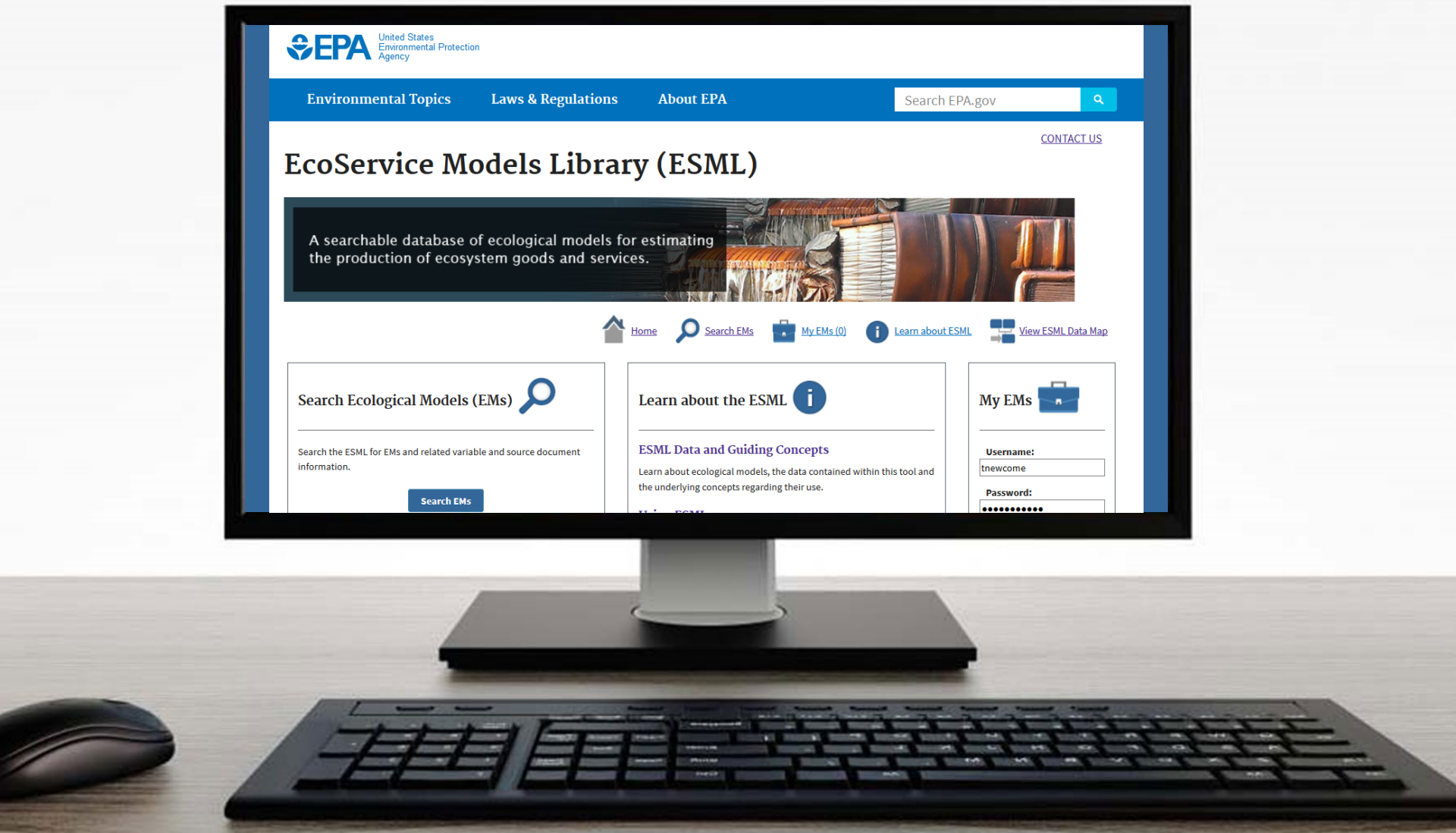

EPA's EcoService Models Library (ESML): A New Tool for Quantifying and Valuing Ecosystem Services

Tammy Newcomer-Johnson, Randy Bruins,
Gregg Lomnicky, John Wilson, and Ted DeWitt

Acknowledgements

- Science
  - Randy Bruins, Retired US EPA (Original Leader)
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What is ESML? https://ESML.epa.gov/

A searchable database of ecological models for estimating the production of ecosystem goods and services.

What does ESML help you to do?

Objective: ESML provides informative model descriptions that help users **find**, **examine**, and **compare** models

Why did we build ESML?

- EPA Office of Water Economists
- Help planners, analysts, and scientists to understand and select useful ecological models
- Help researchers interested in improving ecological modeling methods

Some things ESML is not:

- not a modeling system
- not an ecological valuation database
- not a decision support system
- not a compendium of model software
- not a substitute for original documentation
- not an endorsement

