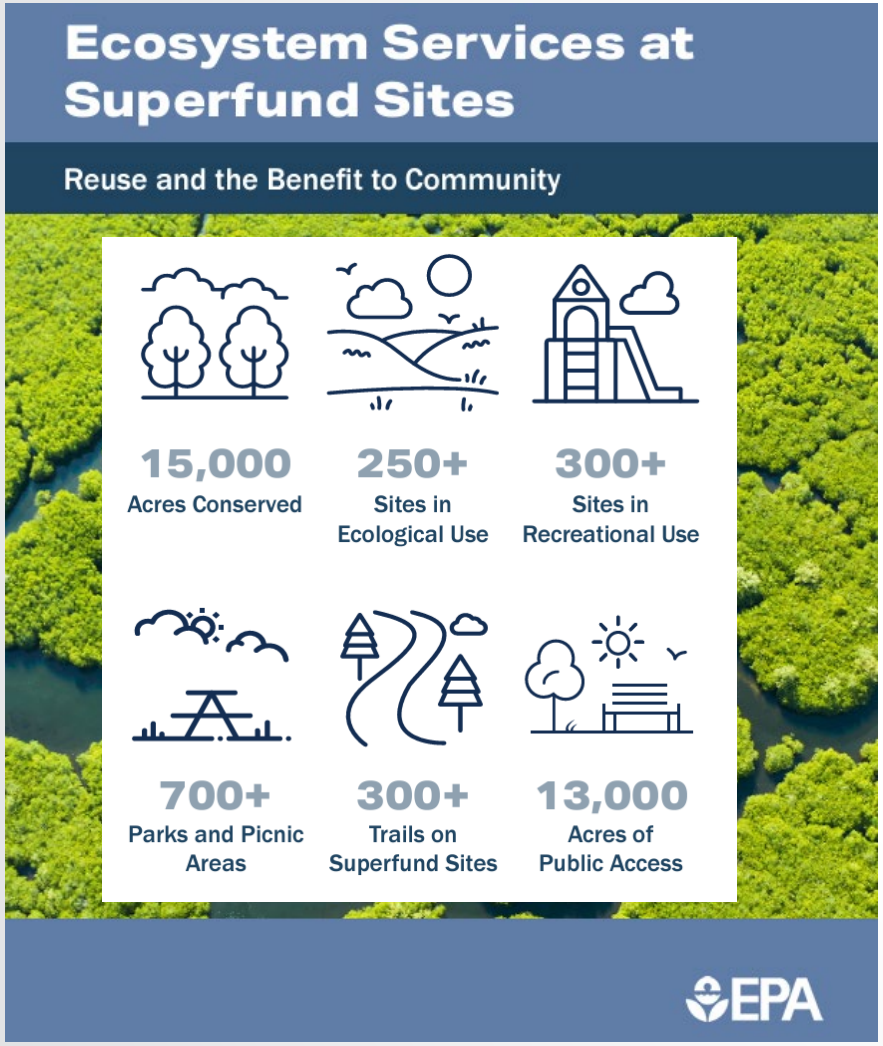
Using Ecosystem Services Tools in EJ Community Development Projects

Tammy Newcomer-Johnson[1], *Leah M. Sharpe*[2], *Kaitlyn Hines*[1,3], *Gregg Lomnicky*[4], *Adam Schlenger*[4], *Jim Harvey*[2]

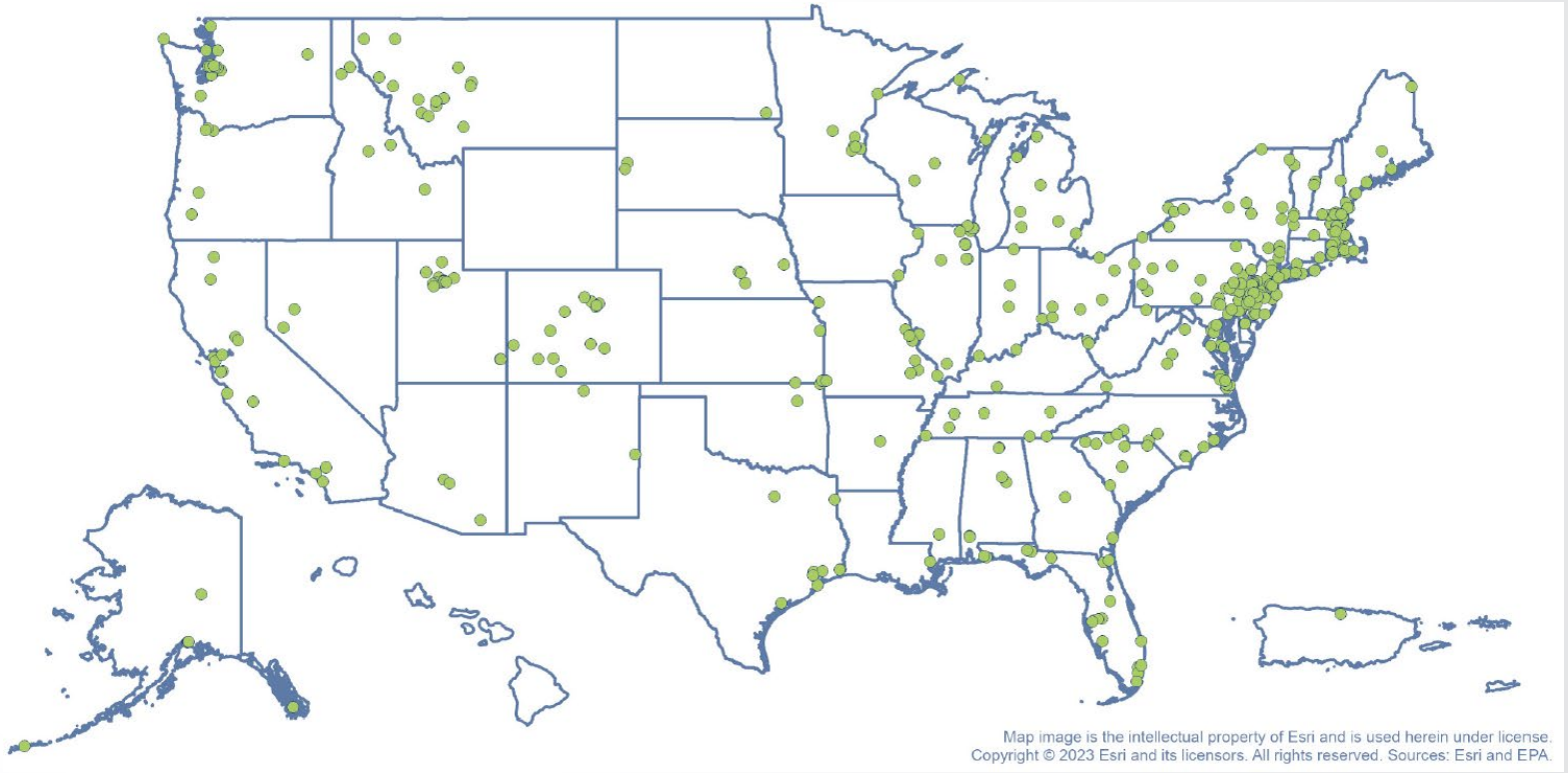
[1]US Environmental Protection Agency (EPA), Office of Research and Development (ORD), Cincinnati, USA
[2]US EPA/ORD, Gulf Breeze, FL, USA
[3]Oak Ridge Associated Universities, Students Services Contract
[4]CSS - Consolidated Safety Services, Inc., USA

*The views expressed in this presentation are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency. Any mention of trade names, products or services does not imply an endorsement by the U.S. Government or the U.S. Environmental Protection Agency.

Ecosystem Services at Superfund Sites



Superfund Sites across the United States (~460 sites)



2023 Report available at: https://semspub.epa.gov/work/HQ/100003256.pdf

Examples of Ecosystem Services at Site Cleanup Projects

Final Ecosystem Goods and Services (FEGS) are those **components of nature** within an **environment** that are **directly enjoyed, consumed or used** to yield human well-being.

