land conservation and restoration, encouraging land use planning and practices that are beneficial to nature and people.

What is the Chicago Wilderness Green Infrastructure Vision?

In 2004, the Northeastern Illinois Planning Commission completed a Green Infrastructure Vision (GIV 1.0) for the Chicago Wilderness region to serve as a visual representation of the Chicago Wilderness Biodiversity Recovery Plan. This product included a map that identified large Resource Protection Areas (RPAs) and recommended protection approaches for each, including additional land preservation and ecological restoration. The second generation GIV, completed in 2012 and currently in version 2.2, is a refinement that is more spatially explicit in classifying and characterizing important resources in a consistent and analytically robust manner. Its primary products are GIS datasets that describe and characterize the regional green infrastructure network. According to the 2004 Chicago Wilderness report, the GIV gives "a high priority… to identifying and preserving important but unprotected natural communities, especially those threatened by development, and to protecting areas that can function as large blocks of natural habitat though restoration and management".

What is GIV 2.3?

This project constitutes a new release of the GIV – Version 2.3. GIV 2.3 now includes an extensive review and visualization of ecosystem service values for six services within the CMAP 7-county region: water flow regulation/flood control, water purification, groundwater recharge, carbon storage, native flora and fauna, and recreation and ecotourism. In addition, three additional services were researched but did not have sufficient information to support visualization at the CMAP regional scale: air purification, microclimate moderation, and increases in property values.

How does GIV 2.3 support land use planning and decision making?

The Chicago Wilderness GIV is being used every day by planners and decision makers at the local, state, regional, and federal levels to guide existing planning efforts and evaluate conservation and restoration opportunities that support preserving and managing the GIV network. Green infrastructure is protected, enhanced, and restored through the work of many different kinds of organizations, including forest preserve and conservation districts, the state and federal governments, park districts, and non-profit and for-profit organizations, among others. The GIV is used to target conservation investments, such as land purchases or restoration. It is also used to help shape future growth, minimizing loss of green infrastructure as the region grows and develops.

With the release of Version 2.3, the GIV can help identify 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. Specifically, GIV 2.3 will provide an estimate of return on investment for conservation capital in different locations within the CMAP service area. It is also important to note that the GIV 2.3 is a land-based network and does not take into account the ecosystem services provided by Lake Michigan. The shoreline, near shore submerged habitat, and the lake itself have abundant ecosystem service values for recreation and ecotourism, native flora and fauna, and, to some extent, carbon storage.

A recent study 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. Using the GIV 2.3 to estimate the monetized social benefit of conservation in comparison with the investments required to protect land is a scientifically valid and valuable product that will lead to increased awareness of decision makers and the general public regarding the importance and contribution of green infrastructure to the region's quality of life as well as a greater understanding of the relationship between the built environment and the region's ecological capital.

Local governments are responsible for planning and permitting development. The most important way to help ensure that local development is balanced with the protection of critical green infrastructure is for local governments to use the GIV 2.3 data in developing their comprehensive plans. These plans guide local growth patterns and typically include an open space component that can be enhanced by also including the GIV data. Local governments should also consider implementation strategies for ensuring that the regional green infrastructure network is legally protected from future disturbance, which could include such measures as an overlay ordinance for green infrastructure protection, a conservation design ordinance that permits higher densities in exchange for protecting sensitive areas, or land donation requirements for green infrastructure areas, among many options. A similar balancing approach is being done at the regional level. One of the goals of GO TO 2040 is to help make sure that gray infrastructure expansion does not come at the expense of the green infrastructure network.

As most ecosystem services do not have established markets, it is challenging to make such estimates without providing detailed information on a variety of assumptions and caveats. The estimates developed for this project are estimates only and will only reflect a portion of the economic benefits of ecological capital. We have attempted to report a range of values for a particular ecosystem service, particularly since aggregate estimates over larger areas are more reliable than parcel level estimates. But even if the estimates change over the time, the key message from this project is that the Chicago Wilderness GIV has economic benefits that can be measured and should be evaluated accordingly in land use planning and decision making across the region.

GIV 2.3 Technical Products

The final deliverables for the GIV 2.3 project include an extensive literature review of ecosystem services as well as GIS layers and models that facilitate ecosystem service valuation to be updated over time as new data and scientific literature become available. The development of the literature review and GIS layers was guided by feedback and input from a Technical Committee, and participants of a half-day workshop held on August 18, 2014. The workshop attendees consisted of Chicago Wilderness members and other key stakeholders in the CMAP region. [Please see the appendices for the Technical Committee members, a workshop attendee list, and other supporting workshop materials.]

The GIV 2.3 project began with a review and evaluation of the ecological economics literature. This resulted in a comprehensive list of 24 ecosystem services available for review. This list was narrowed down to nine services for further research based on consultation with the Technical Committee and the known availability and reliability of existing studies. Of these nine, six were selected to be mapped based on their feasibility to map ecosystem service values at the 30-meter resolution of the GIV.

Table 1. Ecosystem services mapped for Chicago Wilderness GIV 2.3

Ecosystem Service	Description
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.
Groundwater Recharge	Maintain natural rates of groundwater recharge and aquifer replenishment
Carbon Storage	Sequester carbon in vegetation and soils, thereby reducing atmospheric CO_2 and global climate change
Native Flora and Fauna	Maintain species diversity and biomass
Recreation and Ecotourism	Outdoor, nature-based experiences like hiking, birding, hunting, camping, etc.

The GIS layers for GIV 2.3 were developed by adapting Characterization Models developed by The Conservation Fund for GIV 2.2 using Esri's ArcGIS™ 10 and the ModelBuilder™ framework that allowed the user to identify the relative suitability of locations within the GIV network for particular conservation or restoration purposes. These models were re-engineered to utilize dollar value input and to allow for aggregated values across multiple GIV data layers. Dollar values estimates were selected based on a synthesis of the existing ecosystem services literature. We used studies and figures from the CMAP area where possible, within Illinois and the Midwest as our second choice, and elsewhere in the U.S. as a third choice. In a few cases, only global values were available. Median and 'analyst selected' values were mapped for the top four services listed above, with estimated adjusted based on additional GIS analysis (e.g. differentiating the ecosystem service value of floodplains within GIV network features). For the other two ecosystem services, native flora and fauna and recreation and ecotourism, a map of relative ecosystem service value was developed since dollar values estimated were not considered reliable measures of value. The methods for developing each model are described later in this report.

2. ECOSYSTEM SERVICES IN THE CHICAGO WILDERNESS REGION

According to analysis completed for this project, natural ecosystems contribute well more than $6 billion per year in economic value to the 7-county CMAP region. In comparison, the GDP of the Chicago Metropolitan Statistical Area (which mostly overlaps the 7 counties) was $586 billion in 2013. And this may undercount the total value since this estimate is only from ecosystem services that could be reliably measured, and this total does not include any of the economic activity supported by the region's recreation and ecotourism infrastructure.

Comprehensive List

Below is the initial list of 24 ecosystem services distilled from multiple sources (cites available in the full literature review). The nine services researched for the CMAP region are ***bolded***.

Table 2. Comprehensive list of ecosystem services and descriptions

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	
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

Ecosystem Service	Description
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
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

Six methods for valuing methods for valuing ecosystem services in monetary terms have been identified (see literature review for cites and more information):

- **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).

The following table summarizes relevant metrics and types of economic analyses for the ecosystem services examined in this project that are relevant to the Chicago Wilderness GIV.

Table 3. Ecosystem services metrics and economic analyses

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 of constructing and operating stormwater management infrastructure - Replacement cost of damaged infrastructure
Water Purification	- Reduction of N, P, Cl^-, sediment, bacteria, and other pollutants for drinking water, swimming, fishing, aquatic life, and other uses.	- Avoided cost of tertiary water treatment - Replacement cost of water treatment infrastructure
Groundwater Recharge	- Supply of water to groundwater rather than surface runoff	- Avoided cost of water constructing and operating supply infrastructure - Replacement cost of deeper wells - Price of public water supply
Carbon Storage	- Reduction of atmospheric CO_2 and associated climate effects (increased storm intensity, droughts, and heat waves)	- Avoided cost of damage to trees from extreme weather events - Market price of carbon
Native Flora and Fauna	- Protection of wildlife habitat, Maintenance of ecosystem functions and resilience	Surveys of willingness to pay for protection and maintenance
Recreation and Ecotourism	- Money spent on nature-based recreation (hunting, fishing, birding, hiking, etc.)	- Surveys of money expended on nature-based recreation
Air Purification	- Removal of SO_x, NO_x, O_3, CO, and PM_{10} from the air (pollutants with public health impacts)	- Avoided cost of air quality improvement systems - Replacement cost of infrastructure due to poor air quality
Microclimate Moderation	- Energy savings - Reduction of CO_2 emissions	- Avoided cost of energy production and utility bills

Ecosystem Service	Metrics	Types of economic analyses
Increase in Property Values	- Increase of property prices	- Hedonic analysis of components of real estate value

These ecosystem service metrics and economic analyses have been used in the scientific literature to estimate the dollar value of these ecosystem services. For the top four services on this list, we found that dollar value estimates for a particular service could be mapped on a pixel scale using GIS layers from the Chicago Wilderness GIV, which represent landscape types within the Chicago Wilderness region. For the next two on the list, we found that the GIV GIS layers could be used to cartographically represent relative ecosystem service values, but dollar value estimates were not appropriate since ecosystem service value does not correspond to GIV landscape types. For the final three services on the list, we found that the GIV layers were not suitable to represent spatially since the scale of the GIV data (30-meter pixels) was not appropriate for representing value. For air purification and microclimate moderation, the use of iTree and other similar tools are more appropriate for measuring ecosystem service value. Mapping the GIV's role in an increase in property values would require a methodology beyond the scope of this project.