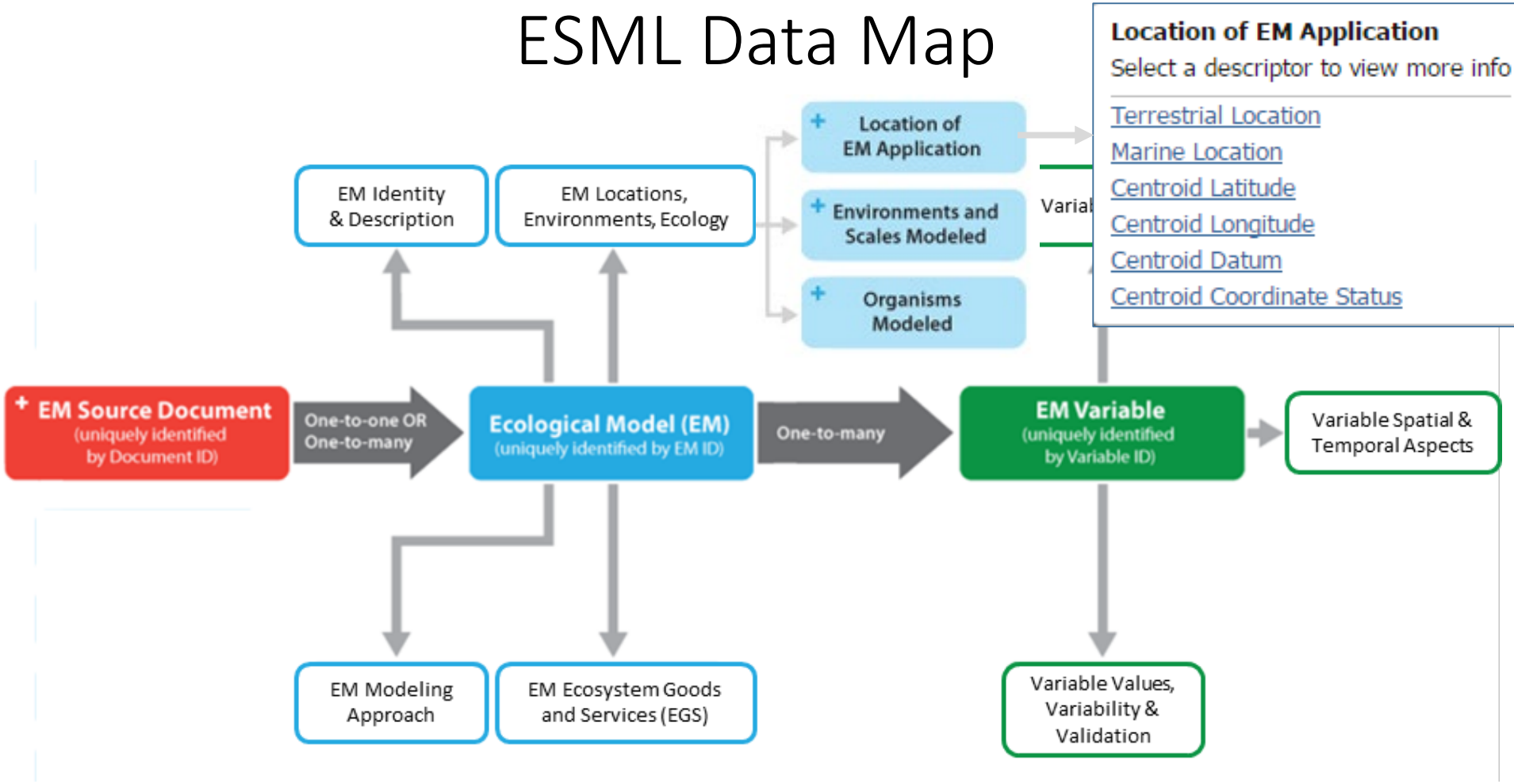
What's in ESML? https://ESML.epa.gov/

- Detailed descriptions of **>150 ecological models (>50 informative model descriptors** – covering purpose, approach, and environmental use)

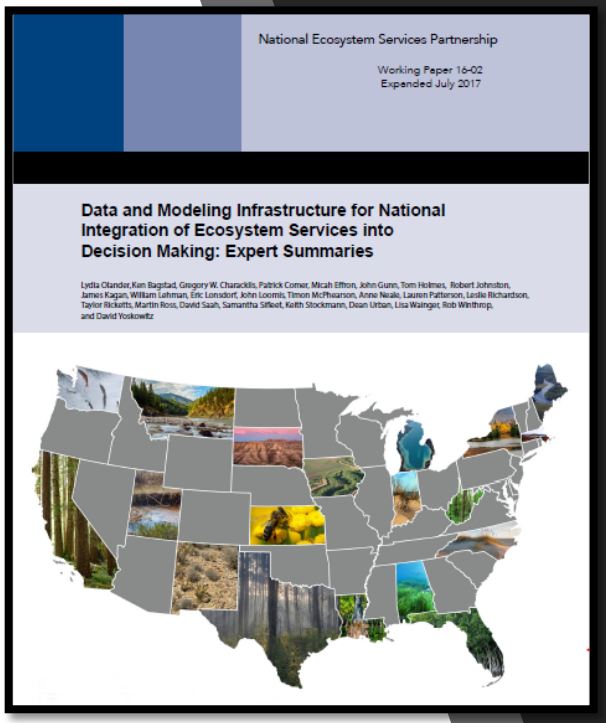
- Detailed descriptions of **ecological model variables (40 additional descriptors)**

- **Variable Relationship Diagrams**, conceptual diagrams for each model

Learn more about descriptors with the ESML Data Map



Example Source Documents



Arnold, J.G., and N. Fohrer. 2005. "SWAT2000: Current Capabilities and Research Opportunities in Applied Watershed Modelling." *Hydrological Processes* 19(3): 563–572. **(SWAT model)**

