

# Ecosystem Service Valuation Tools for Floodplains

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## DECISION SUPPORT HANDLING OF ECOSYSTEM SERVICES

Table 2 may serve as a loose section of this report. In order of ecosystem service category, first column beginning with

Table 2. Decision support tool

	InVEST
Biogeochemical Services	X X
Climate Regulation	Carbon Storage and Sequestration, Coastal Blue Carbon
Water Purification	Water Purification
Hydrological Services	X X
Sediment Retention	Sediment Retention
Inland Flood Regulation	
Coastal Protection	Coastal Protection Toolkit
Ecological Services	X X X
Habitat	Habitat Quality, Habitat Risk Assessment
Aesthetic Value	Scenic Quality
Recreation Value	Recreation and Tourism Rates

Table 1. Comparative matrix

	InVEST
Availability	Free and open-source
Interface	Desktop application, Python API (optional)
Analysis scale	Local to Global
Analysis type	Quantitative
Data input demand	Low to High
Valuation units	Monetary, Nonmonetary
Cartographic output	Yes
Tool requirements	GIS software to view results; 1 model requires ArcGIS
Time requirements	Low to High
Skill requirements	Moderate to High
User support	High
Cost	Low to High

## A COMPARATIVE ANALYSIS OF ECOSYSTEM SERVICE VALUATION DECISION SUPPORT TOOLS FOR WETLAND RESTORATION



Prepared for the Association of State Wetland Managers

By Mark Healy and Dr. Silvia Secchi

Southern Illinois University

# Ecosystem Services (ES)

Benefits society derives from nature

## Valuation of ES

Seeks to quantify services that are used in their final form

**Nutrient Cycling**



**Carbon Sequestration**  
**Water Purification**

Intermediate ES  
(not used by society)

Final ES  
(used by society)

# Valuation Units

**Monetary** | **Nonmonetary**

**Economic** | **Biophysical** | **Socio-cultural**

Much emphasis has been assigned to economic valuation.

There is utility for biophysical and social valuation units.

# Purpose

What tools are out there?

What do you need to know to pick one?

# The Tools

Developed specifically to assess ES

Open Access

“Out-of-box” functionality

**InVEST**

**I**ntegrated **V**aluation of **E**cosystem  
**S**ervices and **T**radeoffs

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**TESSA**

**T**oolkit for **E**cosystem **S**ervice  
**S**ite-Based **A**ssessment

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**Co\$ting  
Nature**

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**Benefit  
Transfer Toolkit**