GIV Landscapes

This table shows a crosswalk between the GIV landscape types and the GIV layers that are used in ecosystem service valuation modeling.

Table 4. GIV layers used in ecosystem service valuation estimates

Crosswalk GIV layer	GIS Model Reference	GIV 2.2 Data Inputs for CMAP Region
Woodlands/Forest		
Core woodland/forest designated areas	**Woodland/Forest Layers 3a & 3b**	Forest Blocks derived from land cover, State Natural Heritage databases, Audubon Important Bird Areas, Oak woodlands
Core woodland/forest	**Woodland/Forest Layer 4**	
Woodland sites	**Woodland/Forest Layer 5**	
Woodland/forest corridors	**Woodland/Forest Layer 7**	Forest land cover to facilitate functional connectivity modeling
Prairie/Grassland/Savanna		
Core prairies	**PGS Layer 1**	State Natural Heritage databases, City of Chicago Nature & Wildlife Prairie Sites, Midewin National Tallgrass Prairie Potential Vegetation

Core savannas	**PGS Layer 2**	State Natural Heritage databases, Will County Forest Preserve District (savannas), Natural and Wild Sites from City of Chicago
Grassland blocks	**PGS Layer 3**	IL Natural Heritage Survey's Landscapes of Ecological Importance
Crosswalk GIV layer	**GIS Model Reference**	**GIV 2.2 Data Inputs for CMAP Region**
Wetlands		
Core wetland designated areas	**Wetland Layers 4a & 4b**	Ducks Unlimited enhanced National Wetland Inventory Dataset (NWI), County ADID wetlands, Kane County Fens Study, CMAP land use wetland classes, State natural heritage databases, Illinois Audubon wetland dependent important bird areas, The Nature Conservancy's Shorebird Site Priority & Waterfowl Site Priority
Core wetlands	**Wetland Layer 5**	
Wetland sites	**Wetland Layer 6**	
Wetland complexes	**Wetland Layer 7**	Pre-settlement Vegetation Types Chicago Wilderness Wetlands Task Force, Hydric Soils
Wetland corridors	**Wetland Layer 8**	Wetland land cover to facilitate functional connectivity modeling
Streams and Lakes		
Undeveloped NHD+ stream buffer	**Steams/Lakes Layer 2**	National Hydrography Dataset Plus (NHDPlus) Waterbodies and Flowlines, Floodplains
Core lakes and streams	**Steams/Lakes Layer 3**	
Undeveloped freshwater systems	**Steams/Lakes Layer 5**	

Ecosystem Service Value Estimates

The following table is a summary of the ecosystem services estimates that were selected for the GIS models based on expert judgment and a thorough analysis of each study. For most models, the median of all studies reviewed for a particular service and associated landscape type was selected for the models. For some services, we selected a value higher or lower than the median if there was a particularly relevant and reliable study from the CMAP region, Illinois, or the Midwest. Please see the literature review for information about each of the studies used to generate the table values.

Table 5. Ecosystem service valuation estimates used on maps

		LANDSCAPE TYPE				
ECOSYSTEM SERVICE		Woodlands / Forest	Prairie / Grassland / Savanna	Wetlands	Natural Floodplains	Lakes
Water Flow Regulation/ Flood control	Selected	$1,603	$16,000	$22,000	$6,500	$37,000
	Median	$1,415	$16,000	$4,900	$3,700	$43,000
Water Purification	Selected	$1,300	$57	$4,350		$0
	Median	$1,060	$57	$3,429		$0
Groundwater Recharge	Selected	$269	$269	$660	$4,806	$566
	Median	$269	$269	$2,479	$4,806	$566
Carbon Storage	Selected	USED SPATIALLY EXPLICIT DATA FROM NBCD + gSSURGO				
	Median	$133	$82	$136		$0

Table Notes/Assumptions:
All numbers in $2014/ac/year.
Selected numbers for flood control compared to detention ponds constructed in Cook County, IL, assuming a 50 year lifespan.

Given the lack of studies, we gave prairie the same value for groundwater recharge as forest.

For wetland water storage, we used the lower bound (1 million gallons/ac).
For prairie carbon storage, we picked the midpoint from Matamala et al. (2008) and avoided damages of $2/tonne/year.
Wetland carbon storage would depend on the type of vegetation (see the literature review for more information)

We had no values for prairie wildlife value, so gave it the same as for woodlands/forest.

The recreation value from the studies for prairie seemed too low, so we gave it the same value as forest.

The following section provides a brief summary of each of the six ecosystem services researched and mapped for the CMAP 7-county region. The summary points are derived from the comprehensive literature review. The summary of why the service is important and the action steps to maintain and enhance the service were drawn directly from feedback at the public workshop in August 2014. The action steps are not intended to be comprehensive but simply an illustration of potential follow up activities that can be undertaken by CMAP and Chicago Wilderness partners. The opportunities to maintain and enhance services provided by the GIV are drawn from feedback at the public workshop and a review of the GIV data layers. More information on all of these products is available in the appendices.

3. GIS LAYERS AND MODELS FOR GIV ECOSYSTEM SERVICES

The following table provides a summary of the GIV layers and model references that are referenced in the tables associated with each ecosystem service in this section.

Table 6. GIV layers and model references for ecosystem service valuation

GIV 2.3	GIV Layer	Model Reference
GIV landscape features		
	Core woodland/forest designated areas	**Woodland/Forest Layers 3a & 3b**
	Core woodland/forest	**Woodland/Forest Layer 4**
	Core prairies	**PGS Layer 1**
	Core savannas	**PGS Layer 2**
	Core wetland designated areas	**Wetland Layers 4a & 4b**
	Core wetlands	**Wetland Layer 5**
	Core lakes and streams	**Steams/Lakes Layer 3**
Functional connections		
	Woodland/forest corridors	**Woodland/Forest Layer 7**
	Wetland corridors	**Wetland Layer 8**
	Undeveloped NHD+ stream buffer	**Steams/Lakes Layer 2**
	Undeveloped freshwater systems	**Steams/Lakes Layer 5**
Restoration building blocks		
	Forest Sites	**Woodland/Forest Layer 5**
	Pre-settlement woodland/forest	**Woodland/Forest Layer 6**
	Grassland blocks	**PGS Layer 3**
	Pre-settlement prairie/grassland	**PGS Layer 4**
	Pre-settlement savanna complexes	**PGS Layer 5**
	Prairie/grassland corridors	**PGS Layer 7**
	Wetland sites	**Wetland Layer 6**
	Wetland complexes	**Wetland Layer 7**
	NHD+ raster buffer	**Steams/Lakes Layer 1**
	Freshwater Systems	**Steams/Lakes Layer 4**
Composite layers		
	GIV ecological network	**Hub Layer 1**
	Protected lands raster	**Hub Layer 2**
	GIV network + protected lands	**Hub Layer 3**

Water Flow Regulation / Flood Control

Why this service is important

Natural systems are the least costly and most efficient way to control flooding. This is particularly important for local governments who have ongoing concerns about the cost to maintain infrastructure and to comply with stormwater management regulations. More frequent and intense storm events due to climate change will result in more stormwater and higher peak discharges. This can result in increased sediment and pollutant runoff as well as increase sanitary/combined sewer back-ups that can contaminate drinking water sources and create public health hazards in neighborhoods.

One way the GIV provides flood control and water flow regulation 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.

Flooding has significant economic costs, and investment in green infrastructure helps avoid some of these costs to repair and replace gray infrastructure and helps reduce private property losses and damages. In addition to being a cost-effective means of mitigating flooding and stormwater impacts, green infrastructure also has many other benefits for place-making, recreation, and habitat provision that single-purpose engineered systems often do not.

Fortunately, the GIV contains nearly all of the natural interconnected wetlands and riparian zones that provide this ecosystem service. 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 GIV absorbs flood waters before entering engineered flood control infrastructure.

Summary points

- A large tree can reduce 5,400 gallons of stormwater runoff per year in the Midwest. A forest stand can intercept over 200,000 gallons per acre per year.
- An acre of forest provides an annual avoided stormwater treatment cost of $21 per acre per year and over $9,000 per acre per year in avoided 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 in the Chicago metropolitan area could save an average $900 per acre per year in flood damages.

Opportunities to maintain and enhance this service provided by the GIV

Conservation and Restoration Implementation Activities

- ✓ Preserve land within unprotected areas of GIV cores, corridors, and sites. GIV layers are listed in order of estimated ecosystem services value. (Note: PGS = Prairie-Grassland-Savanna)

GIV Layer	GIS Model Reference	Economic Benefit (2014$/acre/year)
[Lakes] from Core lakes and streams	**Steams/Lakes Layer 3**	$37,000
Core wetland designated areas	**Wetland Layers 4a & 4b**	$22,000
Core wetlands	**Wetland Layer 5**	$22,000
Wetland corridors	**Wetland Layer 8**	$22,000
Wetland sites	**Wetland Layer 6**	$22,000
Core prairies	**PGS Layer 1**	$16,000
Core savannas	**PGS Layer 2**	$16,000
[Streams] from Core lakes and streams	**Steams/Lakes Layer 3**	$6,500
Core woodland/forest designated areas	**Woodland/Forest Layers 3a & 3b**	$1,603
Core woodland/forest	**Woodland/Forest Layer 4**	$1,603
Woodland/forest corridors	**Woodland/Forest Layer 7**	$1,603
Woodlands sites	**Woodland/Forest Layer 5**	$1,603

- ✓ Prevent land use conversion within functionally connected freshwater systems and stream buffers. GIV layers are listed in order of estimated ecosystem services value.

GIV Layer	GIS Model Reference	Economic Benefit (2014$/acre/year)
Undeveloped freshwater systems	**Stream/Lakes Layer 5**	$6,500
Undeveloped NHD+ stream buffer	**Streams/Lakes Layer 2**	$6,500

- ✓ Restore land to a suitable GIV landscape feature appropriate for the site. GIV layers are listed in order of estimated ecosystem services value.