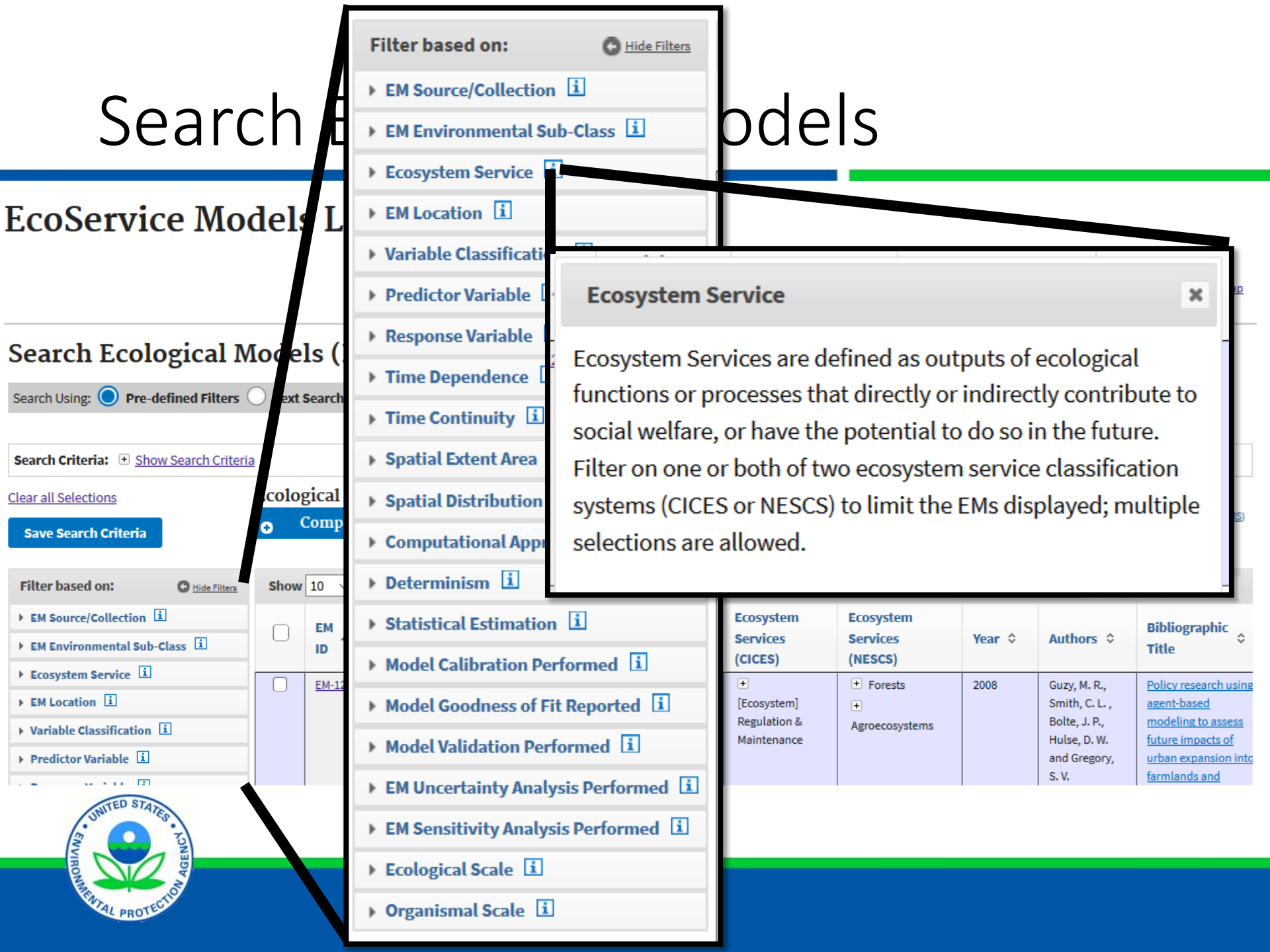
Koh, Insu, Eric V. Lonsdorf, Neal M. Williams, Claire Brittain, Rufus Isaacs, Jason Gibbs, and Taylor H. Ricketts. 2016. "Modeling the Status, Trends, and Impacts of Wild Bee Abundance in the United States." *Proceedings of the National Academy of Sciences* 113 (1): 140–145. (this paper & at least one other use the **InVEST pollination model**)

Nowak, D.J., R.E. Hoehn III, A.R. Bodine, E.J. Greenfield, A. Ellis, T.A. Endreny, Y. Yang, T. Zhou, and R. Henry. 2013. "Assessing Urban Forest Effects and Values: Toronto's Urban Forest." *Resource Bulletin* NRS-79. Newtown Square, PA: Department of Agriculture, Forest Service, Northern Research Station. (**iTree-Eco model**)

Villa, F., K.J. Bagstad, B. Voigt, G. Johnson, R. Portela, M. Honzak, and D. Batker. 2014. "A Methodology for Adaptable and Robust Ecosystem Services Assessment." *PLoS ONE* 9(3): e91101. doi:10.1371/journal.pone.0091001. (**ARIES model**)

Wang, D. and M. Hejazi. 2011. "Quantifying the Relative Contribution of Climate and Direct Human Impacts on Mean Annual Streamflow in the Contiguous United States." *Water Resources Research* 47: W00J12. (**UFORE-Hydro/iTree-Hydro**)

Search E odels



Ecosystem Service Classification Systems

Common International Classification of Ecosystem Services (CICES)