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**ARIES**

**A**rtificial **I**ntelligence for  
**E**cosystem **S**ervices

# InVEST



Stanford  
**WOODS**  
INSTITUTE for the  
ENVIRONMENT

INSTITUTE ON THE  
ENVIRONMENT  
UNIVERSITY OF MINNESOTA  
Driven to Discover™

The Nature  
Conservancy



# TESSA



Anglia Ruskin  
University

# Co\$ting Nature



UNEP WCMC



# Benefit Transfer Toolkit



Colorado  
State  
University



Oregon State  
UNIVERSITY **OSU**

# ARIES



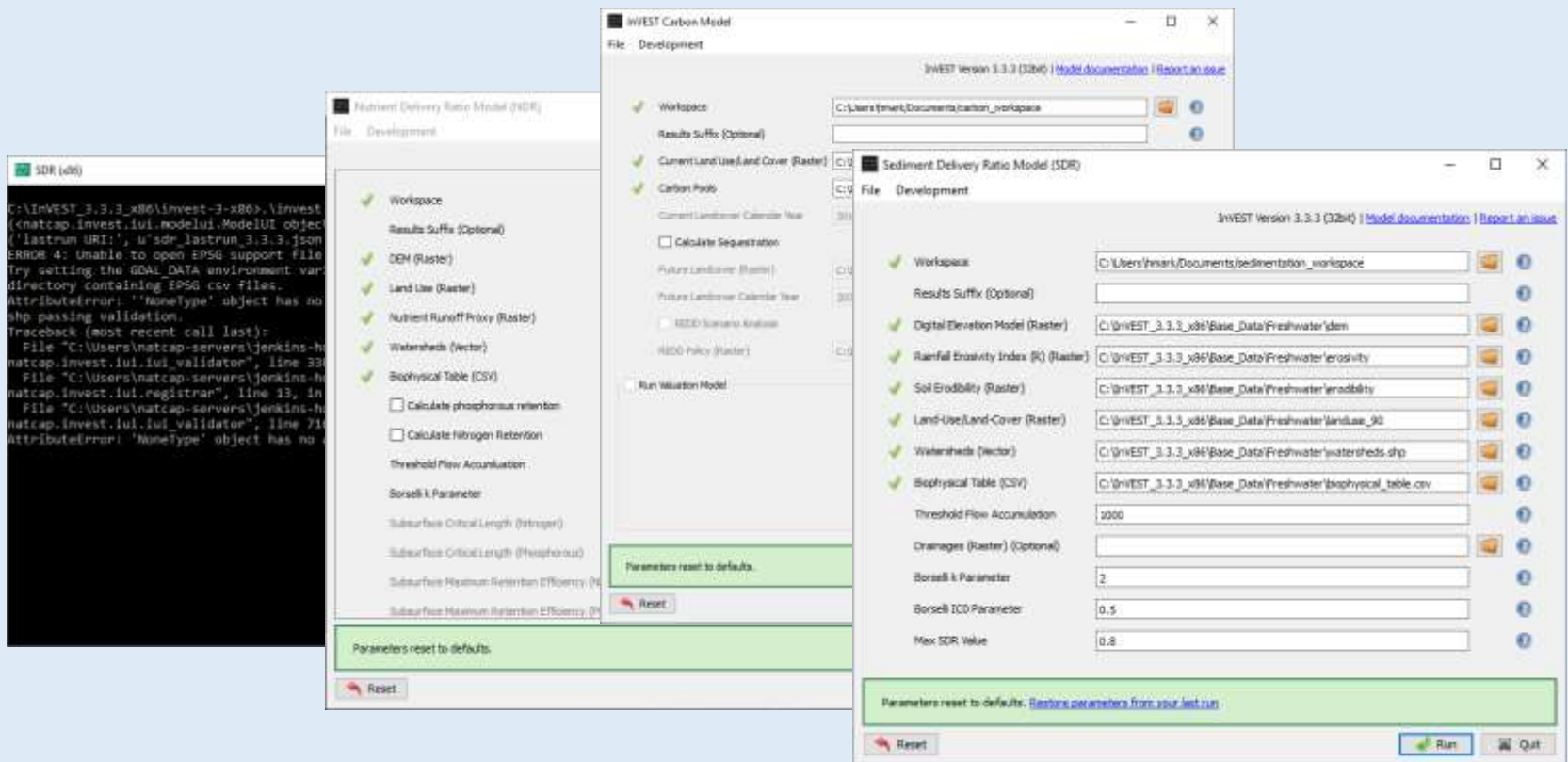
EARTH  
ECONOMICS

**bc**<sup>3</sup> BASQUE CENTRE  
FOR CLIMATE CHANGE  
Klima Aldaketa Ikergai



# InVEST

Modular suite of 16+ ES models.



Digital  
Elevation  
Model



Rainfall  
Erosivity



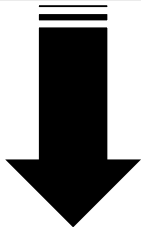
Soil  
Erodibility



Land use /  
Land cover



Watershed



MODEL  
PARAMETERS

$$usle_i = R_i \cdot K_i \cdot LS_i \cdot C_i \cdot P_i$$

$$SDR_i = \frac{SDR_{max}}{1 + \exp\left(\frac{IC_0 - IC_i}{k}\right)}$$

# InVEST

Methodology varies with ES.

Spatially explicit models quantify landscape supply of ES in biophysical terms.

Many models facilitate monetization of values.