GIV Layer	GIS Model Reference
Wetland complexes	**Wetland Layer 7**
Prairie/grassland corridors	**PGS Layer 7**
Grassland blocks	**PGS Layer 3**
Pre-settlement prairie/grassland	**PGS Layer 4**
Pre-settlement savanna	**PGS Layer 5**
Freshwater Systems	**Streams/Lakes layer 4**
NHD+ raster buffer	**Streams/Lakes Layer 1**
Pre-settlement woodland/forest	**Woodland/Forest Layer 6**
Protected lands raster	**Hub Layer 2**

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

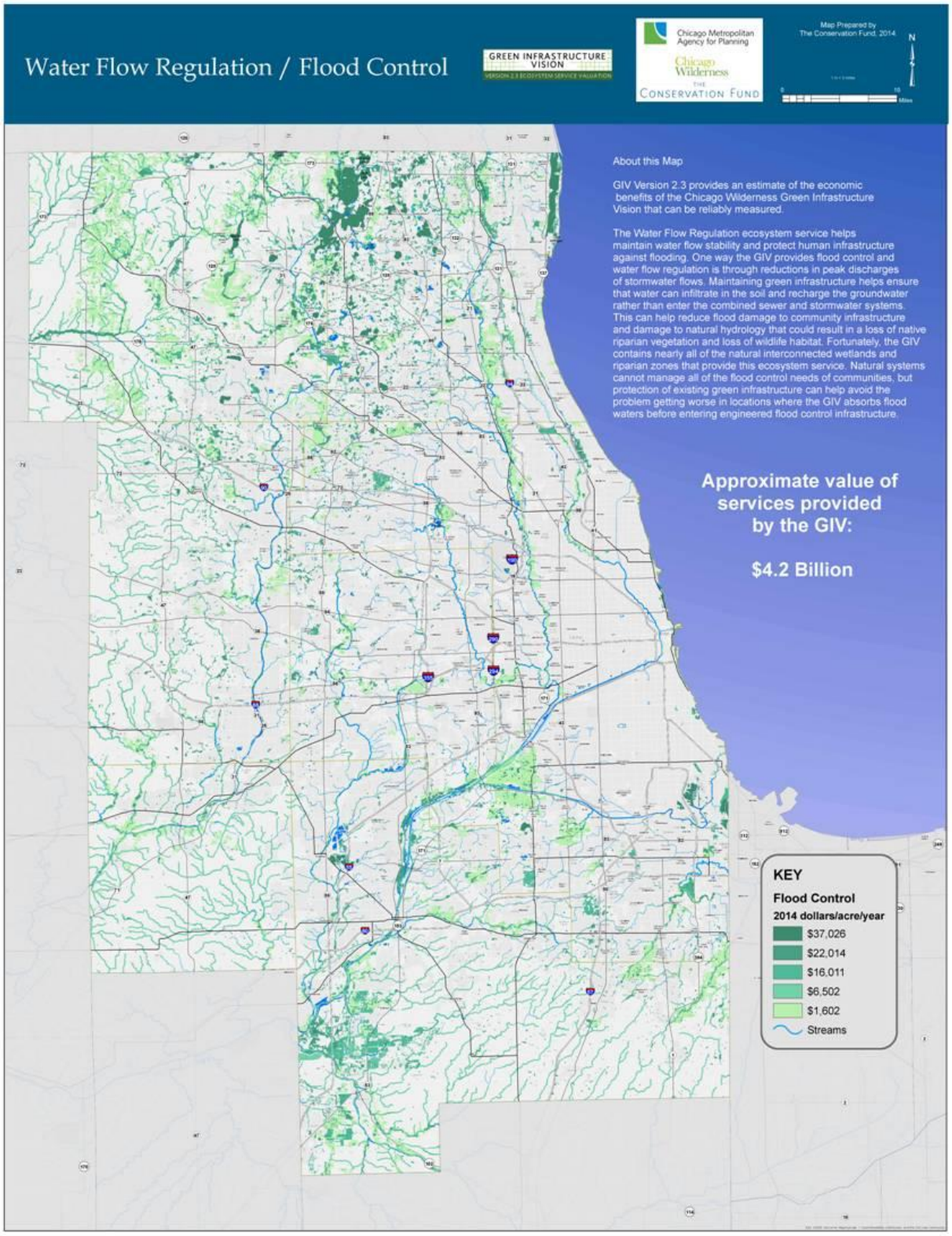
Programs, Policies, and Projects

- ✓ Support protection of high quality natural systems, large-scale wetland complex and floodplain restoration, and restoration of hydrologic systems, in particular in areas identified as opportunities below:
    - ✓ Undeveloped headwaters areas of Lake and McHenry Counties
    - ✓ Des Plaines River flood prone areas
    - ✓ Fox River
    - ✓ Midlothian Creek
    - ✓ Fox River flood prone areas
    - ✓ Salt Creek
    - ✓ Southeast Cook County undeveloped lands
    - ✓ "Collar counties" where there is more undeveloped land
- ✓ Construct wetlands, bioswales, rain gardens, tree planting, permeable pavement, green roof, and grey water storage and reuse systems in existing and new developments to keep rainwater out of storm sewers and minimize flooding
- ✓ Complete buy-outs of flood-prone structures and conversion of these areas to natural flood plain. This has the cumulative effect of reducing future flood losses at the bought out property, reduction of flooding potential upstream and downstream because of the extra storage volume for the stream to use, and increase of natural habitat for wildlife.
- ✓ Support the Center for Neighborhood Technology's Rain Ready Program pilot projects in Chatham and Midlothian.
- ✓ Establish incentive programs and mandates to reduce impervious surfaces and minimize total disturbed land areas on a site.

- ✓ Reduce lawn areas on public and private land and replace with native plants.
- ✓ Encourage high soil volume design for urban trees along streets, parkways, and boulevards.
- ✓ Plant mostly native systems rather than turf grass along right-of-ways.
- ✓ Develop incentive programs for rain harvesting, onsite infiltration, and onsite stormwater management.
- ✓ Pay Forest Preserve Districts to convert publicly owned lands currently in agriculture to restored wetlands where appropriate.
- ✓ Limit/ban development in the floodplain. (Important to note here that not all urban flooding is related to building in the floodplain, but this is still a policy that would help in certain places)
- ✓ Adjust regulations to go beyond compliance with stormwater detention and focus more on hydrologic modification that protects stream channel integrity and reduces offsite runoff (similar to those criteria in place in coastal GA, VA, and MD).

Map Methodology

The GIV 2.2 is the foundation for developing the approximate value of water flow regulation and flood control services provided by the GIV in the CMAP region. Using ArcGIS for Desktop 10.2.2 we built GIS models within the Model Builder environment. The resulting valuation from literature review and expert opinion was spatially explicit and transferred to the GIV layers using raster analysis (cell size = 30mX30m). Each cell was assigned a dollar value according to landscape type. The GIV layers were mosaicked into one raster layer and always preserving the maximum value assigned to each cell when there was any overlap between the layers. Having a dollar value for each cell allowed us to calculate the total value in dollars provided by the GIV for water flow regulation and flood control. Values range from $1,603/acre/year - $37,000 acre/year.


Water Flow Regulation / Flood Control
GREEN INFRASTRUCTURE VISION
VERSION 2.3 ECOSYSTEM SERVICE VALUATION
Chicago Metropolitan Agency for Planning
Chicago Wilderness
THE CONSERVATION FUND
Map Prepared by The Conservation Fund, 2014
N
About this Map
GIV Version 2.3 provides an estimate of the economic benefits of the Chicago Wilderness Green Infrastructure Vision that can be reliably measured.
The Water Flow Regulation ecosystem service helps maintain water flow stability and protect human infrastructure against flooding. One way the GIV provides flood control and water flow regulation 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. Fortunately, the GIV contains nearly all of the natural interconnected wetlands and riparian zones that provide this ecosystem service. 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 GIV absorbs flood waters before entering engineered flood control infrastructure.
Approximate value of services provided by the GIV:
$4.2 Billion
KEY
Flood Control
2014 dollars/acre/year
$37,026
$22,014
$16,011
$6,502
$1,602
Streams

Water Purification

Why this service is important

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 that provide drinking water and opportunities for fishing and swimming. 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. Poor water quality can have other significant economic impacts, including beach closures due to high bacteria levels, the need for dredging due to sedimentation, and limits on water-based recreational activities. The Chicago Wilderness GIV 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.

Summary points

- Forested buffers can remove up to 21 pounds of nitrogen and 4 pounds of phosphorus per acre per year from upland runoff. Forest buffers can reduce up to 98% of nitrogen, phosphorus, sediments, pesticides, pathogens, and other pollutants in surface and groundwater.
- Wetlands can filter 70-90% of nitrogen, 45% of phosphorous, and retain more than 70% of sediment.
- In a comparison of 11 types of best management practices (BMPs) for treating stormwater runoff, constructed wetlands were the most effective for improving water quality. The wetland removed 100% of suspended solids, 99% of nitrate, 100% of zinc, and 100% of petroleum byproducts, and reduced peak flows by 85%. This greatly exceeded the performance of standard retention ponds, as well as expensive manufactured devices.
- The average wastewater treatment costs using conventional methods are $4.36 per 1,000 gallons, but through wetlands construction, the cost is only $0.63/1,000 gallons ($2014).
- The cost of restoring and operating wetlands to remove nitrogen and phosphorus can be 50-70% less than the cost of constructing and operating engineered wastewater treatment systems.

Opportunities to maintain and enhance this service provided by the GIV

<u>Conservation and Restoration Implementation Activities</u>

- ✓ Preserve land within unprotected areas of GIV cores, corridors, and sites. GIV layers are listed in order of estimated ecosystem services value.