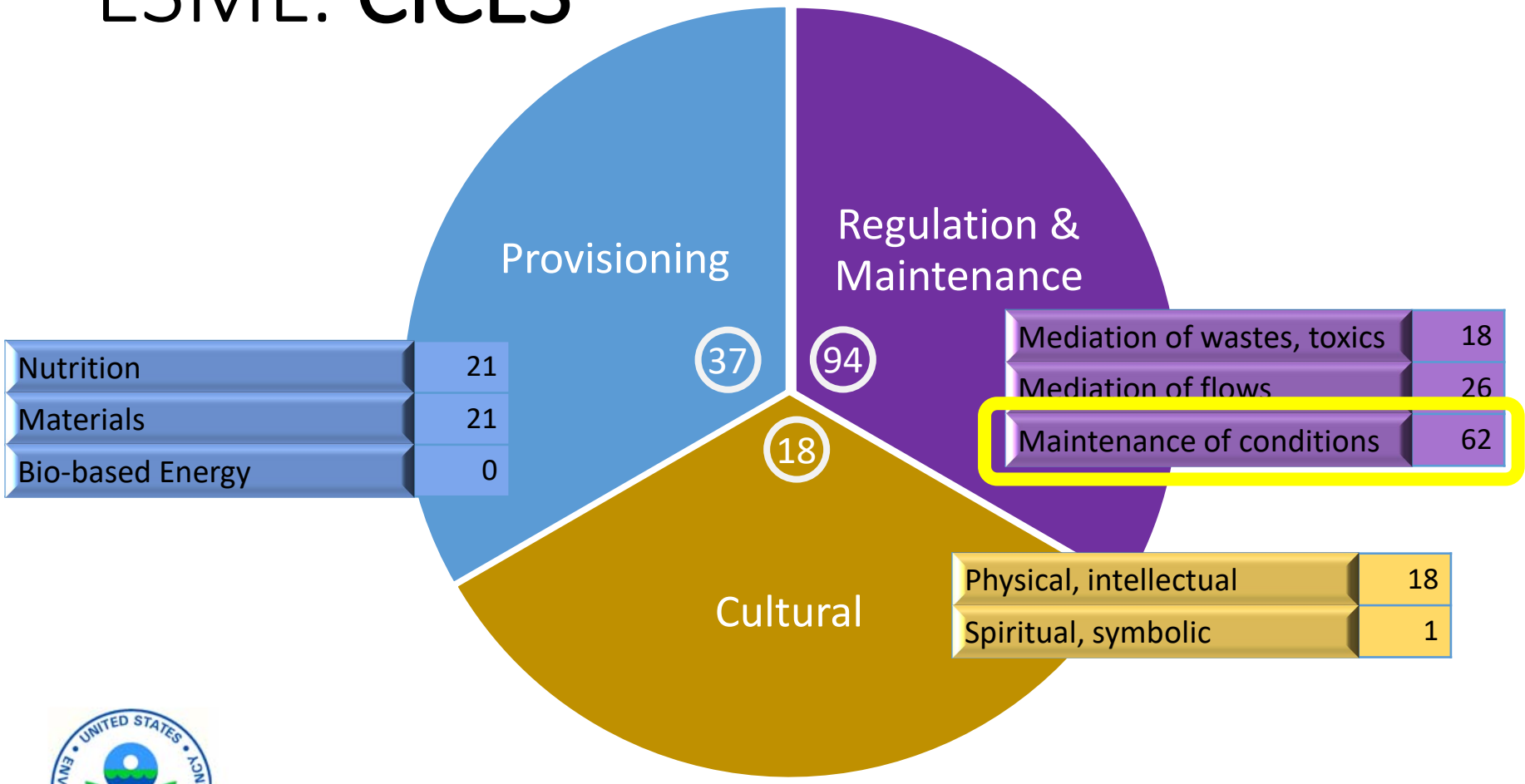
- Developed by European Environment Agency with international participation
- Based on Millennium Ecosystem Assessment
- Intuitive groupings of services
- Mix of intermediate and final ecosystem services
- Classification is independent of environment or human beneficiary
- For further information: cices.eu

Ecosystem Service Classification Systems

National Ecosystem Service Classification System (NESCS)

- Based on EPA's Final Ecosystem Goods and Services Classification System (https://gispub4.epa.gov/FEGS/)
- Includes only final ecosystem services (avoids double-counting)
- Classification recognizes environment and human beneficiary
- For further information: https://www.epa.gov/eco-research/national-ecosystem-services-classification-system-framework-design-and-policy

Partial breakdown of service classes, with number of models in ESML: **CICES**

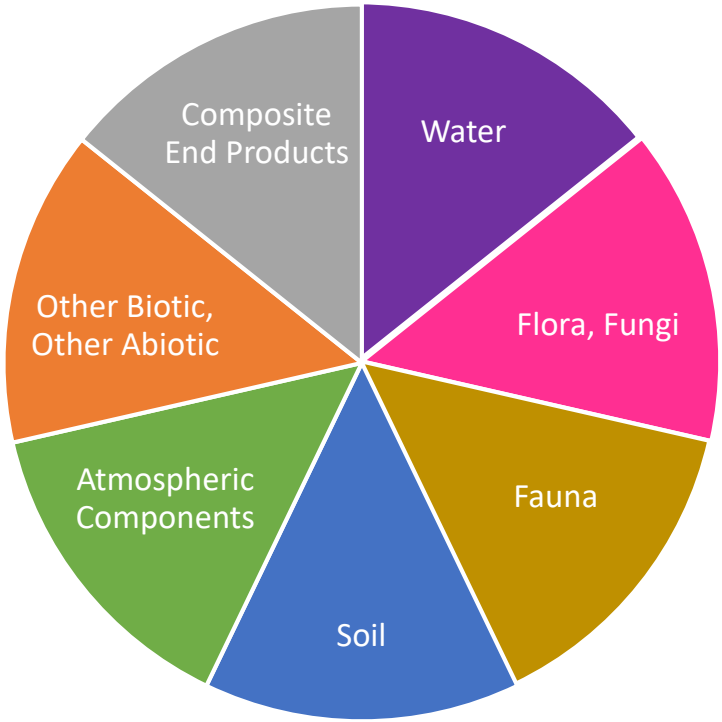


Detail of CICES category, “Maintenance of physical, chemical, biological conditions”

Lifecycle maintenance, habitat and gene pool protection	Pollination and seed dispersal	6
	Maintaining nursery populations and habitats	23
Pest and disease control	Pest control	1
	Disease control	0
Soil formation and composition	Weathering processes	1
	Decomposition and fixing processes	8
Water conditions	Chemical condition of freshwaters	8
	Chemical condition of salt waters	2
Atmospheric composition and climate regulation	Global climate regulation by reduction of greenhouse gas concentrations	13
	Micro and regional climate regulation	6