Subsistence fishing – Portland Harbor, Washington State

Timber production – Black Butte Mine, Oregon

Groundwater reclamation – Phoenix-Goodyear Airport Area, Arizona

Erosion control – Bunker Hill Mining and Metallurgical Complex, Idaho

Pollinator habitat – Palmerton Zinc Pile, Pennsylvania

Cultural heritage – Indian Island, California

Recreational fishing – California Gulch, Colorado

Bird watching – Rocky Mountain Arsenal, Colorado

Educational experiences – Sangamo Electric Dump/Crab Orchard National Wildlife Refuge, Illinois

Harwell et al. 2022 J Environ Manage. doi: 10.1016/j.jenvman.2021.112102

EPA's Ecosystem Services Tools

EPA's Ecosystem Services Tool Selection Portal

www.epa.gov/eco-research/ecosystem-services-portal

Ecosystem services assessment tools help you describe, quantify, and sustain the benefits nature offers humans and weigh the impact of decisions. This tool portal helps select the best tools for your scenario. Choose a path below to find the tools that match your needs.

I'm looking for help with...

Ecological Risk Assessments

Choose this path if you are:

- Evaluating the possible impact of environmental stressors such as chemicals, disease, or invasive species.
- Predicting the likelihood of future effects.
- Using an Ecological Risk Assessment in Remedy Decisions.
- Preparing and/or reviewing Ecological Risk Assessments.

Contaminated Site Cleanup

Choose this path if you are:

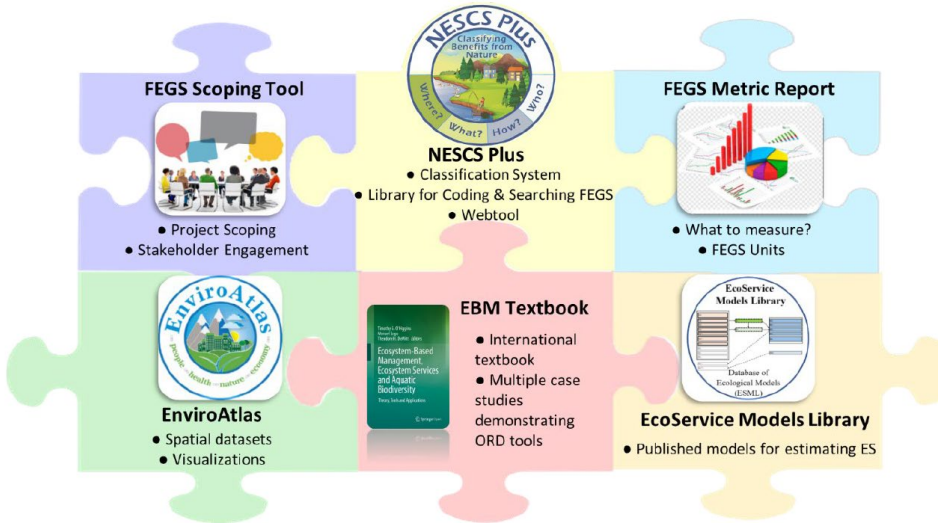
- Doing a preliminary assessment or investigation of a contaminated site.
- Planning or engaged in cleanup or reuse of a contaminated site.
- Working with a Contaminated Site process or model.

Other Decision-Making Contexts

Choose this path if you are:

- Working towards a goal that isn't ecological risk assessment or contaminated site cleanup (for example, natural resource management, park and recreation planning, habitat restoration, and stormwater management).
- Have a general interest in ecosystem services.

Step 1 | Step 2 | Step 3 | Matching Tools



Sharpe et al. 2023. Frontiers. https://doi.org/10.3389/fevo.2023.1290662

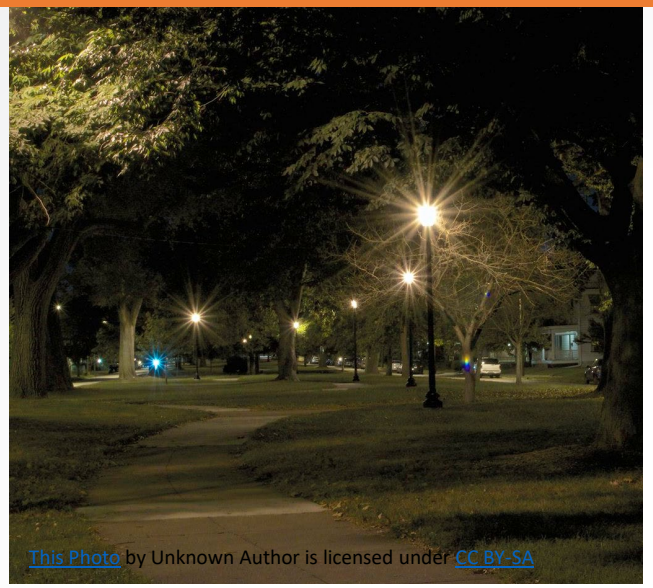
Harwell et al. 2024. Sustainability https://doi.org/10.3390/su16051739

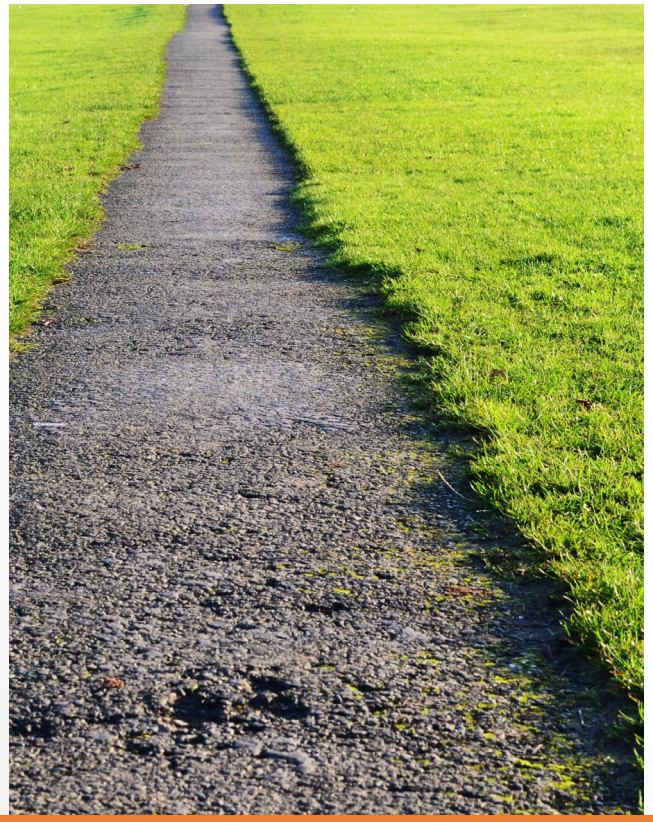
Example: Lake Sandy Jo Superfund Site, Gary, Indiana

- Partnership between the city of Gary, Fern Hill, the Indiana Department of Environmental Management, and the US Environmental Protection Agency
- Goal: to provide additional benefits to the community through consideration of ecosystem services
  - What does the community value?
  - How could these additional benefits be incorporated into development plans?

Community Interests

- Over the course of two virtual workshops and an in-person design charette, community members discussed community priorities and potential benefits, including:
  - Safety and security
  - Living standards
  - Health
  - Educational opportunities
  - Recreational opportunities
  - Stormwater/flood management
  - Aesthetics
  - Air quality





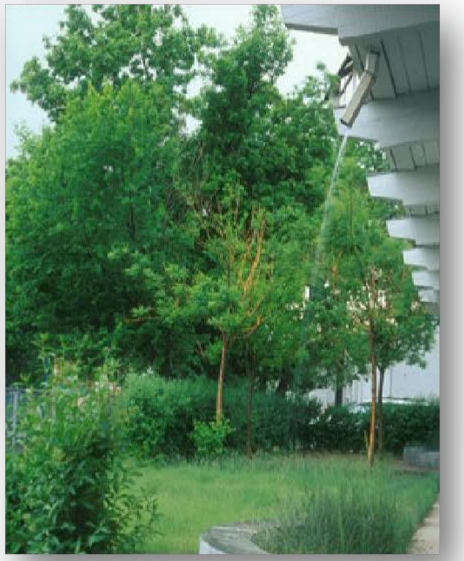
Safety and security

- Lighting and emergency poles
- Greening
- Clear lines of sight
- Fencing

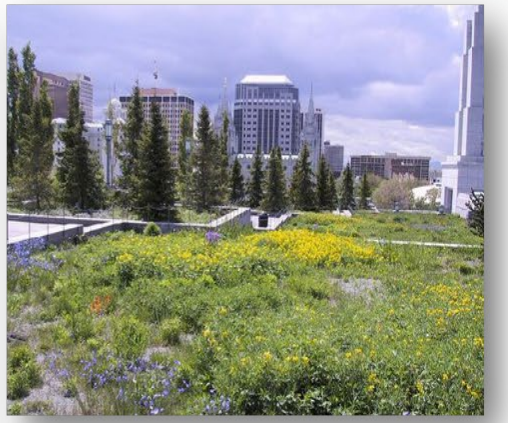
Air quality

- Vegetation barriers
- Trees
- Green roofs

Rainwater collected in planter box then channeled into rain garden
Boulder, CO



Irrigation by disconnected downspout
Denver, CO



Green roof
Salt Lake City, UT

Vegetative swale
Fort Carson, CO

Pervious pavement sidewalk
Sioux City, SD

Retention pond
Fargo, ND

Water management

- Landscape features
- Surface covers
- Vegetation

https://19january2021snapshot.epa.gov/water-research/stormwater-management-and-green-infrastructure-research_.html