GIV Layer	GIS Model Reference	Economic Benefit (2014$/acre/year)
Core wetland designated areas	**Wetland Layers 4a & 4b**	$4,350
Core wetlands	**Wetland Layer 5**	$4,350
Wetland corridors	**Wetland Layer 8**	$4,350

GIV Layer	GIS Model Reference	Economic Benefit (2014$/acre/year)
Core woodland/forest designated areas	**Woodland/Forest Layers 3a & 3b**	$1,300
Core woodland/forest	**Woodland/Forest Layer 4**	$1,300
Woodland/forest corridors	**Woodland/Forest Layer 7**	$1,300
Woodlands sites	**Woodland/Forest Layer 5**	$1,300
Core prairies	**PGS Layer 1**	$57
Core savannas	**PGS Layer 2**	$57

- ✓ Prevent land use conversion within functionally connected freshwater systems and stream buffers.

GIV Layer	GIS Model Reference
Undeveloped freshwater systems	**Stream/Lakes Layer 5**
Undeveloped NHD+ stream buffer	**Streams/Lakes Layer 2**

- ✓ Restore land to a suitable GIV landscape feature appropriate for the site.

GIV Layer	GIS Model Reference
Wetland complexes	**Wetland Layer 7**
Pre-settlement woodland/forest	**Woodland/Forest Layer 6**
Prairie/grassland corridors	**PGS Layer 7**
Grassland blocks	**PGS Layer 3**
Pre-settlement prairie/grassland	**PGS Layer 4**
Pre-settlement savanna	**PGS Layer 5**
Freshwater Systems	**Streams/Lakes layer 4**
NHD+ raster buffer	**Streams/Lakes Layer 1**
Protected lands raster	**Hub Layer 2**

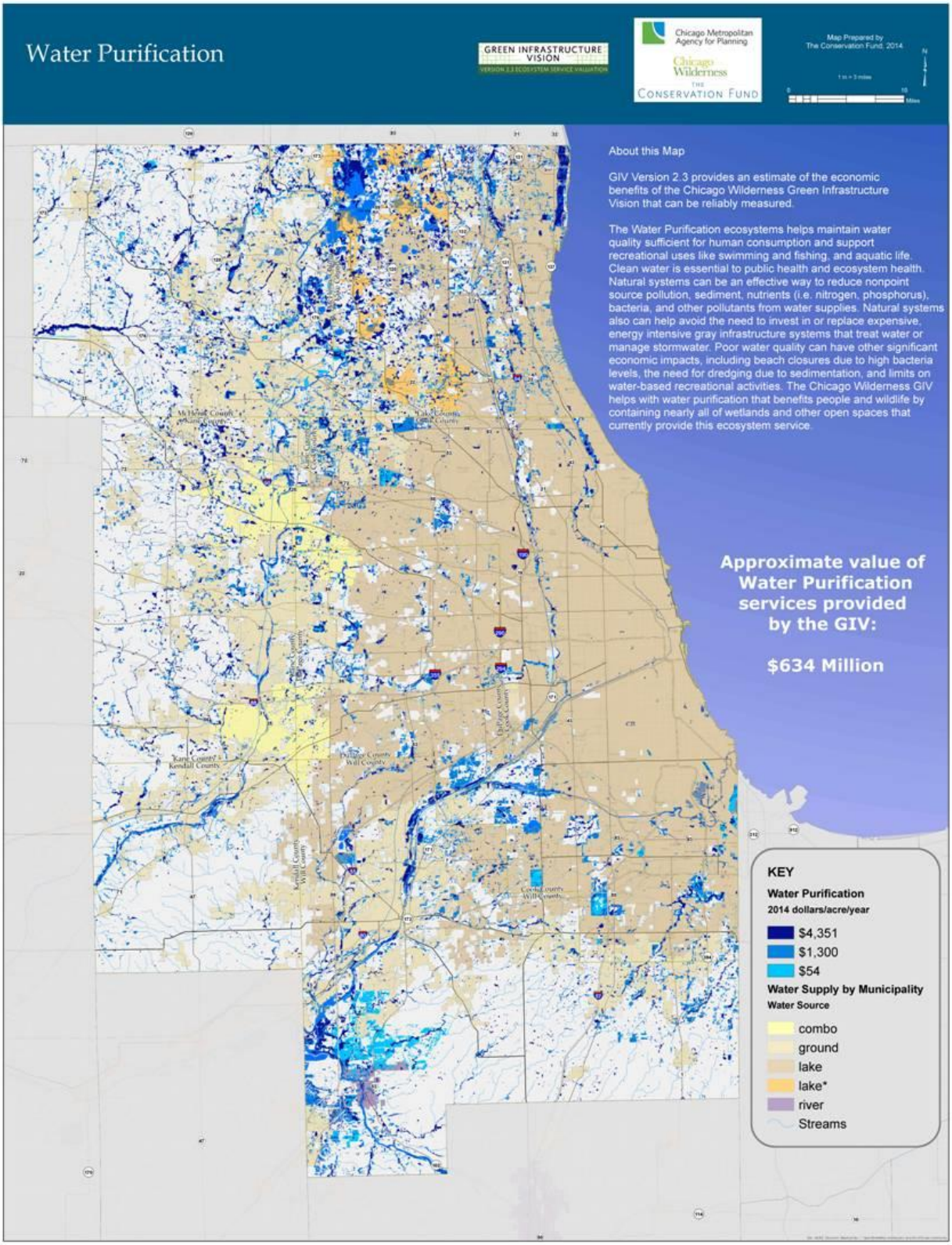
Action steps to maintain and enhance this service identified by workshop participants

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.

Map Methodology

The GIV 2.2 is the foundation for developing the approximate value of water purification services provided by the GIV in the CMAP region. Using ArcGIS for Desktop 10.2.2 we built GIS models within the Model Builder environment. The resulting valuation from literature review and expert opinion was spatially explicit and transferred to the GIV layers using raster analysis (cell size = 30mX30m). Each cell was assigned a dollar value according to landscape type. The GIV layers were mosaicked into one raster layer and always preserving the maximum value assigned to each cell when there was any overlap between the layers. Having a dollar value for each cell allowed us to calculate the total value in dollars provided by the GIV for water purification. Values ranged from $57 acre/year - $4350 acre/year.


Water Purification
GREEN INFRASTRUCTURE VISION
VERSION 2.3 ECOSYSTEM SERVICE VALUATION
Chicago Metropolitan Agency for Planning
Chicago Wilderness
THE CONSERVATION FUND
Map Prepared by The Conservation Fund, 2014
About this Map
GIV Version 2.3 provides an estimate of the economic benefits of the Chicago Wilderness Green Infrastructure Vision that can be reliably measured.
The Water Purification ecosystems helps maintain water quality sufficient for human consumption and support recreational uses like swimming and fishing, and aquatic life. 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. Poor water quality can have other significant economic impacts, including beach closures due to high bacteria levels, the need for dredging due to sedimentation, and limits on water-based recreational activities. The Chicago Wilderness GIV 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.
Approximate value of Water Purification services provided by the GIV:
$634 Million
KEY
Water Purification
2014 dollars/acre/year
$4,351
$1,300
$54
Water Supply by Municipality
Water Source
combo
ground
lake
lake*
river
Streams

Groundwater Recharge

Why this service is important

Groundwater recharge is a key to adequate water supplies for people and wildlife, particularly 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. The Chicago Wilderness GIV includes the natural river and stream network and lands that serve as infiltration areas to underground aquifers.

Summary points

- Forest soils can store 50% more water than urban land and allow 34% more groundwater recharge.
- Forested wetlands overlying permeable soil can release up to 100,000 gallons per acre per day of groundwater.

Opportunities to maintain and enhance this service provided by the GIV

Conservation and Restoration Implementation Activities

- ✓ Preserve land within unprotected areas of GIV cores, corridors, and sites. GIV layers are listed in order of estimated ecosystem services value.

GIV Layer	GIS Model Reference	Economic Benefit (2014$/acre/year)
[Floodplains]	**Multiple GIV layers**	$4,806
[Streams] from Core lakes and streams	**Steams/Lakes Layer 3**	$4,806
Core wetland designated areas	**Wetland Layers 4a & 4b**	$660
Core wetlands	**Wetland Layer 5**	$660
Wetland corridors	**Wetland Layer 8**	$660
[Lakes] from Core lakes and streams	**Steams/Lakes Layer 3**	$566
Core prairies	**PGS Layer 1**	$269
Core savannas	**PGS Layer 2**	$269

Core woodland/forest designated areas	**Woodland/Forest Layers 3a & 3b**	$269
GIV Layer	GIS Model Reference	Economic Benefit (2014$/acre/year)
Core woodland/forest	**Woodland/Forest Layer 4**	$269
Woodland/forest corridors	**Woodland/Forest Layer 7**	$269
Woodlands sites	**Woodland/Forest Layer 5**	$269

- ✓ Prevent land use conversion within functionally connected freshwater systems and stream buffers. GIV layers are listed in order of estimated ecosystem services value.

GIV Layer	GIS Model Reference	Value (2014$/acre/year)
Undeveloped freshwater systems	**Stream/Lakes Layer 5**	$4,806
Undeveloped NHD+ stream buffer	**Streams/Lakes Layer 2**	$4,806

- ✓ Restore land to a suitable GIV landscape feature appropriate for the site.