# TESSA

**Toolkit guides users through a six step ES assessment at local scales**

Broad resource.  
Includes decision trees leading to 50+ hands-on ES valuation methods



# Co\$ting Nature

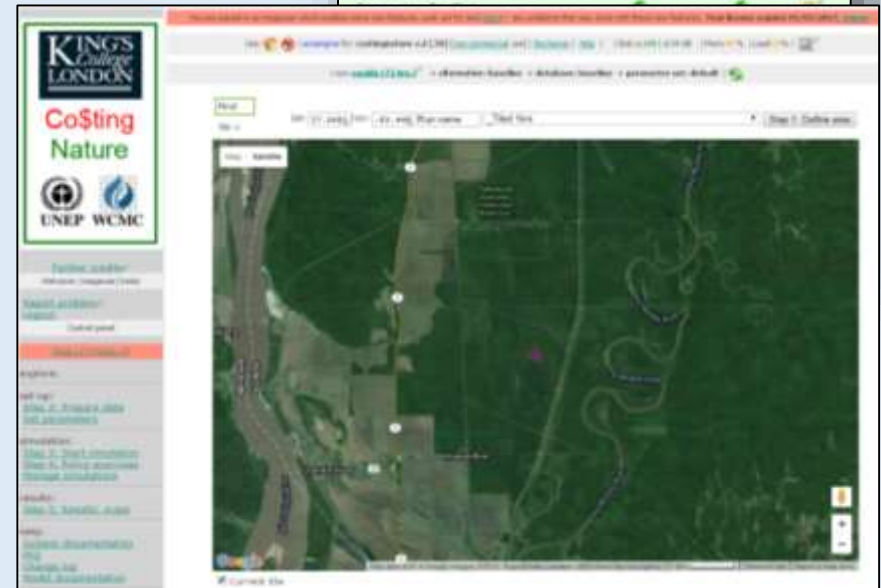
**Web application that allows for a rapid ES assessment.**

Assumes a geographic data mining approach.

Probabilistically generates ES indices from stacked data layers.



All ES maps found.			
Map data			
Input data layer		In workspace	Available
Total annual precipitation (WorldClim)	✓	✓	🗑️
Study area mask (Hydrosheds)	✓	✓	🗑️
Local drainage direction (Hydrosheds)	✓	✓	🗑️
Elevation (SRTM Hydrosheds)	✓	✓	🗑️
Cover of bare ground (Landat 2000)	✓	✓	🗑️
Cover of herb-covered ground (Landsat 2000)	✓	✓	🗑️
Cover of tree-covered ground (Landsat 2000)	✓	✓	🗑️
Carbon stock	✓	✓	🗑️
Cell area	✓	✓	🗑️
Cereal crop fraction	✓	✓	🗑️
Fibre crop fraction	✓	✓	🗑️
Forage crop fraction	✓	✓	🗑️
Fruit crop fraction	✓	✓	🗑️
Oil crop fraction	✓	✓	🗑️
Other crops fraction	✓	✓	🗑️
Pulses crop fraction	✓	✓	🗑️
Root and tuber crop fraction	✓	✓	🗑️



# Benefit Transfer Toolkit

## Benefit Transfer (for ES) :

*The transfer of ecosystem service value estimates from studied sites to an unstudied site of interest with similar characteristics.*

# Benefit Transfer Toolkit


**Web-hosted toolkit that facilitates benefit transfer for nature based recreation** (water quality forthcoming)

Merged and updated two economic databases. Literature review includes ~2900 recreation valuation studies.

Includes options for regional value tables and meta-regression.



# Benefit Transfer Toolkit



# Benefit Transfer Toolkit

[Toolkit Home](#)
[Background ▾](#)
[View Databases ▾](#)
[Tools ▾](#)
[Recreation Studies Map](#)
[login](#)

<a href="#">Individual Studies</a>	<a href="#">Full Dataset</a>	<a href="#">Average Values</a>	General Recreation		
<b>Reference</b>					
	Location	Site Name	Valuation Method	Economic Value Estimate (\$)	Units (converted from original units)
Azevedo, C.D., J.A. Herriges and C.L. Kling. 2003. Combining revealed and stated preferences: Consistency tests and their interpretations. American Journal of Agricultural Economics 85(3):525-537.	IA	---	Travel Cost Method	\$238.30	Per Person Per Day
Azevedo, C.D., J.A. Herriges and C.L. Kling. 2003. Combining revealed and stated preferences: Consistency tests and their interpretations. American Journal of Agricultural Economics 85(3):525-537.	IA	---	Contingent Valuation	\$238.30	Per Person

## Meta-Regression Functions

Instructions: Select the region where the Wildlife Viewing opportunity type being valued.