Aesthetics

- Greenspace
- Trees and other vegetation choices
- Diverse plants flowering throughout the year
- Artistic Installments

Educational Opportunities

- Outdoor classrooms
- Study plots for students, researchers, & citizen scientists
- Community gardens
- Educational signage

Recreational Opportunities

- Trails
- Bird and pollinator habitat
- Play and exercise space

Renewable energy

- Solar powered commercial buildings
- Solar lighting
- Solar array
- Wind power

Reduced urban heat island

- Decrease the amount of black impervious surfaces
- Vegetation choices
  - Big broad leafed deciduous trees
- Cool or green roofs
- Cool paving materials and permeable parking

https://www.jlconline.com/how-to/roofing/cool-roofs-for-hot-climates_o

https://apnews.com/article/virus-outbreak-technology-arizona-bdd2b997ebdf976c22090eaf5b32bcb7

https://climatekids.nasa.gov/heat-islands/

National Ecosystem Services Classification System (NESCS+)

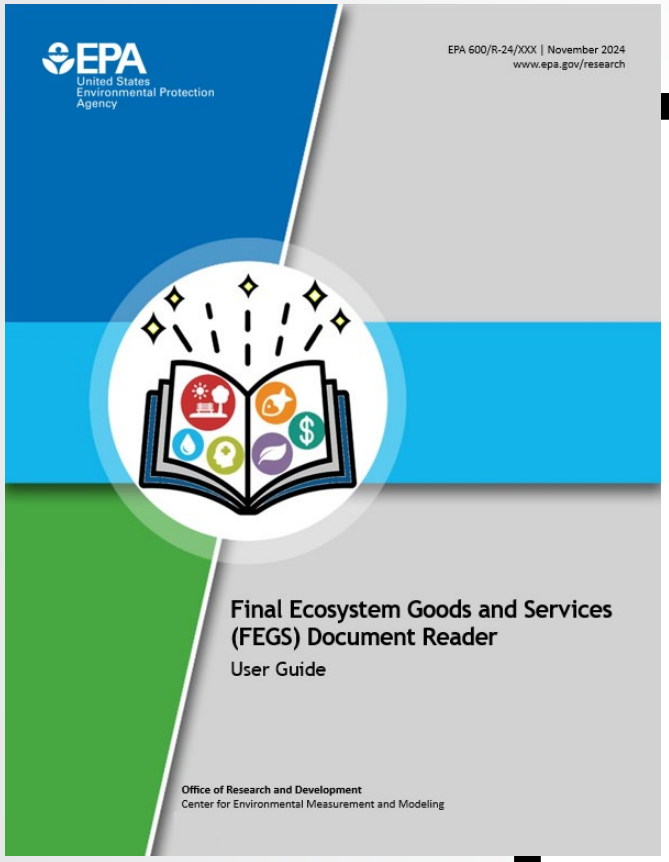
- NESCS Plus is an organizer.
- It aids identifying and classifying what matters directly to people.

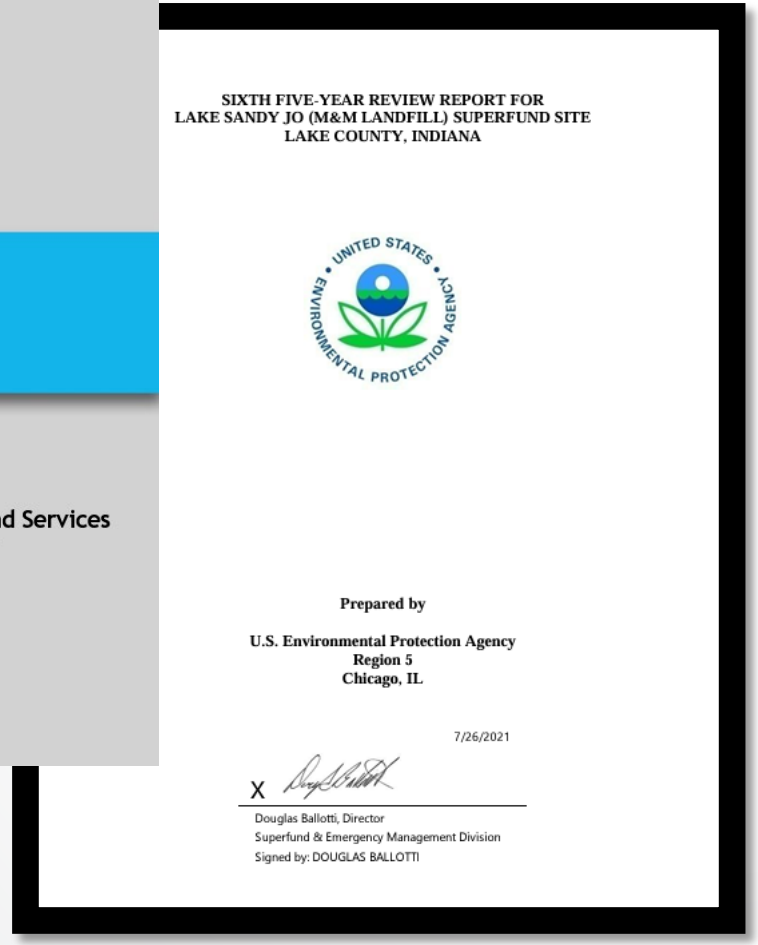
Ecological End-Product (Final Ecosystem Good)	Environment	Direct Use/User Beneficiary
		
Charismatic Bird Species	Grasslands	Recreational Bird Watchers
What?	**Where?**	**Who?/How?**

www.epa.gov/eco-research/nescs-plus

Beneficiary Profile from FEGS Doc Reader

(n=435 entries)