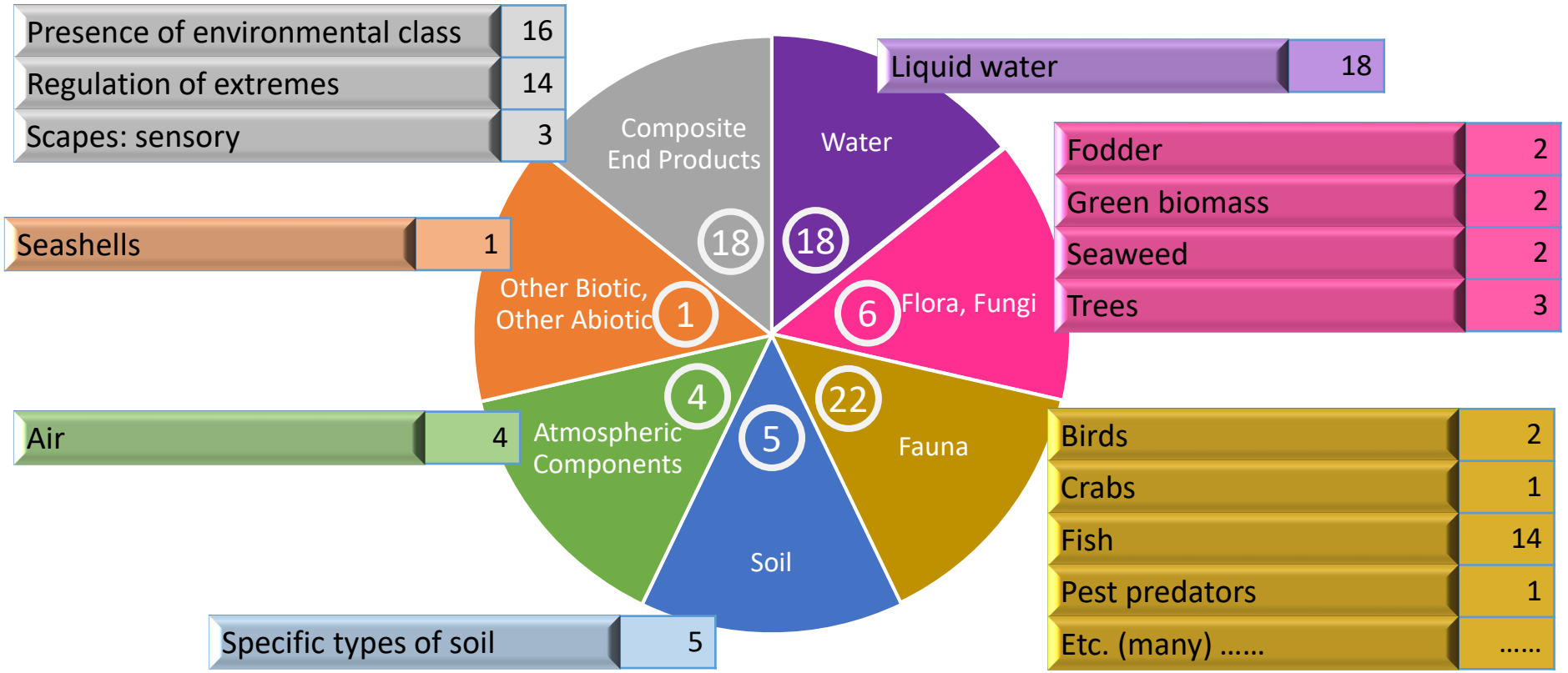
Partial breakdown of service classes, with number of models in ESML: **NESCS**

Note 1: NESCS identifies these 7 End-product categories for each of 14 different environments. The environments are combined for this presentation.

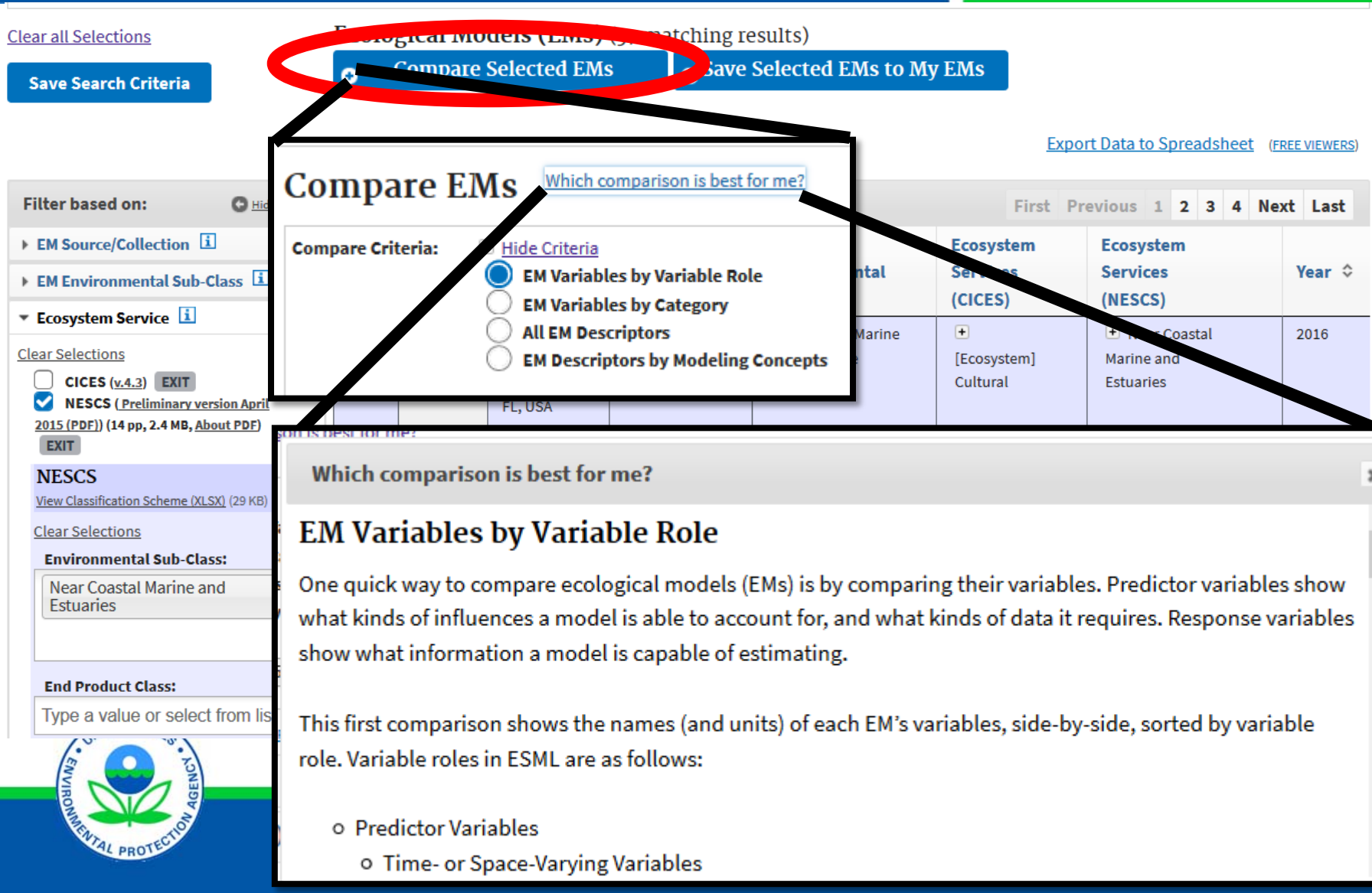


Note 2: Because intermediate services are excluded, fewer models align with the final services included in NESCS