Select Region:

- ☐ Alaska
- ☐ Pacific Coast (*CA, OR, WA, HI*)
- ☐ Intermountain (*AZ, CO, ID, KS, MT, ND, NE, NM, NV, SD, UT, WY*)
- ☐ Northeast (*CT, DE, IA, IL, IN, MA, MD, ME, MI, MN, MO, NH, NJ, NY, OH, PA, RI, VT*)
- ☐ Southeast (*AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA*)
- ☐ Multiple Areas

Select Land Ownership Type:

- ☐ Public Land
- ☐ Other Land Type

Select Primary Wildlife Viewing Type:

- ☐ Birdwatching
- ☐ Charismatic Megafauna
- ☐ General wildlife viewing

## Meta-Regression Function Transfer: Wildlife Viewing

Instructions: Select the region where the Wildlife Viewing opportunity is located; select the land ownership type; and select the primary Wildlife Viewing type being valued.

Select Region:

- Alaska
- Pacific Coast (CA, OR, WA, HI)
- Intermountain (AZ, CO, ID, KS, MT, ND, NE, NM, NV, SD, UT, WY)
- Northeast (CT, DE, IA, IL, IN, MA, MD, ME, MI, MN, MO, NH, NJ, NY, OH, PA, I, VT, WI, WV)
- Southeast (AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA)
- Multiple Areas

Select Land Ownership Type:

- ☐ Public Land
- ☐ Other Land Type

Select Primary Wildlife Viewing Type:

- Birdwatching
- Charismatic Megafauna
- General wildlife viewing

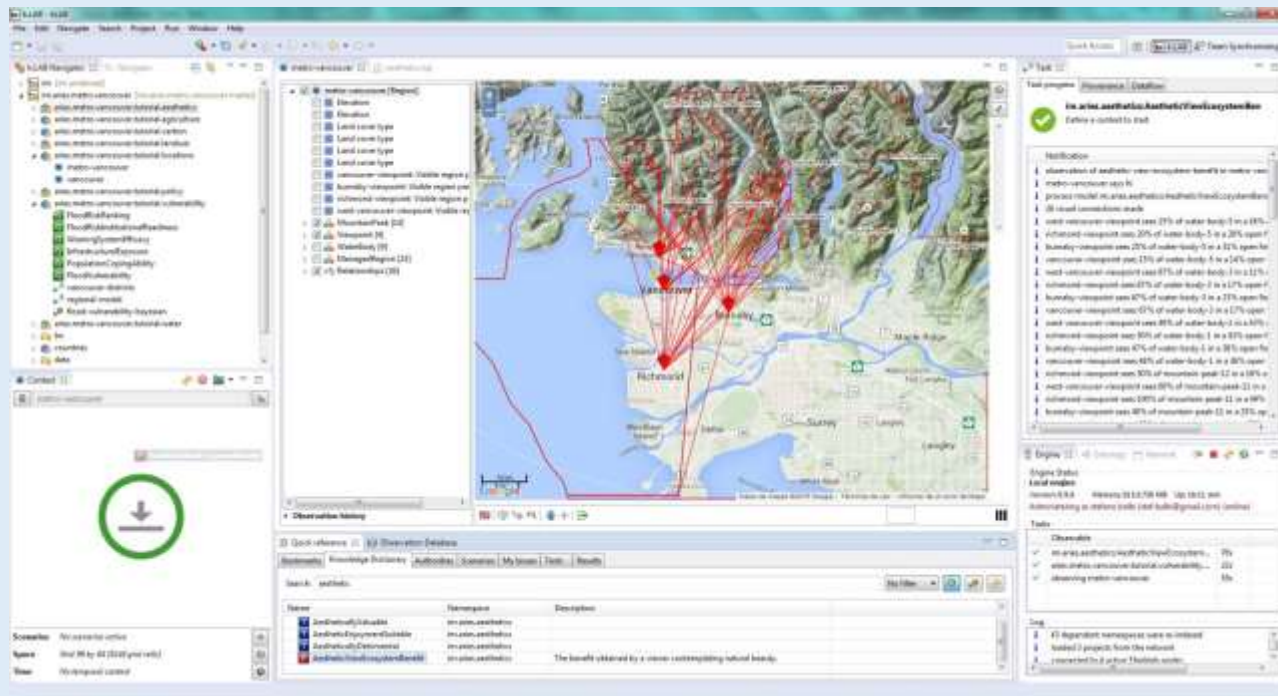
Calculate

[Click here for Statistical Model](#)



# ARIES

Facilitates cloud-networked, integrated modeling of ES in an IDE called k.LAB.



# ARIES

**Facilitates cloud-networked, integrated modeling of ES in an IDE called k.LAB.**

Valuation approaches include the provisioning of equations and look-up tables, Bayesian models, process-based models, and agent-based models

A “user-friendly” web application called k.EXPLORER is forthcoming.

# Choosing a Tool

Consider purpose, spatial context and logistical constraints

## 6 Tool Characteristics:

- |               |                    |
|---------------|--------------------|
| 1. ES handled | 4. Data Demand     |
| 2. Precision  | 5. Skills Required |
| 3. Scale      | 6. User Support    |

# 1. ES

## Hydrological

Water Purification <sup>a</sup>, Sediment <sup>b</sup> and  
Flood Regulation <sup>c</sup>, Coastal Protection <sup>d</sup>

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## Climate Regulation

Carbon Storage and Sequestration <sup>e</sup>,  
Coastal Blue Carbon <sup>f</sup>

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## Ecological

Habitat Quality <sup>g</sup>

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## Recreational

Visitation Rates <sup>h</sup>, Recreational Value <sup>i</sup>  
(e.g., “Willingness to Pay”)

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## Aesthetic

Scenic Quality <sup>j</sup>, Open Space <sup>k</sup>

# 1. ES

	a	b	c	d	e	f	g	h	i	j	k
<b>InVEST</b>	Blue	Blue		Blue	Red	Red	Green	Purple		Orange	
<b>TESSA</b>	Blue	Blue	Blue		Red			Purple	Purple		
<b>Co\$ting Nature</b>	Blue		Blue		Red		Green	Purple			
<b>Benefit Transfer Toolkit</b>	Light Blue							Purple	Purple		Orange
<b>ARIES</b>	Blue	Blue	Blue		Red				Purple	Orange	Orange

# 2. Precision

## Purpose

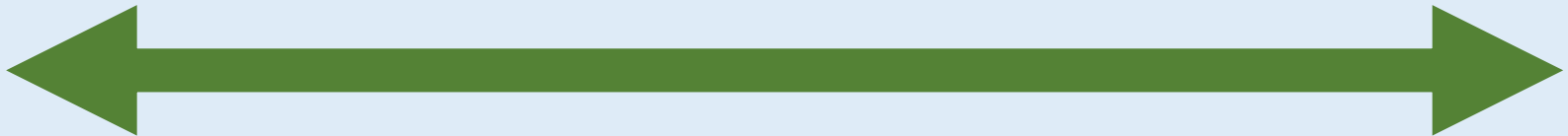
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Generate  
Awareness