SIXTH FIVE-YEAR REVIEW REPORT FOR
LAKE SANDY JO (M&M LANDFILL) SUPERFUND SITE
LAKE COUNTY, INDIANA

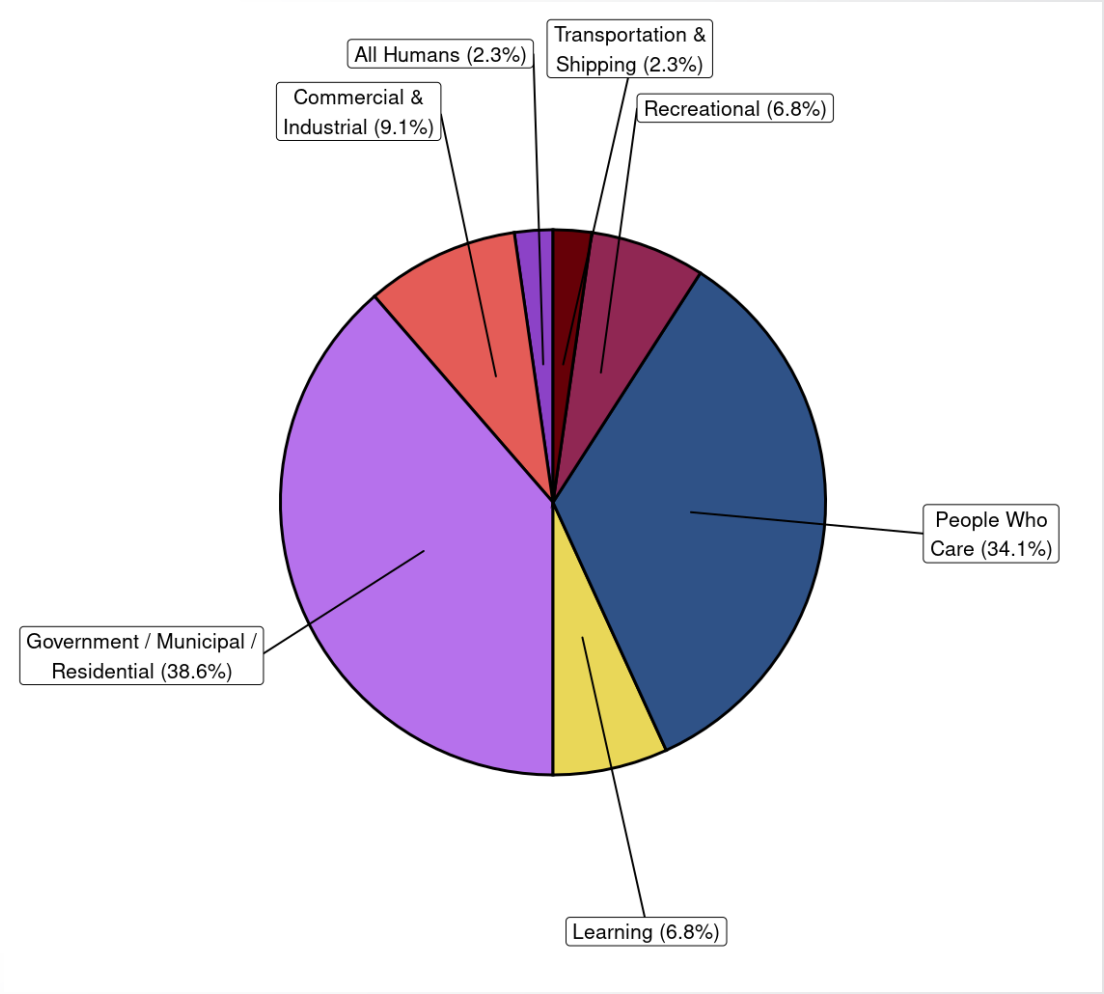
Prepared by

U.S. Environmental Protection Agency
Region 5
Chicago, IL

7/26/2021

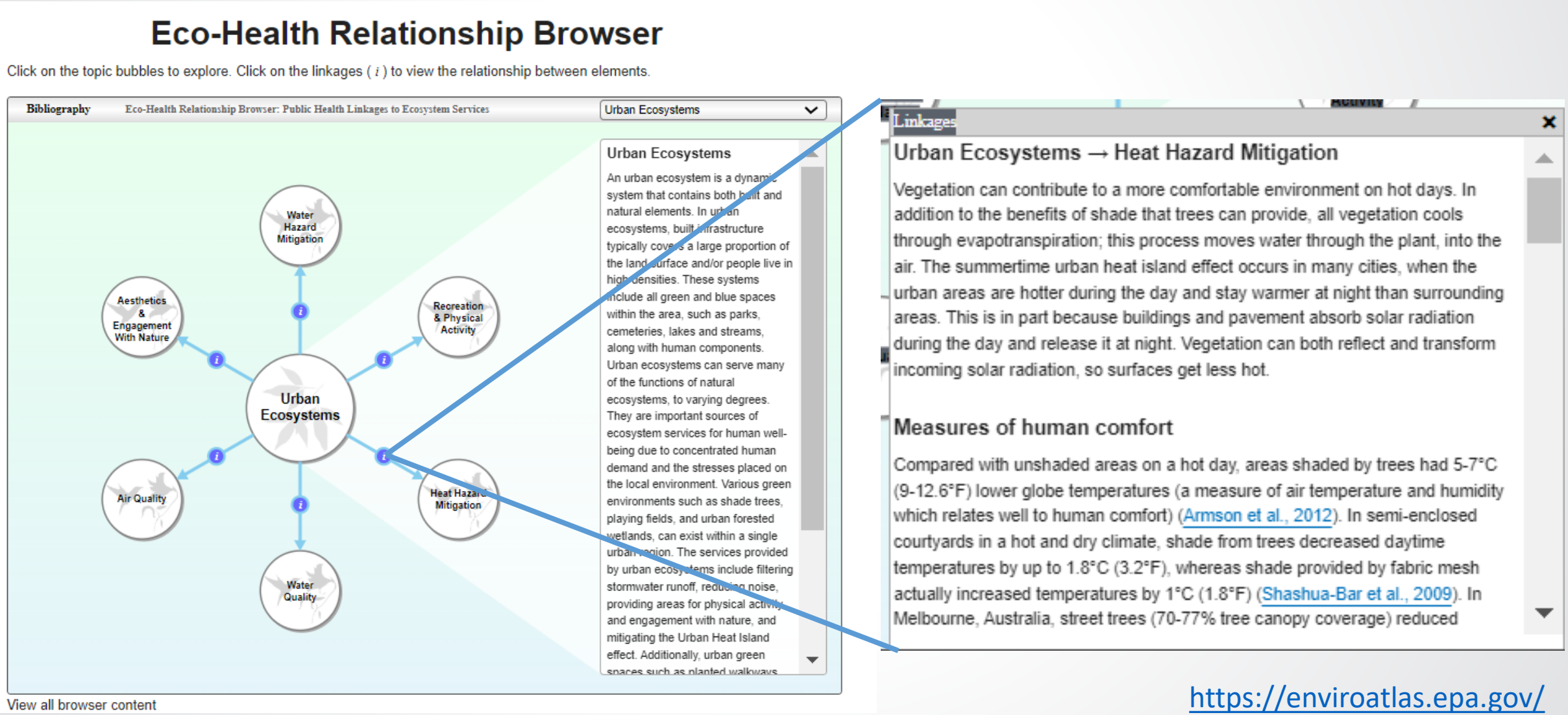
X

Douglas Ballotti, Director
Superfund & Emergency Management Division
Signed by: DOUGLAS BALLOTTI



https://rstudio-connect.dmap-stage.aws.epa.gov/content/6e74ea8f-8fe2-4c44-bcc9-8994969e0774