Partial breakdown of service classes, with number of models in ESML: **NESCS**



Compare Selected EMs



Variable Relationship Diagram for: EM-142/EnviroAtlas - Annual water recharge by tree cover

PD: Predictor Variables - Time- or Space-Varying

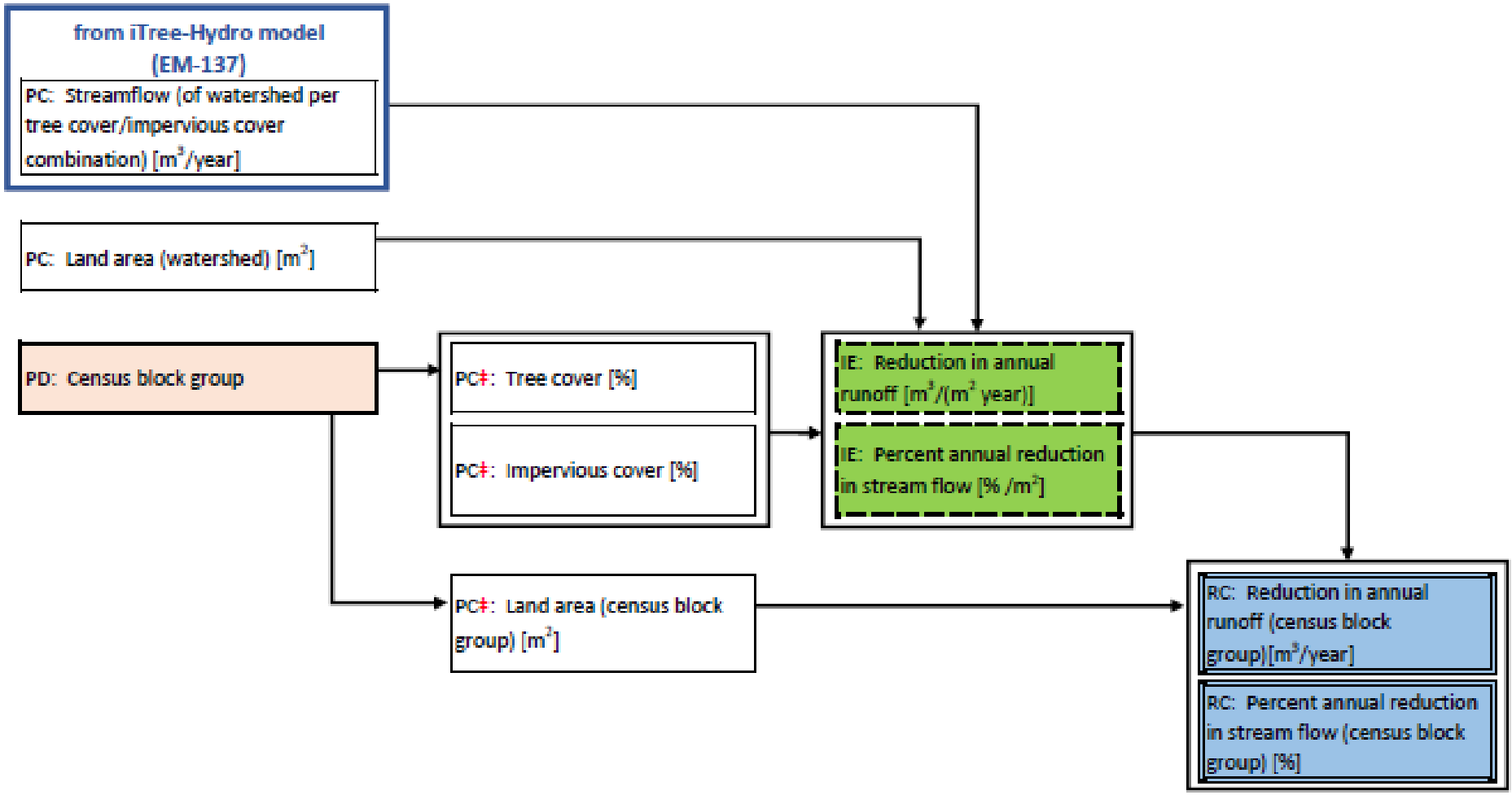
PC: Predictor Variables - Constant or Parameter

IE: Intermediate Variables - in ESML

RC: Response Variables - Computed

Variable units, if available, are given in brackets following variable name. Arrows denote that one variable (or variables, if gathered within a box) is required for computation of the other.

‡Double dagger denotes a variable whose value is constant with respect to a driving class variable (such as when derived from a lookup table).



What are the benefits of ESML?

- Detailed descriptions of:
    1. Source documents
    2. ecological models (>50 individual descriptors)
    3. ecological model variables (40 additional descriptors)

- Variable Relationship Diagrams

- Ability to find, compare, and save descriptions of models for estimating the production of ecosystem goods and services