GIV Layer	GIS Model Reference
Wetland complexes	**Wetland Layer 7**
Prairie/grassland corridors	**PGS Layer 7**
Grassland blocks	**PGS Layer 3**
Pre-settlement prairie/grassland	**PGS Layer 4**
Pre-settlement savanna	**PGS Layer 5**
Freshwater Systems	**Streams/Lakes layer 4**
NHD+ raster buffer	**Streams/Lakes Layer 1**
Pre-settlement woodland/forest	**Woodland/Forest Layer 6**
Protected lands raster	**Hub Layer 2**

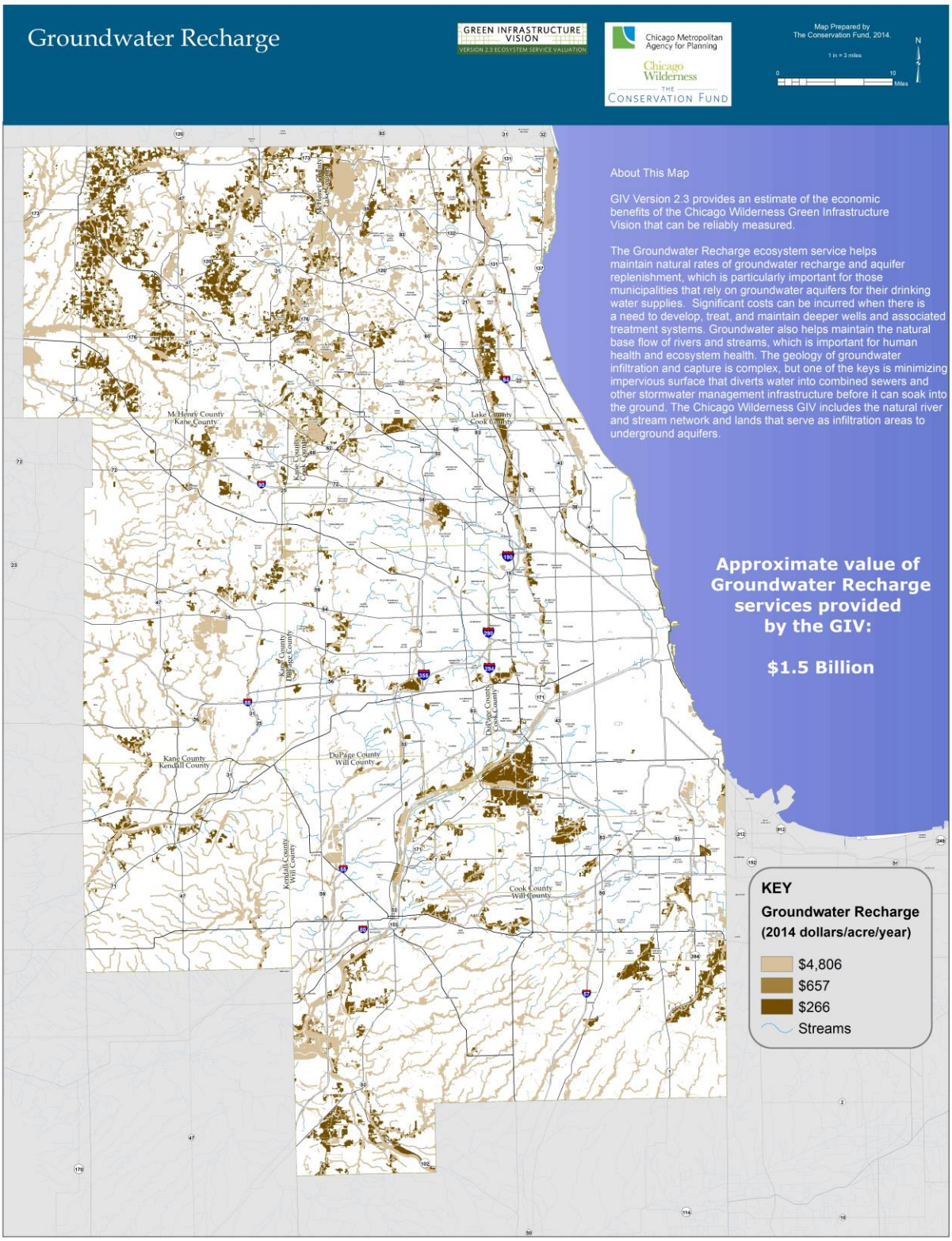
Action steps to maintain and enhance this service identified by workshop participants

Programs, Policies, and Projects

- ✓ Focus groundwater recharge initiatives in the "Collar counties" where there are more recharge areas and where adequate water supply is needed for economic development.
- ✓ Implement restoration projects that re-create historical groundwater flow regimes within pre-settlement wet, wet-mesic, and dry prairie areas.
- ✓ Establish education program for landowners and land managers on strategies to infiltrate groundwater on their properties.
- ✓ Increase infiltration in urban areas through strategic reduction of impervious surfaces and diversions of water from stormwater management infrastructure through constructed wetlands, bioswales, and rain gardens.
- ✓ Complete buy-outs of flood-prone structures and conversion of these areas to natural flood plain.
- ✓ Re-meander streams and restoring natural stream flow in rural areas.
- ✓ Minimize impervious surfaces within areas with shallow wells and state designated groundwater recharge zones.
- ✓ Adopt policies to encourage infiltration on private properties.
- ✓ Establish incentive programs and mandates to reduce impervious surfaces and minimize total disturbed land areas on a site.
- ✓ Implement policies to reduce salt on roads and fertilizers on lawns.
- ✓ Reduce lawn areas on public and private land and replace with native plants.
- ✓ Promote high soil volume design for urban trees along streets, parkways, and boulevards.
- ✓ Create incentive programs for rain harvesting, onsite infiltration, and onsite stormwater management. Creative incentives where unnecessary impervious surfaces can be removed cost effectively (e.g. old industrial sites, unused parking lots, etc.)

Map Methodology

The GIV 2.2 is the foundation for developing the approximate value of groundwater recharge services provided by the GIV in the CMAP region. Using ArcGIS for Desktop 10.2.2 we built GIS models within the Model Builder environment. The resulting valuation from literature review and expert opinion was spatially explicit and the values were transferred to the GIV layers using raster analysis (cell size = 30m x 30m). Each cell was assigned a dollar value according to landscape type. The GIV layers were mosaicked into one raster layer and always preserving the maximum value assigned to each cell when there was any overlap between the layers. Having a dollar value for each cell allowed us to calculate the total value in dollars provided by the GIV for groundwater recharge. Values ranged from $269 acre/year - $4,806 acre/year.


Groundwater Recharge
GREEN INFRASTRUCTURE VISION
VERSION 2.3 ECOSYSTEM SERVICE VALUATION
Chicago Metropolitan Agency for Planning
Chicago Wilderness
THE CONSERVATION FUND
Map Prepared by The Conservation Fund, 2014.
1 in = 3 miles
0
10
Miles
N
About This Map
GIV Version 2.3 provides an estimate of the economic benefits of the Chicago Wilderness Green Infrastructure Vision that can be reliably measured.
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. The Chicago Wilderness GIV includes the natural river and stream network and lands that serve as infiltration areas to underground aquifers.
Approximate value of Groundwater Recharge services provided by the GIV:
$1.5 Billion
McHenry County
Kane County
Lake County
Cook County
Kane County
Cook County
Kane County
DuPage County
DuPage County
Cook County
Kane County
Kendall County
DuPage County
Will County
Kendall County
Will County
Cook County
Will County
KEY
Groundwater Recharge
(2014 dollars/acre/year)
$4,806
$657
$266
Streams

Carbon Storage

Why this service is important

The ability for natural systems to capture carbon helps reduce greenhouse gas emissions, particularly carbon dioxide (CO_2), in the atmosphere that contributes to climate change. Carbon is stored both above ground in leaves and other vegetation and below ground in the soil. The GIV includes natural areas and areas of pre-settlement native vegetation that, for the most part, represent areas where carbon storage is occurring and where new opportunities exist through habitat restoration. Protecting the existing GIV also supports the region's Climate Action Plans and helps build resilience against the likelihood of increasing frequency and intensity of storm events.

Summary points

- Forests help remove large amounts of CO_2 from the air. During photosynthesis, trees convert CO_2 into oxygen; carbon is also stored in the body of the tree, in the soil surrounding its roots, and in debris that falls to the ground. Larger and healthier trees sequester carbon at greater rates.
- A large tree can remove over 1,000 pounds per year of CO_2 from the atmosphere.
- A mature oak-hickory forest can contain over 130 tons of carbon per acre.
- Restoring prairie vegetation rebuilds organic matter in the surface soil and sequesters carbon, taking centuries to reach maximum storage potential.
- Remnant prairie at Fermi National Accelerator Laboratory contained around 0.76 kg of carbon per square meter above ground and 13.5 kg per square meter below ground.

Opportunities to maintain and enhance this service provided by the GIV

<u>Conservation and Restoration Implementation Activities</u>

- ✓ Preserve land within unprotected areas of GIV cores, corridors, and sites. GIV layers are listed in approximate order of estimated ecosystem services value. Please see the Map Methodology section below that explains how specific values were generated.
- ✓

GIV Layer	GIS Model Reference
Core woodland/forest designated areas	**Woodland/Forest Layers 3a & 3b**
Core woodland/forest	**Woodland/Forest Layer 4**
Woodland/forest corridors	**Woodland/Forest Layer 7**
Woodlands sites	**Woodland/Forest Layer 5**
Core wetland designated areas	**Wetland Layers 4a & 4b**
Core wetlands	**Wetland Layer 5**

GIV Layer	GIS Model Reference
Wetland corridors	**Wetland Layer 8**
Core prairies	**PGS Layer 1**
Core savannas	**PGS Layer 2**

- ✓ Restore land to a suitable GIV landscape feature appropriate for the site.

GIV Layer	GIS Model Reference
Pre-settlement woodland/forest	**Woodland/Forest Layer 6**
Wetland complexes	**Wetland Layer 7**
Prairie/grassland corridors	**PGS Layer 7**
Grassland blocks	**PGS Layer 3**
Pre-settlement prairie/grassland	**PGS Layer 4**
Pre-settlement savanna	**PGS Layer 5**
Protected lands raster	**Hub Layer 2**

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

Programs, Policies, and Projects

- ✓ Implement large scale restoration of woodlands and prairies, particularly within the 400,000 acres called for the GO TO 2040.
- ✓ Use iTree to identify suitable locations for large investments in urban tree planting.
- ✓ Protect woodlands/forests through land acquisition and conservation easements.
- ✓ Expand tree planting programs in schools and communities.
- ✓ Convert existing agricultural land in public ownership to woodlands/prairie as appropriate.
- ✓ Require mitigation by developers when reducing tree cover and disturbing native vegetation.
- ✓ Provide incentives to restore woodlands and prairies on private properties.