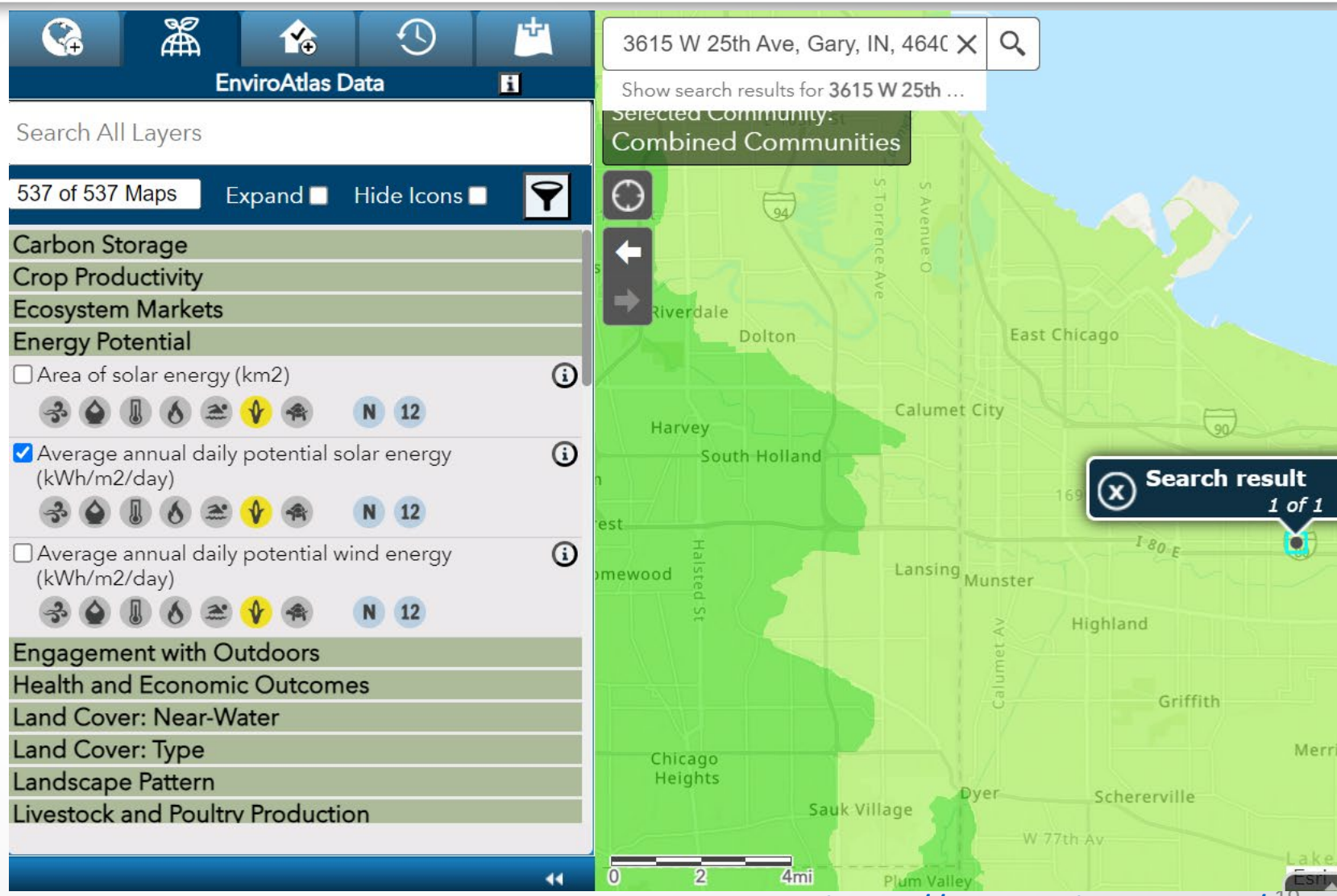
Learn about Eco-Health Linkages



https://enviroatlas.epa.gov/

Solar potential data in EnviroAtlas

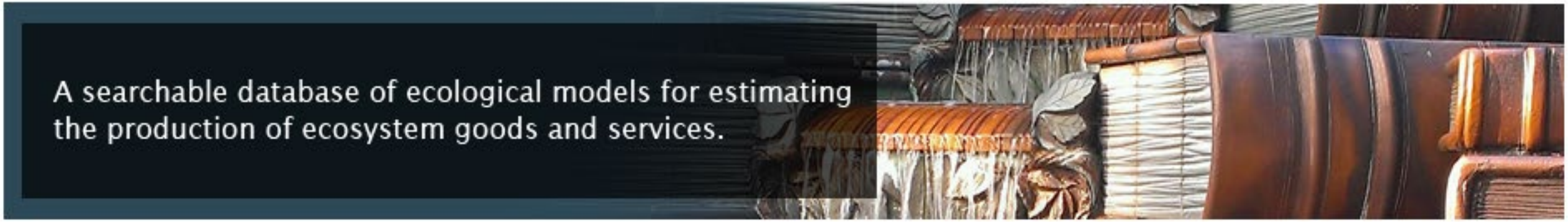
- Over 500 map layers
- Interactive Mapping Application
- Eco-Health Relationship Browser
- Analytic and Interpretive Tools
- GIS Toolboxes
- Guides, Use Cases, Tutorials



https://enviroatlas.epa.gov/

What is the EcoService Models Library (ESML)?

https://ESML.epa.gov/



- Detailed descriptions of >315 ecological models (>50 individual descriptors – covering purpose, approach, and environmental use such as ecosystem services using NESCS Plus and CICES)
- Detailed descriptions of ecological model variables (40 additional descriptors)
- Variable Relationship Diagrams, conceptual diagrams for each model

Modeling Scenarios for LSJ Ecosystem Services Areas

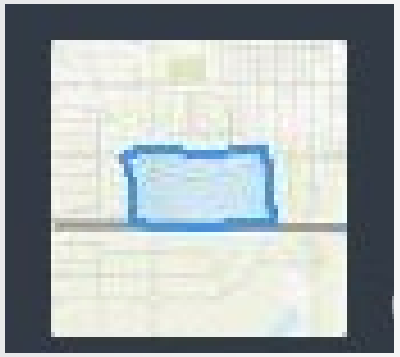
1. Wildlife that may use the site (US Fish and Wildlife Service)
2. Wildflowers to attract pollinators (Williams et al. 2015)
3. Trees for air quality, energy, and stormwater (US Forest Service i-Tree)
4. Low impact development options (EPA Stormwater Calculator)
5. Education benefits of school field trips (Hutcheson et al. 2018)
6. High-level suite of ecological functions (Ecosystem Intelligence Tool)

U.S. Fish & Wildlife Service

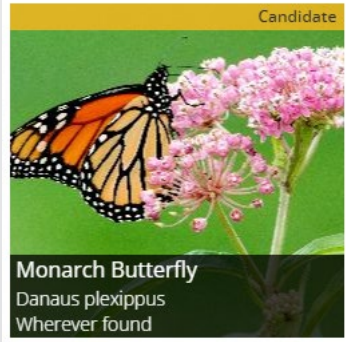
IPaC Information for Planning and Consultation

https://ipac.ecosphere.fws.gov/

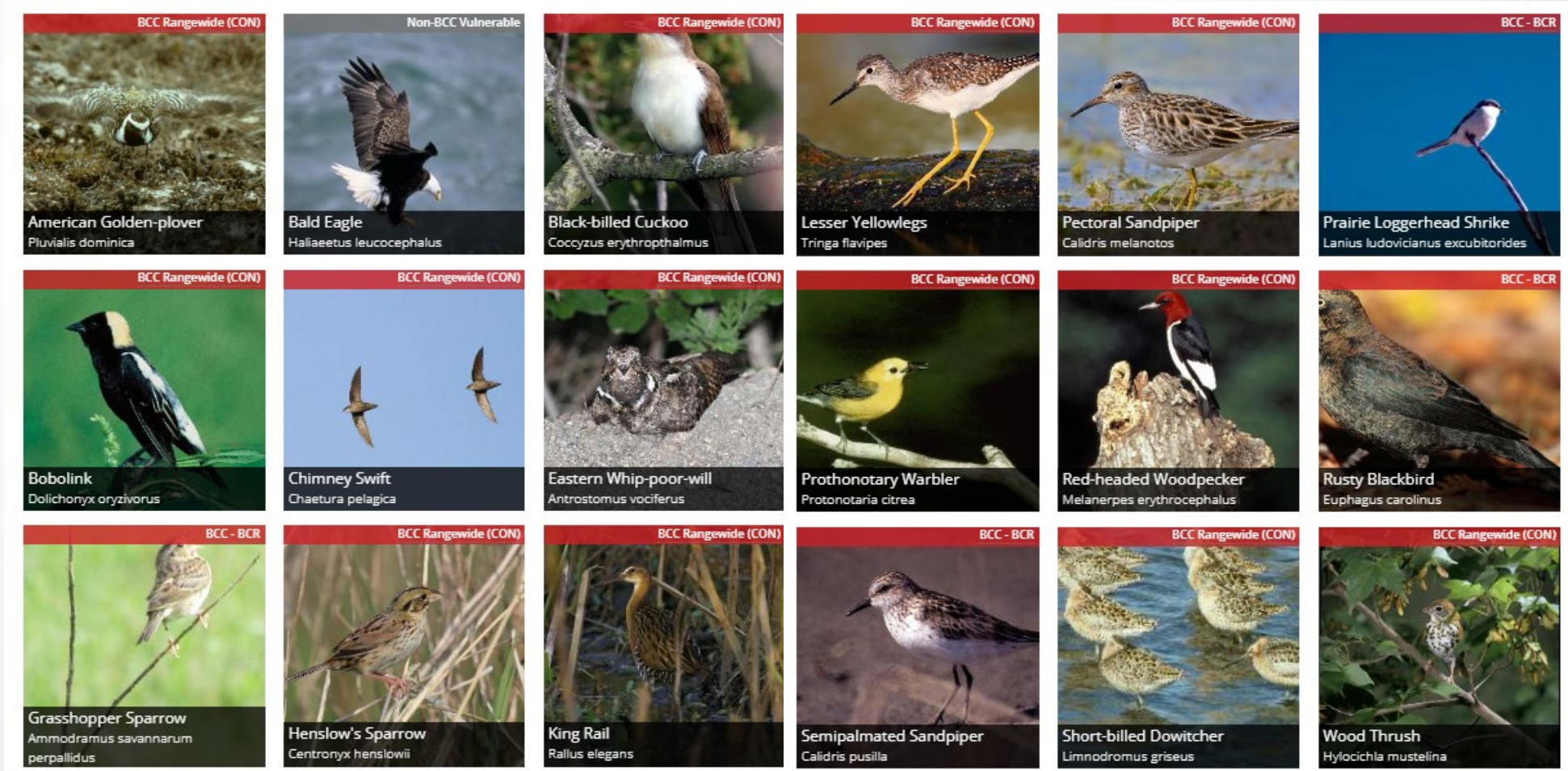
Location



Rare insect species

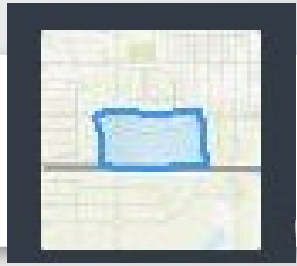


18 Migratory bird species



U.S. Fish & Wildlife Service

IPaC Information for Planning and Consultation



Monarch Butterfly

Danaus plexippus

STATUS

Candidate; A species under consideration for official listing for which there is sufficient information to support listing.