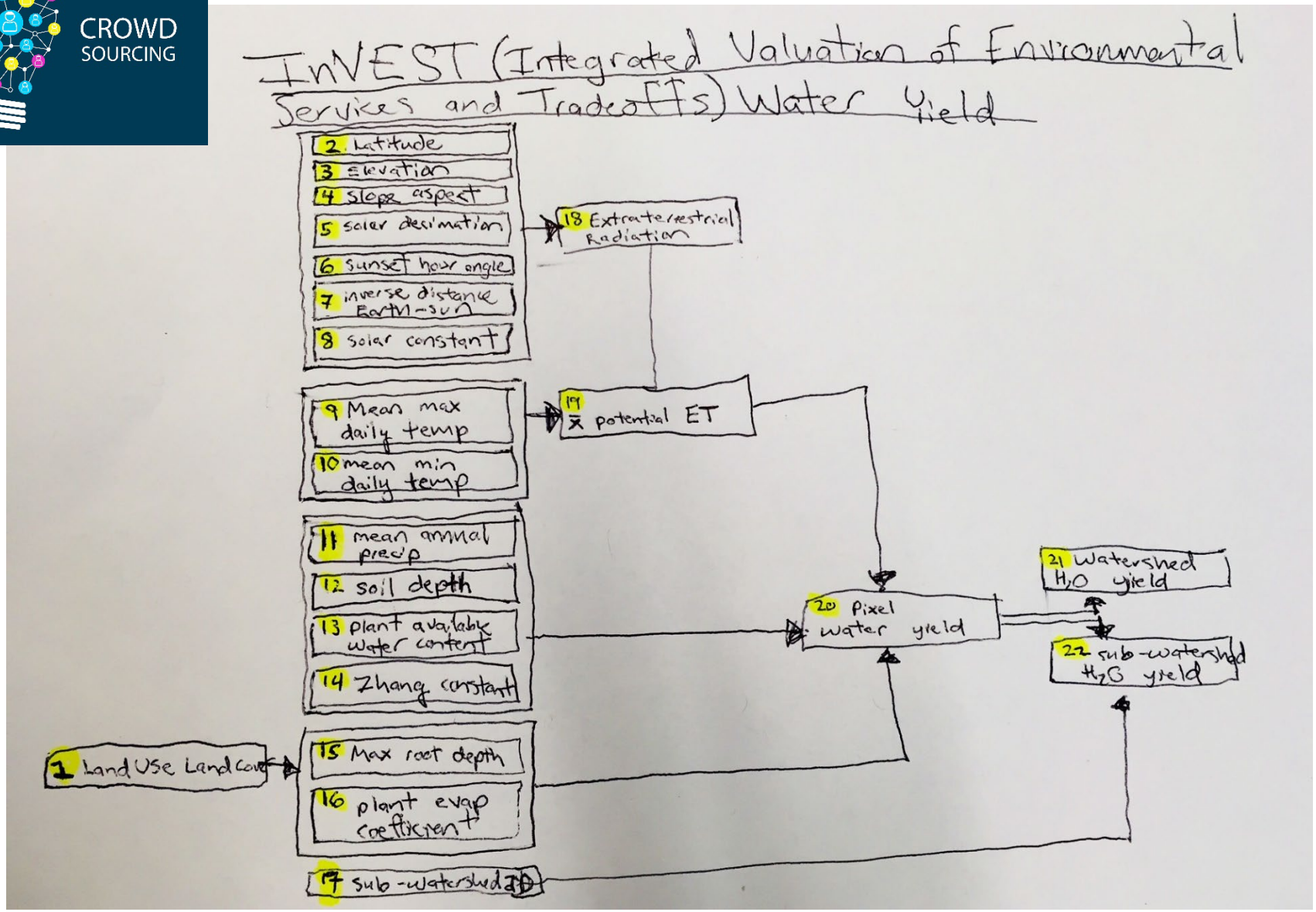
CROWD SOURCING

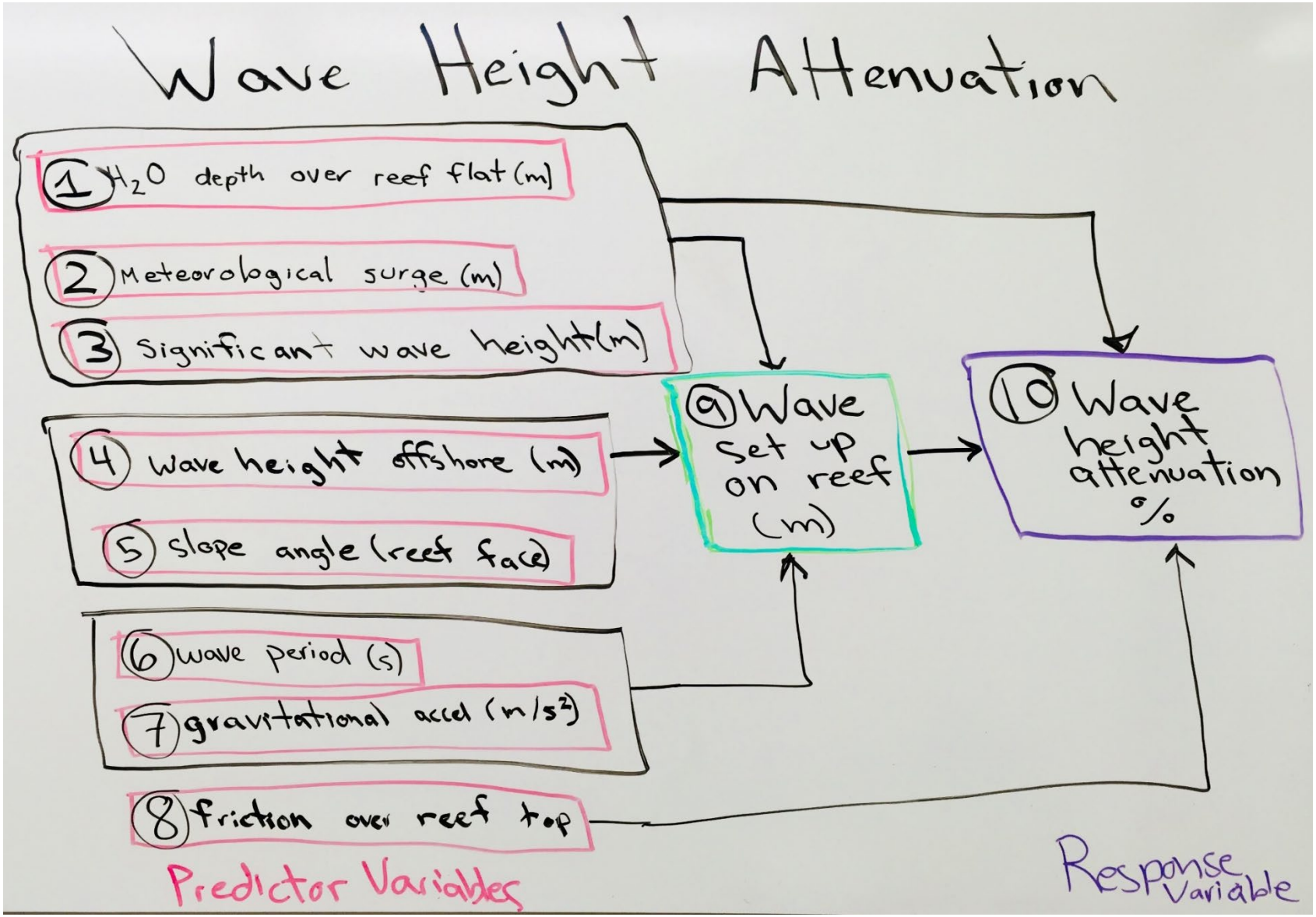
Fill out the EMSubmissionTemplate.xlsx:

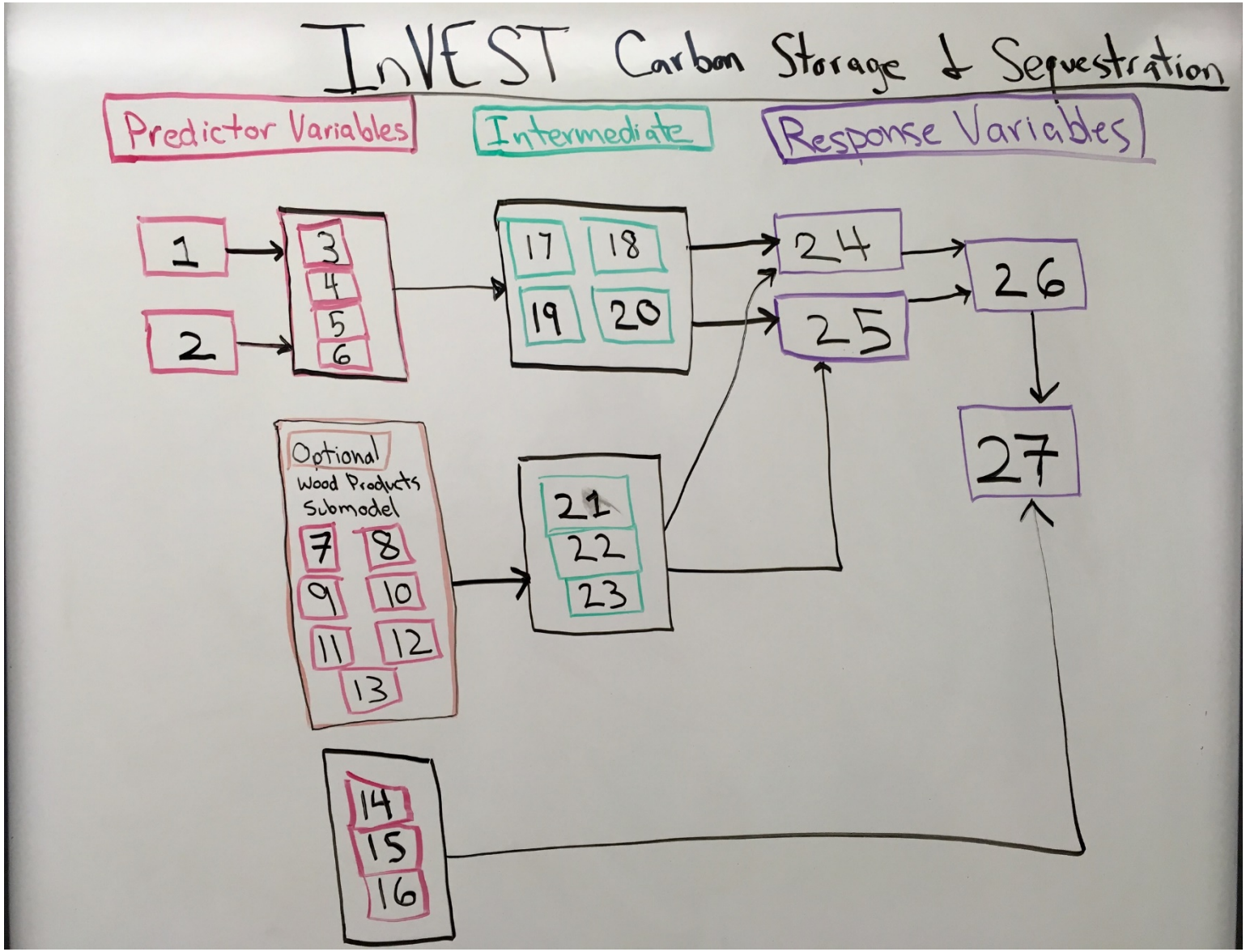
1. Describe the source document
2. Describe the variables
3. Sketch a Variable Relationship Diagram

Email to ESML@epa.gov

CROWD SOURCING




Wave Height Attenuation
1 H_2O depth over reef flat (m)
2 Meteorological surge (m)
3 Significant wave height (m)
4 Wave height offshore (m)
5 Slope angle (reef face)
6 Wave period (s)
7 gravitational accel (m/s^2)
8 friction over reef top
9 Wave set up on reef (m)
10 Wave height attenuation %
Predictor Variables
Response Variable


InVEST Carbon Storage & Sequestration
Predictor Variables
Intermediate
Response Variables
1
2
3
4
5
6
17
18
19
20
24
25
26
27
Optional
Wood Products
Submodel
7
8
9
10
11
12
13
21
22
23
14
15
16

Hope you enjoyed our ESML tour!

Next steps:

- Develop use case demonstrations
- Add more models
- Linking to EnviroAtlas data layers
- Outreach: model authors and others…

Thanks for the opportunity to share!

Contact:
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(513)569-7150