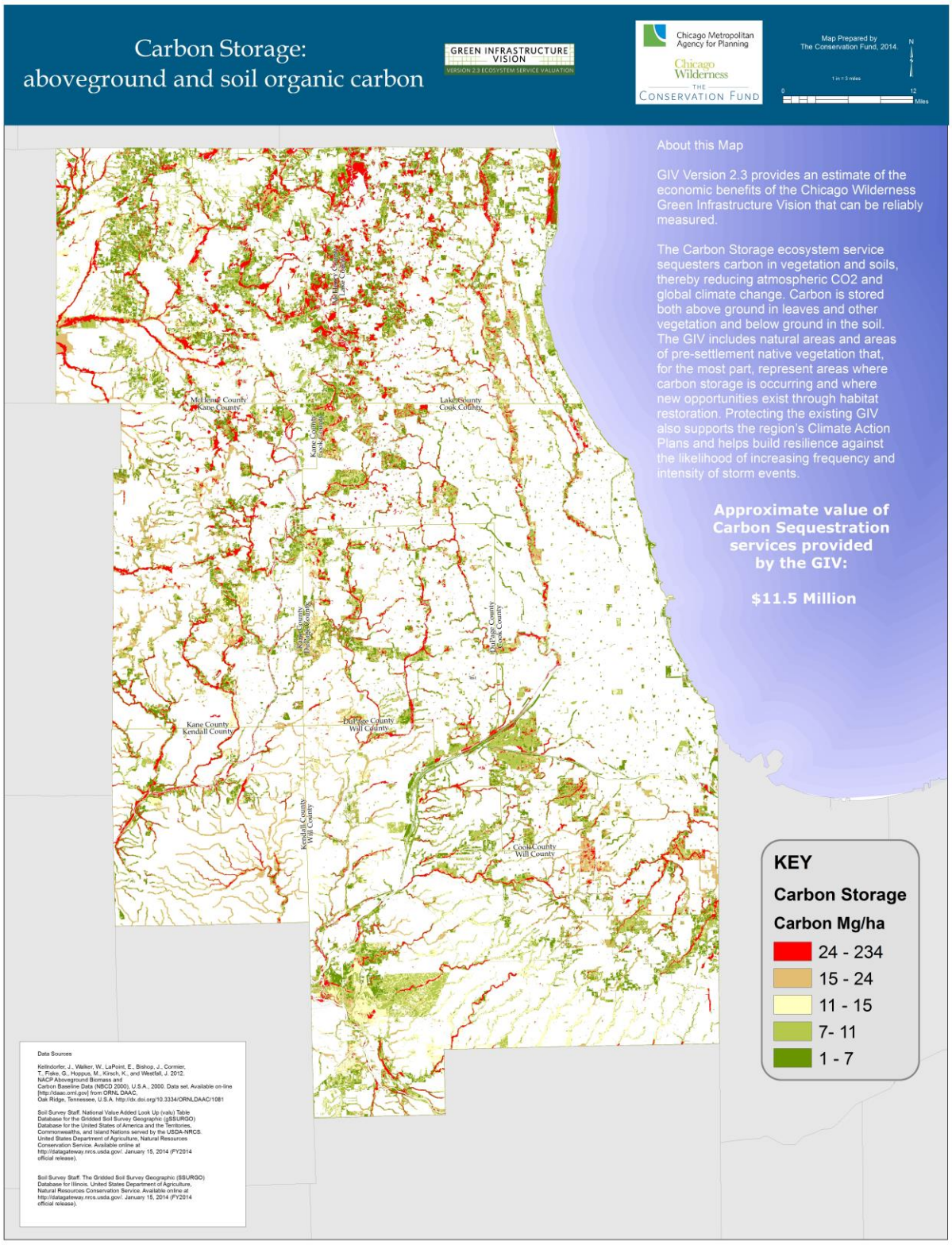
Map Methodology

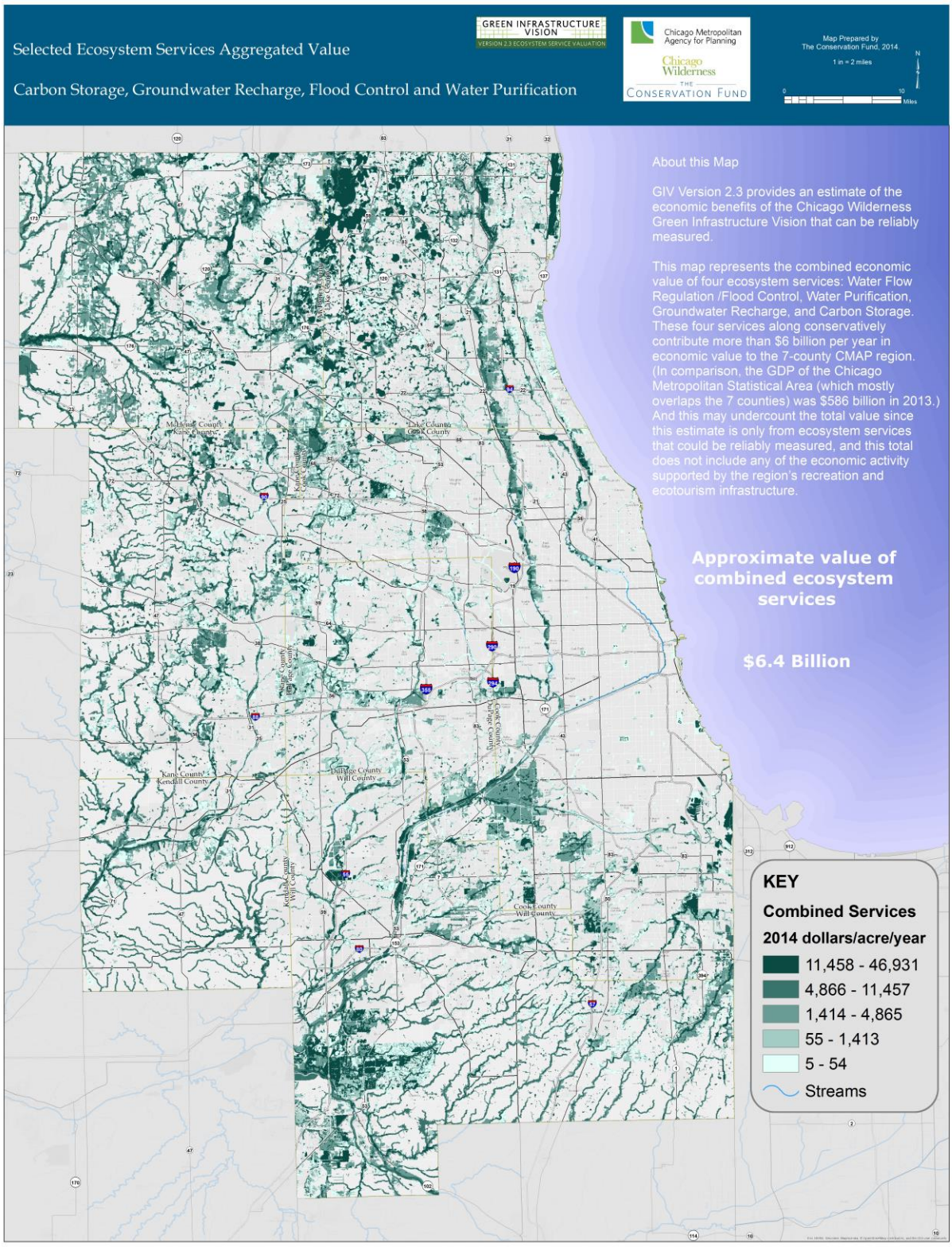
Carbon storage was calculated using two datasets in order to estimate above ground and below ground standing carbon stock. The first one is The National Biomass and Carbon Dataset 2000 (NBCD 2000). A high spatial resolution (30 m), year-2000 baseline estimate of basal area-weighted canopy height, aboveground live dry biomass, and standing carbon stock for the conterminous (lower 48)

United States. One 16-bit signed raster layer at 30 m resolution. Digital numbers represent the amount of aboveground live dry biomass present in kg/m2 * 10. Thus, aboveground live dry biomass in kg/m2 = <Digital Number> / 10. Values were multiplied by 10 to preserve significant figures yet reduce file size. Units of kg/m2 were selected to coincide with FIA results/methodology. The units were converted to metric tons (tonnes) per hectare. To estimate the number of metric tonnes of biomass in a given region of interest/polygon, sum the values that NBCD2000 Mapping Zone README 3lie within the polygon of interest and then multiply the result by 0.09 (which accounts for the fractional portion of a hectare present in a single 30 meter pixel).

The second dataset is the Gridded SSURGO (gSSURGO), similar to the standard product from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) Database, but is in the Environmental Systems Research Institute, Inc. (ESRI®) file geodatabase format. The National Value Added Look Up (valu) Table database is designed to facilitate thematic mapping for several important soil properties and interpretations. The valu1 table within this database is a compilation of 57 pre-summarized or "ready to map" attributes derived from the soil survey geographic database, including soil organic carbon. The map unit average soil organic carbon values are given in units of grams carbon per square meter for 11 standard layer or zone depths. We used the entire soil depth.

We converted both data sets to the same units and added them using Raster Calculator. To calculate the dollar value of carbon storage per grid cell = $(C_{above} + C_{below})$ * $2/tonne/year.