DESCRIPTION

Note - the monarch is a candidate species and not yet listed or proposed for listing. Consultation with U.S. Fish and Wildlife Service under section 7 of the Endangered Species Act is not required for candidate species, like the monarch. We encourage agencies, however, to take advantage of any opportunity they may have to conserve the species.

For information on monarch conservation, visit https://www.fws.gov/initiative/pollinators/monarchs, http://www.mafwa.org/?page_id=2347, and, for the West, https://wafwa.org/committees-working-groups/monarch-working-group/.

Adult monarch butterflies are large and conspicuous, with bright orange wings surrounded by a black border and covered with black veins. The black border has a double row of white spots, present on the upper side of the wings. Adult monarchs are sexually dimorphic, with males having narrower wing venation and scent patches. The bright coloring of a monarch serves as a warning to predators that eating them can be toxic.

During the breeding season, monarchs lay their eggs on their obligate milkweed host plant (primarily Asclepias spp.), and larvae emerge after two to five days. Larvae develop through five larval instars (intervals between molts) over a period of 9 to 18 days, feeding on milkweed and sequestering toxic chemicals (cardenolides) as a defense against predators. The larva then pupates into a chrysalis before emerging 6 to 14 days later as an adult butterfly. There are multiple generations of monarchs produced during the breeding season, with most adult butterflies living approximately two to five weeks; overwintering adults enter into reproductive diapause (suspended reproduction) and live six to nine months.

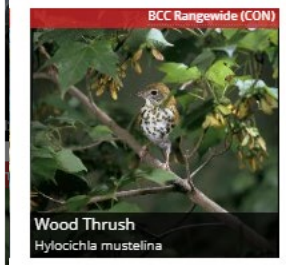
In many regions where monarchs are present, monarchs breed year-round. Individual monarchs in temperate climates, such as eastern and western North America, undergo long-distance migration, and live for an extended period of time. In the fall, in both eastern and western North America, monarchs begin migrating to their respective overwintering sites. This migration can take monarchs distances of over 3,000 km and last for over two months. In early spring

Migratory Bird Probability of Presence for this Project

Tell me about these graphs.

probability of presence | breeding season | survey effort | no data

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
American Golden-plover BCC Rangewide (CON) BCC Rangewide (CON)												
Bald Eagle Non-BCC Vulnerable Non-BCC Vulnerable												
Black-billed Cuckoo BCC Rangewide (CON) BCC Rangewide (CON)												
Bobolink BCC Rangewide (CON) BCC Rangewide (CON)												
Chimney Swift BCC Rangewide (CON) BCC Rangewide (CON)												
Eastern Whip-poor-will BCC Rangewide (CON) BCC Rangewide (CON)												
Grasshopper Sparrow BCC - BCR BCC - BCR												
Henslow's Sparrow BCC Rangewide (CON) BCC Rangewide (CON)												
King Rail BCC Rangewide (CON) BCC Rangewide (CON)												
Lesser Yellowlegs BCC Rangewide (CON) BCC Rangewide (CON)												



Wildflower planting mix supporting Bees in Gary, IN

(Utilizing ESML model 784, https://esml.epa.gov/detail/em/784, Williams et al. 2015 https://doi.org/10.1890/14-1748.1)

A mix to support wild bee abundance and species richness.

1. Asclepias syriaca – Common milkweed***
2. Dalea purpurea – Purple prairie clover
3. Lupinus perennis – Wild lupine***
4. Monarda fistulosa – Wild bergamot
5. Ratibida pinnata – Prairie coneflower
6. Rudbeckia hirta – Black-eyed Susan***
7. Silphium perfoliatum – Cup plant
8. Solidago speciosa – Showy goldenrod
9. Symphyotrichum leave – Smooth blue aster
10. Symphyotrichum novae-angliae – New England aster

*** represents species also found in the proposed seeding mix for Lake Sandy Jo

1


2


3


4


5

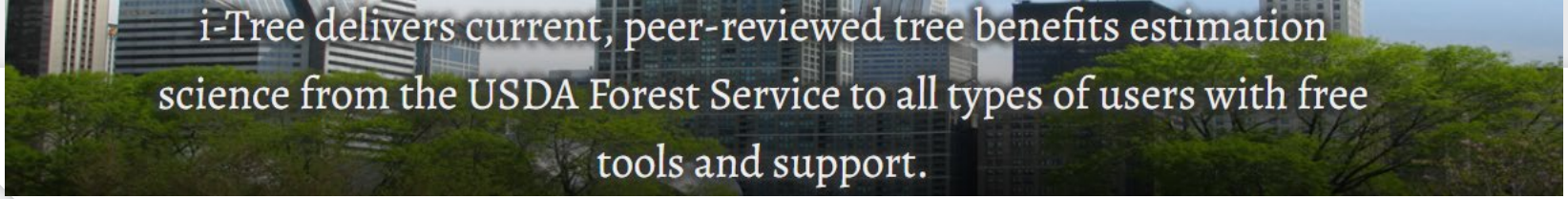

6


7


8


9


10

EPA

https://www.itreetools.org/

i-Tree

Trees provide more than just beauty and shade.

They **remove hazardous pollutants** from the air you breathe, **absorb carbon dioxide** from the air to store as wood, and **control storm water** by intercepting and absorbing rainfall.

Tools for Assessing Individual Trees

MyTree

Are you new to i-Tree? Start with our EASIEST tool! MyTree helps you quickly assess **individual trees** with a minimum of fuss.

web browser or *Android* / *Apple* *devices; Learn* ***How to use it****!*

i-Tree Design

A full-featured web tool with expanded building interactions and forecasting for estimating the benefits of **individual trees**.

via your web browser; Learn ***How to use it****!*

i-Tree Eco

Eco is our flagship tool that accommodates tree inventory IMPORT or field data evaluation to derive **individual tree** benefit estimates.

requires installation on a Windows PC; Learn ***How to use***

Tree Canopy Assessment Tools

OurTrees

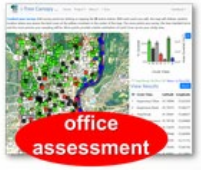
Quick **tree canopy** and related information for your community within the continental US!

web browser or *Android* / *Apple* *devices*

i-Tree Landscape

US **tree canopy** and Census maps/data at your fingertips! Identify priority planting & protection areas for climate & social issues.

via your web browser; Learn ***How to use it!***



i-Tree Canopy

From your chair, easily estimate land cover and **tree canopy** plus benefits using random point sampling on aerial imagery.

via your web browser; Learn ***How to use it!***

Tree Planting Tools

i-Tree Planting

Make a case to invest in tree planting by estimating the value those trees will provide in coming years.