Land-Use  
Management/Planning

Policy Analysis

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Low











Medium

High

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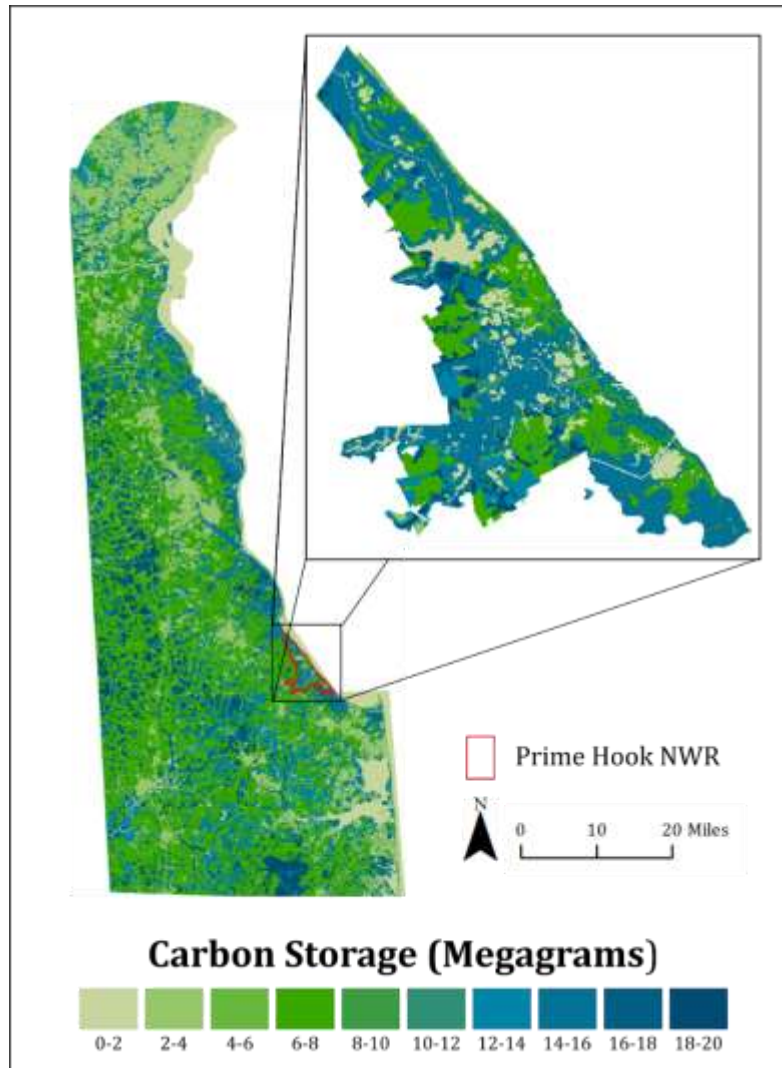
Precision Spectrum

# 3. Scale

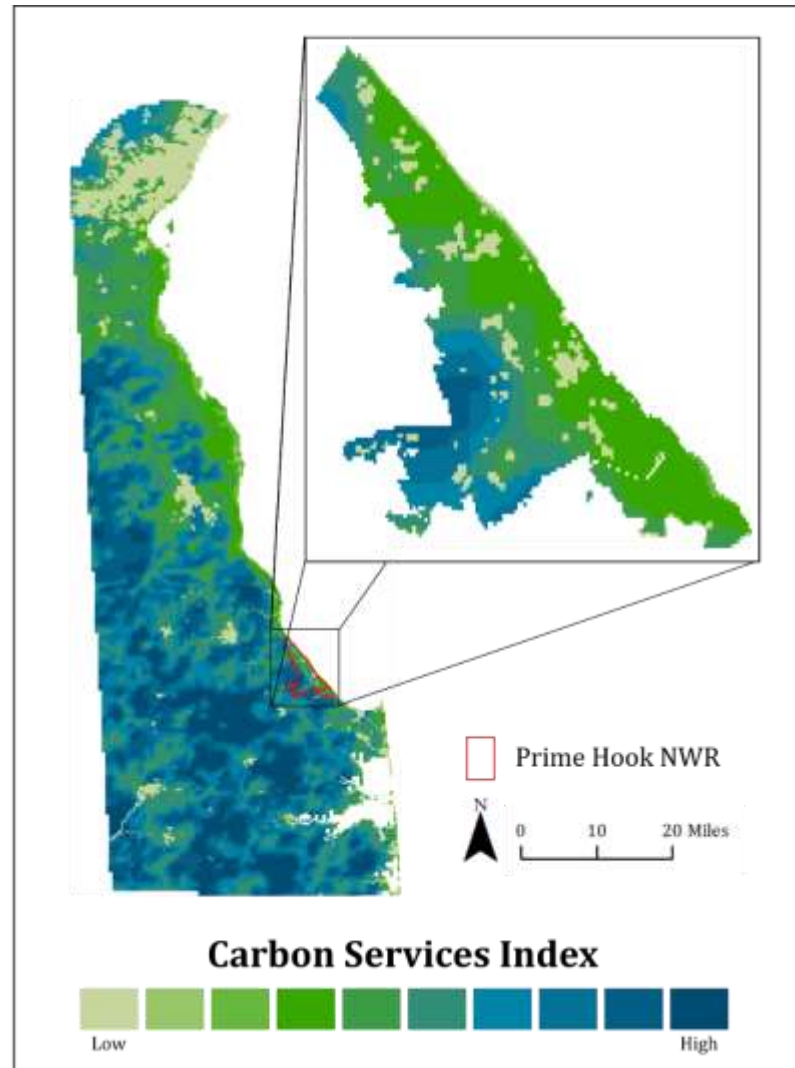
Tool	Local	Regional	Global
<b>InVEST</b>			
<b>TESSA</b>			
<b>Co\$ting Nature</b>			
<b>Benefit Transfer Toolkit</b>			
<b>ARIES</b>			