Carbon Storage:
aboveground and soil organic carbon
GREEN INFRASTRUCTURE VISION
VERSION 2.3 ECOSYSTEM SERVICE VALUATION
Chicago Metropolitan Agency for Planning
Chicago Wilderness
THE CONSERVATION FUND
Map Prepared by The Conservation Fund, 2014.
N
1 in = 3 miles
0
12
Miles
About this Map
GIV Version 2.3 provides an estimate of the economic benefits of the Chicago Wilderness Green Infrastructure Vision that can be reliably measured.
The Carbon Storage ecosystem service sequesters carbon in vegetation and soils, thereby reducing atmospheric CO2 and global climate change. Carbon is stored both above ground in leaves and other vegetation and below ground in the soil. The GIV includes natural areas and areas of pre-settlement native vegetation that, for the most part, represent areas where carbon storage is occurring and where new opportunities exist through habitat restoration. Protecting the existing GIV also supports the region's Climate Action Plans and helps build resilience against the likelihood of increasing frequency and intensity of storm events.
Approximate value of Carbon Sequestration services provided by the GIV:
$11.5 Million
McHenry County
Kane County
Lake County
Cook County
Kane County
Cook County
Kane County
Kendall County
DuPage County
Will County
Kane County
DuPage County
Cook County
Kane County
Kendall County
Will County
Cook County
Will County
KEY
Carbon Storage
Carbon Mg/ha
24 - 234
15 - 24
11 - 15
7- 11
1 - 7
Data Sources
Kellndorfer, J., Walker, W., LaPoint, E., Bishop, J., Cormier, T., Fiske, G., Hoppus, M., Kirsch, K., and Westfall, J. 2012. NACP Aboveground Biomass and Carbon Baseline Data (NBCD 2000), U.S.A., 2000. Data set. Available on-line [http://daac.ornl.gov/] from ORNL DAAC, Oak Ridge, Tennessee, U.S.A. http://dx.doi.org/10.3334/ORNLDAAC/1081
Soil Survey Staff. National Value Added Look Up (valu) Table Database for the Gridded Soil Survey Geographic (gSSURGO) Database for the United States of America and the Territories, Commonwealths, and Island Nations served by the USDA-NRCS. United States Department of Agriculture, Natural Resources Conservation Service. Available online at http://datagateway.nrcs.usda.gov/. January 15, 2014 (FY2014 official release).
Soil Survey Staff. The Gridded Soil Survey Geographic (SSURGO) Database for Illinois. United States Department of Agriculture, Natural Resources Conservation Service. Available online at http://datagateway.nrcs.usda.gov/. January 15, 2014 (FY2014 official release).


Selected Ecosystem Services Aggregated Value
Carbon Storage, Groundwater Recharge, Flood Control and Water Purification
GREEN INFRASTRUCTURE VISION
VERSION 2.3 ECOSYSTEM SERVICE VALUATION
Chicago Metropolitan Agency for Planning
Chicago Wilderness
THE CONSERVATION FUND
Map Prepared by The Conservation Fund, 2014.
1 in = 2 miles
Miles
About this Map
GIV Version 2.3 provides an estimate of the economic benefits of the Chicago Wilderness Green Infrastructure Vision that can be reliably measured.
This map represents the combined economic value of four ecosystem services: Water Flow Regulation /Flood Control, Water Purification, Groundwater Recharge, and Carbon Storage. These four services along conservatively contribute more than $6 billion per year in economic value to the 7-county CMAP region. (In comparison, the GDP of the Chicago Metropolitan Statistical Area (which mostly overlaps the 7 counties) was $586 billion in 2013.) And this may undercount the total value since this estimate is only from ecosystem services that could be reliably measured, and this total does not include any of the economic activity supported by the region's recreation and ecotourism infrastructure.
Approximate value of combined ecosystem services
$6.4 Billion
KEY
Combined Services
2014 dollars/acre/year
11,458 - 46,931
4,866 - 11,457
1,414 - 4,865
55 - 1,413
5 - 54
Streams

Native Flora and Fauna

Why this service is important

Natural systems provide opportunities for native vegetation and wildlife to thrive, which helps maintain ecosystem functions and processes. A functionally connected network of natural lands and waters provides benefits as a whole that is greater than the sum of its parts. While native flora and fauna help support other ecosystem services, including ones like pollination, it has its own value in preserving biodiversity. The Chicago Wilderness Biodiversity Recovery Plan provides the overarching framework for preservation and enhancement of the region's biodiversity, and the GIV represents the Plan spatially. Fortunately, the GIV contains nearly all of the high priority native vegetation and wildlife within the region and will increase as more areas are restored.

Summary points

- Ecosystem resistance and resilience to stresses depends on species composition and diversity. Diverse ecosystems are more likely to contain species tolerant to disturbances like flooding, drought, or pests.
- Biological diversity and genetic information are not easy to translate into dollar terms, but a number of studies have quantified the economic value of habitat, with wetlands having a value up to $14,800 per acre per year ($2014).

Opportunities to maintain and enhance this service provided by the GIV

<u>Conservation and Restoration Implementation Activities</u>

GIV layers are listed in order of estimated ecosystem services value. Please see the Map Methodology section below that explains how specific values were generated.

- ✓ Protect "Top tier" – Designated habitat confirmed as important for biodiversity.

GIV Layer	GIS Model Reference
Core wetland designated areas	**Wetland Layers 4a & 4b**
Core woodland/forest designated areas	**Woodland/Forest Layers 3a & 3b**
Core prairies	**PGS Layer 1**
Core savannas	**PGS Layer 2**

- ✓ Protect other GIV core areas.

GIV Layer	GIS Model Reference
Core wetlands	**Wetland Layer 5**
Core lakes and streams	**Steams/Lakes Layer 3**
Core woodland/forest	**Woodland/Forest Layer 4**

- ✓ Protect and restore functional habitat connections.

GIV Layer	GIS Model Reference
Wetland corridors	**Wetland Layer 8**
Woodland/forest corridors	**Woodland/Forest Layer 7**
Undeveloped freshwater systems	**Stream/Lakes Layer 5**
Undeveloped NHD+ stream buffer	**Streams/Lakes Layer 2**

- ✓ Expand and restore GIV landscapes.

GIV Layer	GIS Model Reference
Woodlands sites	**Woodland/Forest Layer 5**
Wetlands sites	**Wetlands Layer 6**
Wetland complexes	**Wetland Layer 7**
Prairie/grassland corridors	**PGS Layer 7**
Grassland blocks	**PGS Layer 3**
Pre-settlement prairie/grassland	**PGS Layer 4**
Pre-settlement savanna	**PGS Layer 5**
Freshwater Systems	**Streams/Lakes layer 4**
NHD+ raster buffer	**Streams/Lakes Layer 1**
Pre-settlement woodland/forest	**Woodland/Forest Layer 6**

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

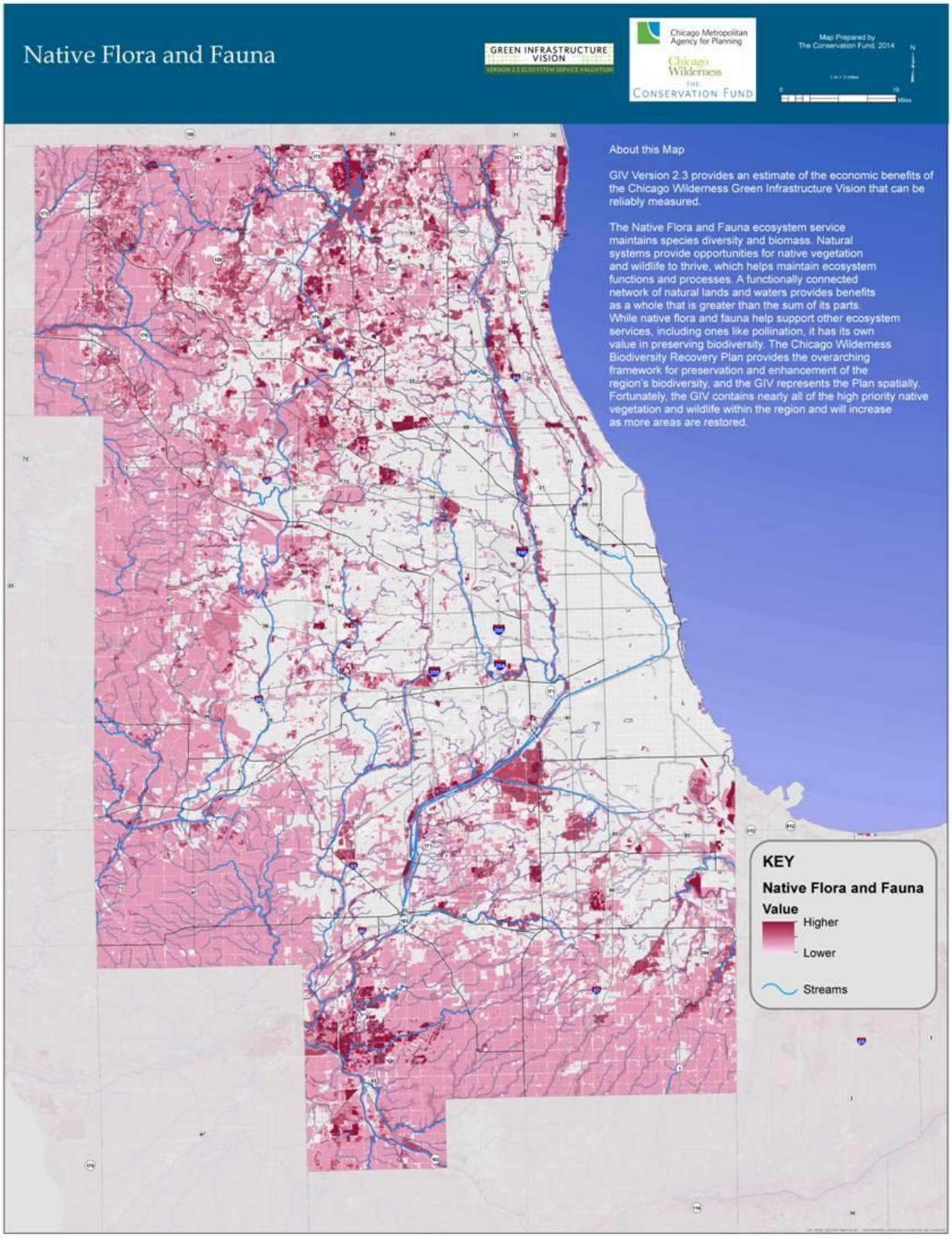
Programs, Policies, and Projects

Initiatives that support ecosystem services protection and enhancement:

- ✓ Highlight the Lake County Forest Preserve District commitment to protecting three 10,000-acre complexes in and around Lake County.
- ✓ Implement the Illinois Wildlife Action Plan recommendations for a series of large, protected lands.
- ✓ Preserve of high quality natural areas.
- ✓ Control invasive species.
- ✓ Use utility corridors as habitat for pollinators.
- ✓ Establish incentives for private landowners to provide habitat for pollinators and native vegetation.