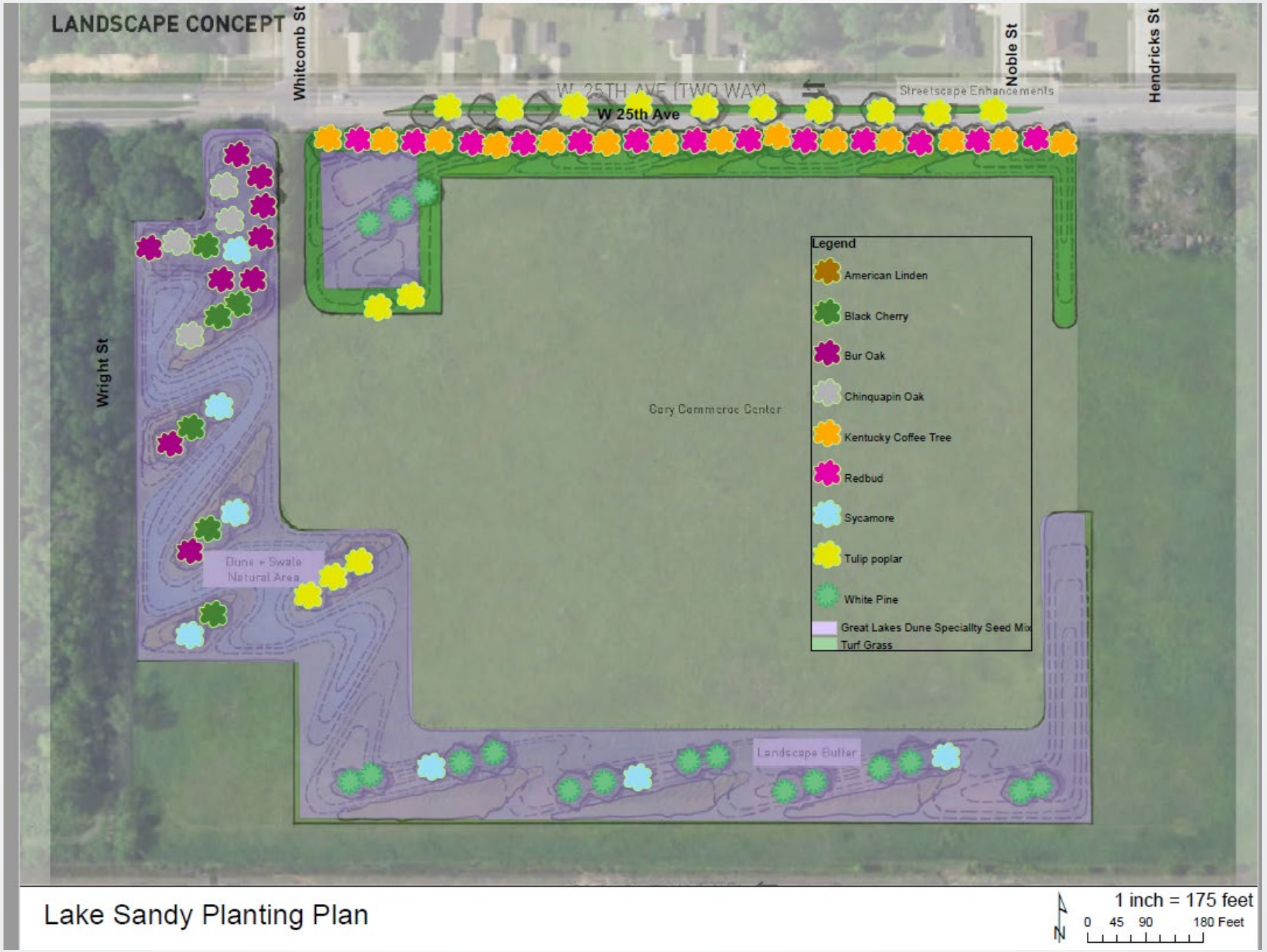
via your web browser; Learn ***How to use it!***

i-Tree Species

Find species for your location based on their ecosystem services.

via your web browser; Learn ***How to use it!***

Greenspace Scenario



MyTree Benefits

Over 20 years.

Tulip tree, *(Liriodendron tulipifera)*

Serving Size: 1.00 in. diameter
Condition: Excellent
Location: Gary, In, United States
Expected over 20 years: $36.08

Discover benefits of all your community trees!

Carbon Dioxide Uptake	**$17.72**
Carbon Sequestered[1]	207.77 lbs
CO_2 Equivalent[2]	761.84 lbs
Storm Water Mitigation	**$10.57**
Runoff Avoided	1,182.39 gal
Rainfall Intercepted	4,264.77 gal
Air Pollution Removal	**$7.79**
Carbon Monoxide	2.61 oz
Ozone	43.54 oz
Nitrogen Dioxide	4.16 oz
Sulfur Dioxide	1.63 oz
$PM_{2.5}$	0.52 oz

Benefit estimates are based on USDA Forest Service research and are meant for guidance only. Visit www.itreetools.org to learn more.

See the Project Menu for currency conversions.

+ Read the fine print.

Share

https://mytree.itreetools.org#/bene

MyTree Benefits

Over 20 years.

Sycamore spp, *(Platanus)*

Serving Size: 1.00 in. diameter
Condition: Excellent
Location: Gary, In, United States
Expected over 20 years: $21.10

Discover benefits of all your community trees!

Carbon Dioxide Uptake	**$6.84**
Carbon Sequestered[1]	80.21 lbs
CO_2 Equivalent[2]	294.12 lbs
Storm Water Mitigation	**$9.01**
Runoff Avoided	1,008.47 gal
Rainfall Intercepted	3,637.48 gal
Air Pollution Removal	**$5.25**
Carbon Monoxide	2.22 oz
Ozone	29.27 oz
Nitrogen Dioxide	2.67 oz
Sulfur Dioxide	1.12 oz
$PM_{2.5}$	0.27 oz

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MyTree Benefits

Over 20 years.

Redbud spp, *(Cercis)*

Serving Size: 1.00 in. diameter
Condition: Excellent
Location: Gary, In, United States
Expected over 20 years: $24.71

Discover benefits of all your community trees!

Carbon Dioxide Uptake	**$11.23**
Carbon Sequestered[1]	131.73 lbs
CO_2 Equivalent[2]	483.01 lbs
Storm Water Mitigation	**$8.92**
Runoff Avoided	998.21 gal
Rainfall Intercepted	3,600.45 gal
Air Pollution Removal	**$4.56**
Carbon Monoxide	2.2 oz
Ozone	25.35 oz
Nitrogen Dioxide	2.25 oz
Sulfur Dioxide	0.98 oz
$PM_{2.5}$	0.2 oz

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MyTree Benefits

Over 20 years.

Chinkapin oak, *(Quercus muehlenbergii)*

Serving Size: 1.00 in. diameter
Condition: Excellent
Location: Gary, In, United States
Expected over 20 years: $33.56

Discover benefits of all your community trees!

Carbon Dioxide Uptake	**$20.26**
Carbon Sequestered[1]	237.63 lbs
CO_2 Equivalent[2]	871.3 lbs
Storm Water Mitigation	**$8.31**
Runoff Avoided	929.49 gal
Rainfall Intercepted	3,352.61 gal
Air Pollution Removal	**$4.99**
Carbon Monoxide	2.05 oz
Ozone	27.74 oz
Nitrogen Dioxide	2.54 oz
Sulfur Dioxide	1.06 oz
$PM_{2.5}$	0.26 oz

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+ Read the fine print.

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EPA National Stormwater Calculator