### 3. Scale

## DELAWARE | Carbon Services



**InVEST Carbon Model**



**Co\$ting Nature**



# **4. Data Demand**

**The tools have been developed to keep data input and technical expertise required to a minimum.**

Most tools will operate on coarse publicly available geospatial data and tables from scientific reports.

Tool

Data  
Demand

Skills  
Required

Support

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**InVEST**

Moderate to  
High

---

**TESSA**

Low to  
Moderate

---

**Co\$ting  
Nature**

Low

---

**Benefit  
Transfer Toolkit**

Low

---

**ARIES**

Moderate to  
High

---

Tool	Data Demand	Skills Required	Support
InVEST	Moderate to High	Moderate to High	
TESSA	Low to Moderate	Low	
Co\$ting Nature	Low	Low	
Benefit Transfer Toolkit	Low	Low	
ARIES	Moderate to High	Moderate to High	

# 5. Skills Required

Tool/model data input/output are frequently spatially explicit.

Proficiency with geospatial software often optimizes tool utilization.

**Needed technical knowledge of underlying physical processes is often mitigated by a high level user support.**

# **6. User Support**

**At minimum, all tools have adequate user manuals.**

Tools with the best user support facilitate forums and training programs.

Tool	Data Demand	Skills Required	Support
<b>InVEST</b>	Moderate to High	Moderate to High	High
<b>TESSA</b>	Low to Moderate	Low	Moderate
<b>Co\$ting Nature</b>	Low	Low	Low
<b>Benefit Transfer Toolkit</b>	Low	Low	Low
<b>ARIES</b>	Moderate to High	Moderate to High	Moderate

# Insights

One model/tool doesn't fit all purposes and contexts. Though some definitely outperform others.

Tools such as **TESSA** and **ARIES** embrace this concept and allow user flexibility.

# Insights

**InVEST** model development and research is well funded and most active.

**InVEST** developers and **TESSA** offer additional software and support beyond valuation.



# Insights

Tools such as the **Benefit Transfer Toolkit** and **InVEST** openly provide their underlying databases and/or model code.

e.g., **open-source**

# Questions?

**Mark Healy**

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See [ASWM.org](http://ASWM.org) for the report and other wetland management publications and webinars

“A Comparative Analysis of Ecosystem Service Valuation Decision Support Tools for Wetland Restoration”

# Links

## **InVEST**

<http://www.naturalcapitalproject.org/invest/>

## **TESSA**

<http://tessa.tools/>

## Co\$ting Nature

<http://www.policysupport.org/costingnature>

## USGS Benefit Transfer Toolkit

<https://my.usgs.gov/benefit-transfer/>

## ARIES

<http://aries.integratedmodelling.org/>