Map Methodology

The GIV 2.2 is the foundation for developing the relative value of native flora and fauna provided by the GIV in the CMAP region. Using ArcGIS for Desktop 10.2.2 we built GIS models within the Model Builder environment. Designated habitat confirmed as important for biodiversity was given the highest value. Other core areas within the GIV were given importance but not as high as areas with confirmed high ecological value. Each cell was assigned a value according to landscape type. The GIV layers were mosaicked into one raster layer and always preserving the maximum value assigned to each cell when there was any overlap between the layers. The relative values range from 2-10 with 10 being the highest and 2 the lowest.


Native Flora and Fauna
GREEN INFRASTRUCTURE VISION
VERSION 2.3 ECOSYSTEM SERVICE VALUATION
Chicago Metropolitan Agency for Planning
Chicago Wilderness
THE CONSERVATION FUND
Map Prepared by The Conservation Fund, 2014
About this Map
GIV Version 2.3 provides an estimate of the economic benefits of the Chicago Wilderness Green Infrastructure Vision that can be reliably measured.
The Native Flora and Fauna ecosystem service maintains species diversity and biomass. Natural systems provide opportunities for native vegetation and wildlife to thrive, which helps maintain ecosystem functions and processes. A functionally connected network of natural lands and waters provides benefits as a whole that is greater than the sum of its parts. While native flora and fauna help support other ecosystem services, including ones like pollination, it has its own value in preserving biodiversity. The Chicago Wilderness Biodiversity Recovery Plan provides the overarching framework for preservation and enhancement of the region's biodiversity, and the GIV represents the Plan spatially. Fortunately, the GIV contains nearly all of the high priority native vegetation and wildlife within the region and will increase as more areas are restored.
KEY
Native Flora and Fauna
Value
Higher
Lower
Streams

Recreation and Ecotourism

Why this service is important

Natural systems provide opportunities to experience the outdoors and participate in healthy activities like hiking. The number of licenses sold for fishing and hunting, number of boats registered, and the number of visits to natural areas gives an indication of the economic value of recreation lands in the region, but given that many publicly owned natural areas have no entrance fees, the known economic value of these lands is much lower than what can be documented through the purchase of licenses and equipment.

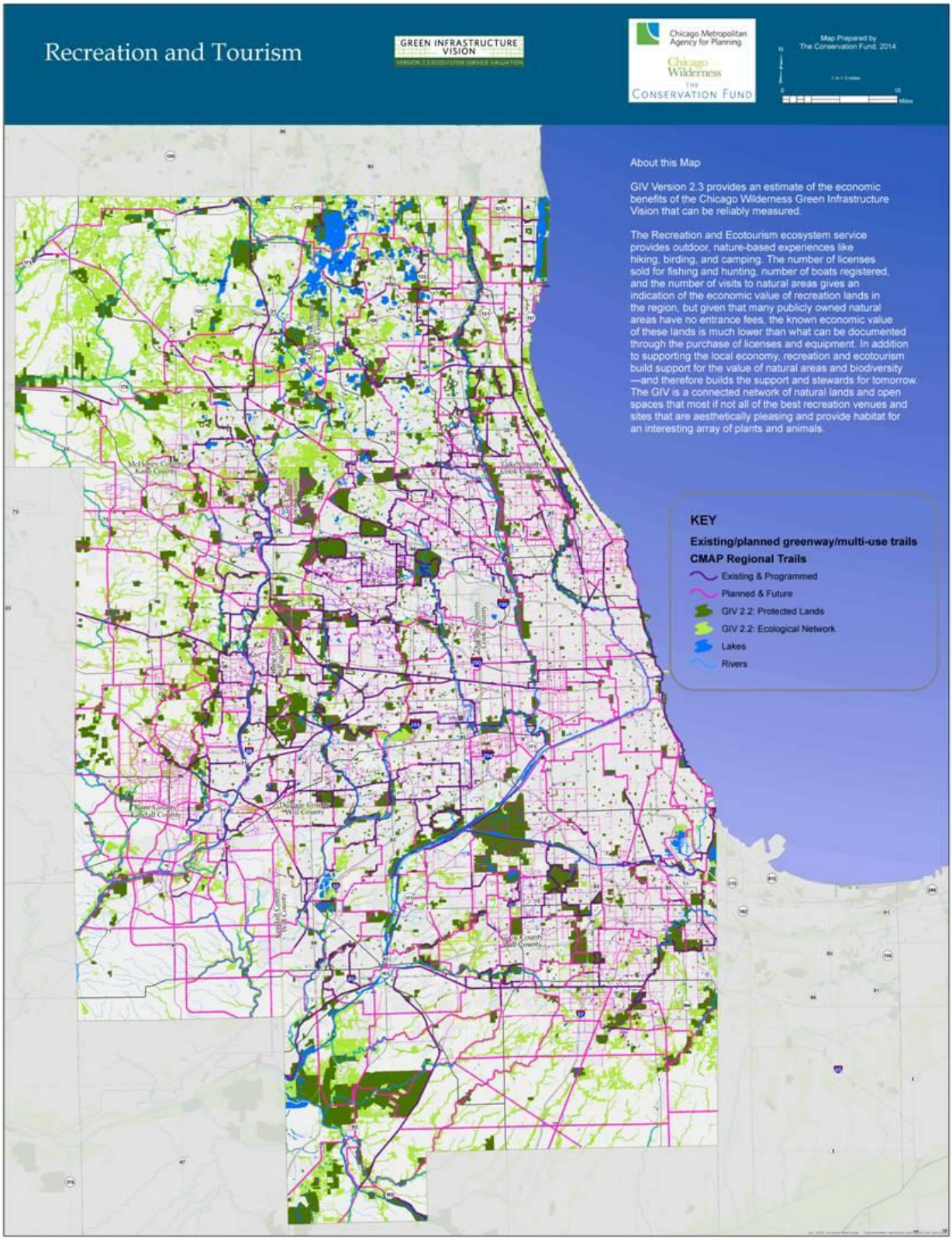
In addition to supporting the local economy, recreation and ecotourism build support for the value of natural areas and biodiversity—and therefore builds the support and stewards for tomorrow. The GIV is a connected network of natural lands and open spaces that most if not all of the best recreation venues and sites that are aesthetically pleasing and provide habitat for an interesting array of plants and animals.

Summary points

- In 2011, Illinois residents and non-residents spent $3.8 billion on wildlife-associated recreation. They also spent 13.3 million days and $973 million fishing in Illinois (excluding Lake Michigan).
- In a 2008 survey, over 97% of Illinois residents thought outdoor recreation areas are important for health and fitness and almost 94% thought community recreation areas are important for quality of life and promote economic development. Over 80% thought more lands should be acquired for open space and/or for outdoor recreation.
- Access to open space, parks, and recreation is a top factor used by small businesses in choosing a new location.

<u>Map Methodology</u>

This map is a visual representation of all lands protected and managed for open space in the CMAP region (Hub Layer 2) imbedded in the ecological network (Hub Layer 1) and an overlay of the extensive trail system. Trail system includes both planned and exiting trails.


Recreation and Tourism
GREEN INFRASTRUCTURE VISION
Chicago Metropolitan Agency for Planning
Chicago Wilderness
THE CONSERVATION FUND
Map Prepared by The Conservation Fund, 2014
About this Map
GIV Version 2.3 provides an estimate of the economic benefits of the Chicago Wilderness Green Infrastructure Vision that can be reliably measured.
The Recreation and Ecotourism ecosystem service provides outdoor, nature-based experiences like hiking, birding, and camping. The number of licenses sold for fishing and hunting, number of boats registered, and the number of visits to natural areas gives an indication of the economic value of recreation lands in the region, but given that many publicly owned natural areas have no entrance fees, the known economic value of these lands is much lower than what can be documented through the purchase of licenses and equipment. In addition to supporting the local economy, recreation and ecotourism build support for the value of natural areas and biodiversity —and therefore builds the support and stewards for tomorrow. The GIV is a connected network of natural lands and open spaces that most if not all of the best recreation venues and sites that are aesthetically pleasing and provide habitat for an interesting array of plants and animals.
KEY
Existing/planned greenway/multi-use trails
CMAP Regional Trails
Existing & Programmed
Planned & Future
GIV 2.2: Protected Lands
GIV 2.2: Ecological Network
Lakes
Rivers

4. APPENDICES

Under separate cover

- Project Steering Committee List
- Public Workshop Materials
  - Workshop Agenda
  - Attendee List
  - Feedback Forms (blank originals, scanned responses, and transcribed)
  - Presentation (PPT)
- Literature Review
- User Guide for GIV 2.3 with GIS layers and models