Disconnection

Street Planters

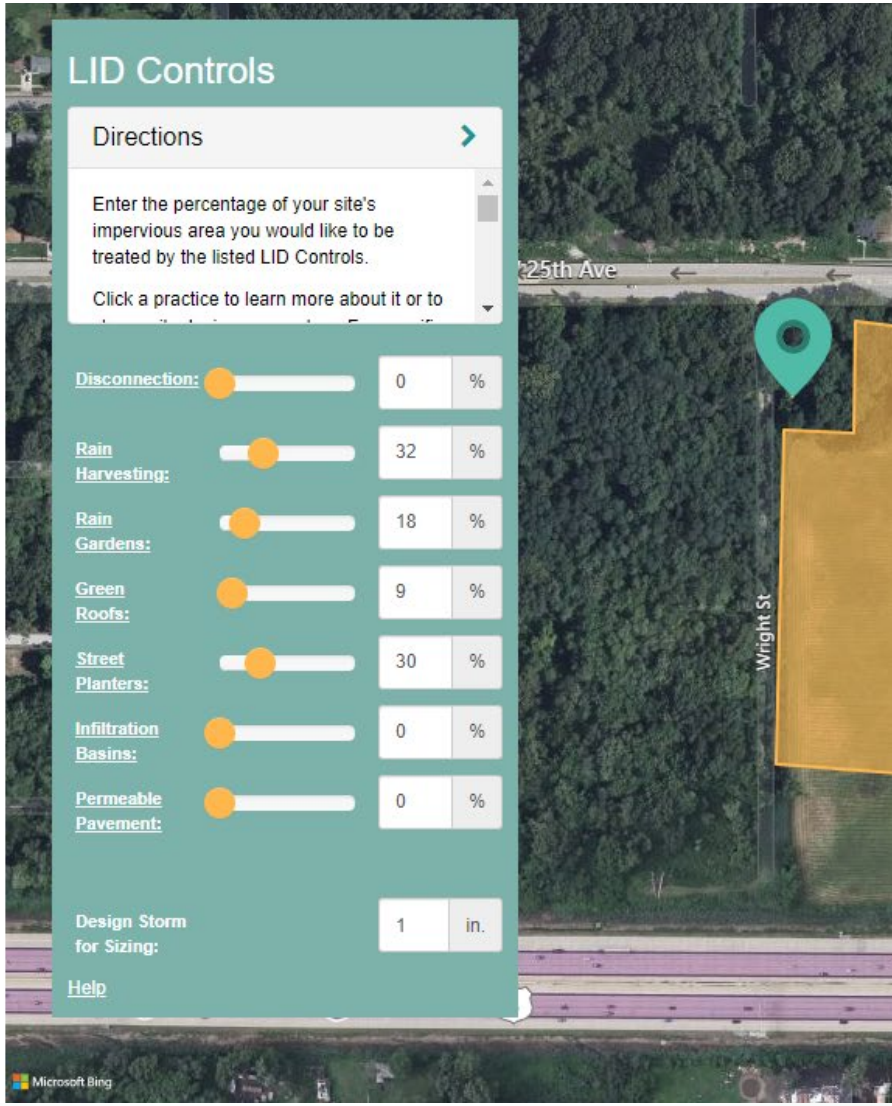
Rain Harvesting

Infiltration Basins

Rain Gardens

Permeable Pavement

Green Roofs



Rossman, L. Bernagros, J., Barr, C., and Simon, M. 2022. National Stormwater Calculator User's Guide Version 3.4.0. EPA/600/C-22/150 https://www.epa.gov/water-research/national-stormwater-calculator

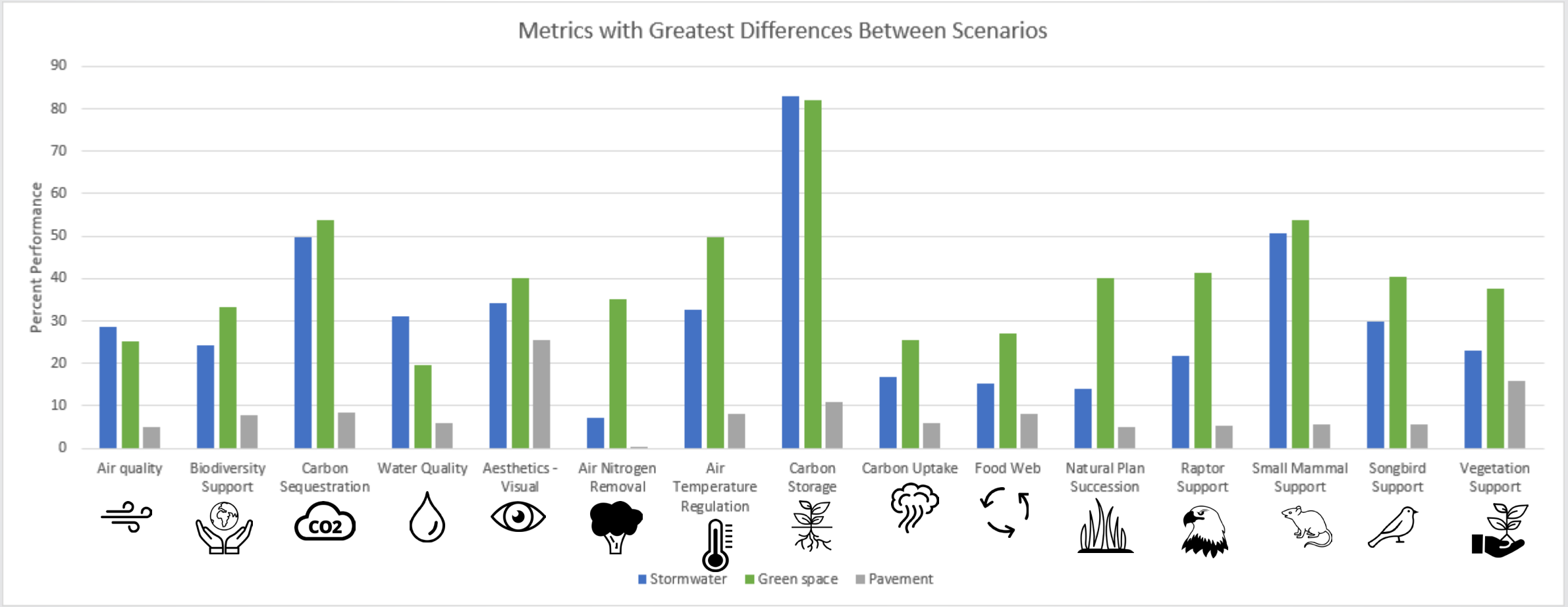
Education Value Model

- ESML-875 Hutcheson et al. 2018 doi:10.1016/j.ecoser.2018.03.005
- Calculates the benefit ($ value) of ecosystem services
- The educational value to Gary Indiana of one visit for all high school seniors (public and private) to learn about the ecosystem services incorporated into the LSJ project is approximately $54,236

ecosystem intelligence™

DRIVING PERVASIVE POSITIVE IMPACT

High-level planning tool provides initial rough estimates



https://www.ecosystemintelligence.com/

Beyond Lake Sandy Jo

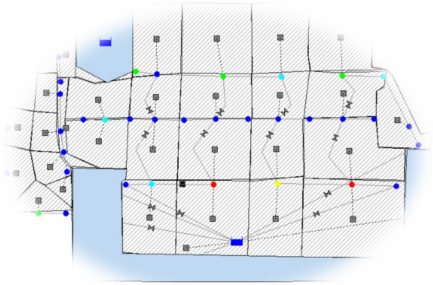
"The commercial reuse of a site like [Lake Sandy Jo] can bolster local economies by supporting jobs and generating revenue. Moreover, what we see at this site is the importance of bringing the local community in on redevelopment plans so they can share their goals and vision for revitalization" EPA Region 5 administrator Debra Shore

- The intent is that this approach would be useful for sites other than Lake Sandy Jo
  - That the city is empowered to take this approach for other sites/projects

Lake Sandy Jo Ecosystem Service Modeling

Wildflower Planting Mix

- Shows the impacts of increasing pollinator habitat
- Planting a targeted wildflower mix enhances pollinator diversity and presence over time



EPA Stormwater Management Model (SWMM)

- Used for planning, analysis, and design related to stormwater runoff
- Using Low Impact Controls, like rain gardens and street planters, reduce flooding and runoff

Information for Planning and Consulting (IPAC)

- Tool to identify the critical and endangered species in an area as well as migratory birds that pass through
- Setting up natural green spaces could provide habitat for 10 locally endangered species in northern Indiana as well as for 15 species of migratory birds

Education Valuation Model

- Calculates the benefit ($ value) of ecosystem services
- The educational value to Gary Indiana of one visit for all high school seniors (public and private) to learn about the ecosystem services incorporated into the LSJ project is approximately $54,236

Estimated ecosystem services from models

25 Species Protected

Developing green spaces will create habitat for **10** critical / endangered species as well as **15** species of migratory birds

33% Decrease in Stormwater Runoff

Building low impact controls will result in a **33%** decrease in surface runoff and exfiltration loss, along with a **66%** decrease in external outflow

Education Value of $54,236

Investing in educational green spaces could result in **$54,236** of educational value for an all high school seniors class student trip

4x More Pollinators

Planting a mix of local wildflower species in the ecosystem services area will support an increase in bee pollinator abundance

Relevant Resources

ES in Contaminated Sites

- U.S. Environmental Protection Agency (USEPA). 2017. Ecosystem Services at Contaminated Site Cleanups. Engineering Forum Issue Paper. EPA/542/R-17/004. URL: https://www.epa.gov/sites/default/files/2017-09/documents/ecosystem_services_at_contaminated_site_cleanups_ef_issue_paper.pdf.
- Harwell, M.C., Jackson, C., Kravitz, M., Lynch, K., Tomasula, J., Neale, A., Mahoney, M., Pachon, C., Scheuermann, K., Grissom, G. and Parry, K. 2021. Ecosystem services consideration in the remediation process for contaminated sites. *Journal of Environmental Management*, 285, p.112102.

Clu-In website for Ecosystem Services Information

- https://clu-in.org/ecotools/ecosystem.cfm.

Ecosystem Services and Risk Assessments

- Report: Kim et al. (2023). Operationalizing Ecosystem Services Endpoints and Assessment Tools for Supporting Risk Assessments. EPA/600/R-23/039. https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=357699&Lab=CPHEA.

Ecosystem Services Tool Selection Portal

- https://www.epa.gov/eco-research/ecosystem-services-tool-selection-portal.