

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

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Gregg Lomnicky, John Wilson, and Ted DeWitt



Acknowledgements

- Science

- Randy Bruins, Retired US EPA (Original Leader)
- Tammy Newcomer-Johnson, EPA (Leader/Speaker)
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- Ted DeWitt, Jessica Moon, Melissa Errend, EPA Newport OR



- Software

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- Use Case Leads

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- Chuck Maurice, US EPA R5
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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.

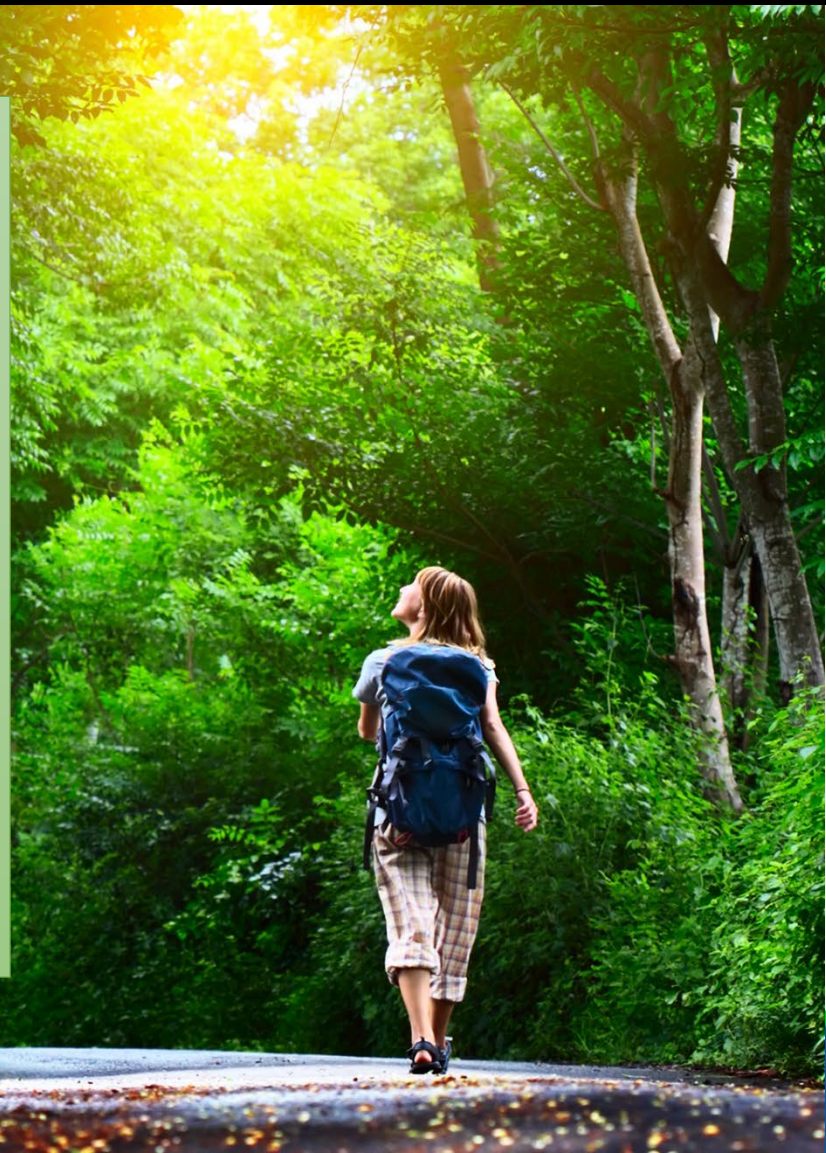
What does ESML help you to do?

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

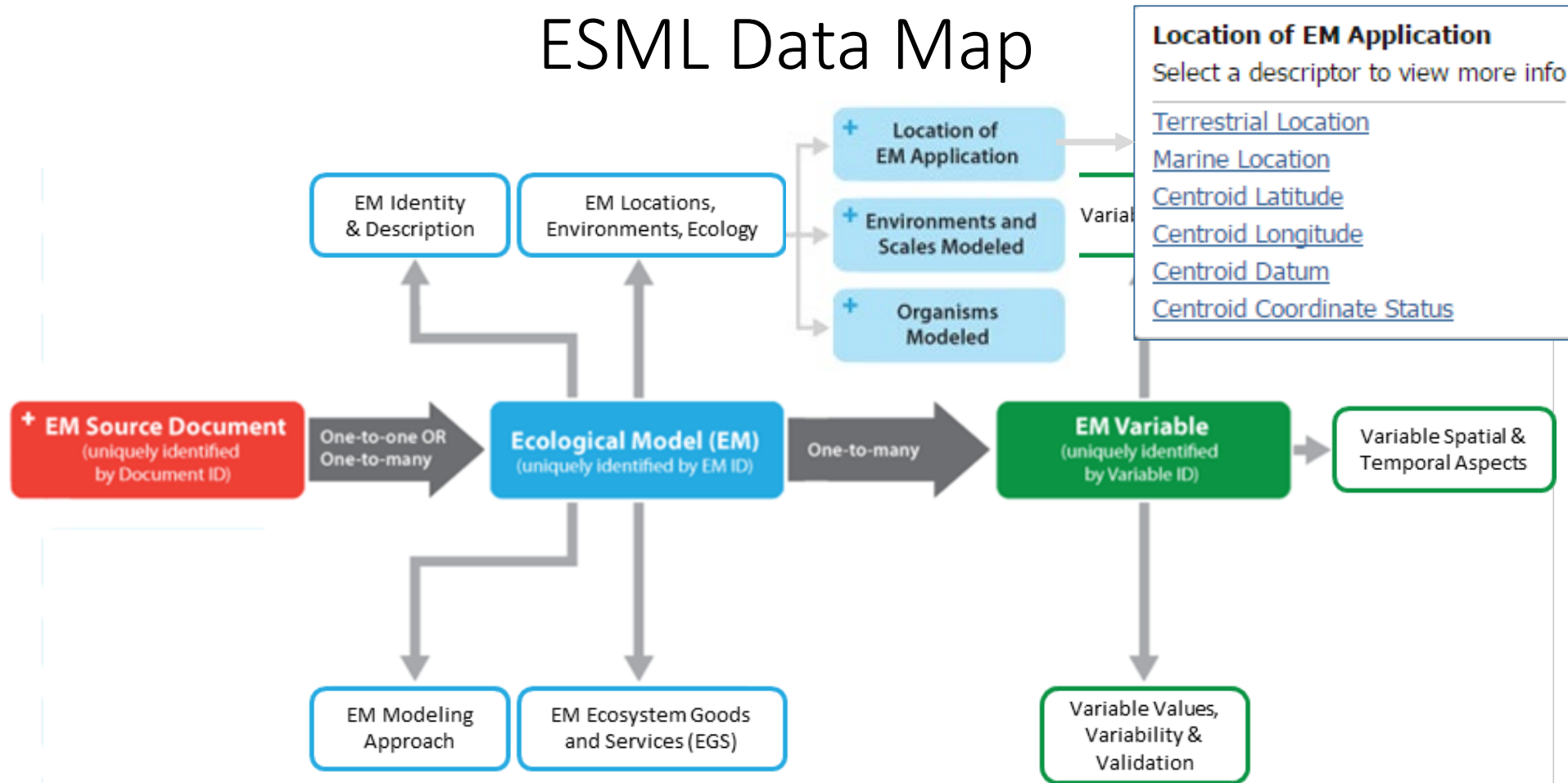


What's in ESML? <https://ESML.epa.gov/>

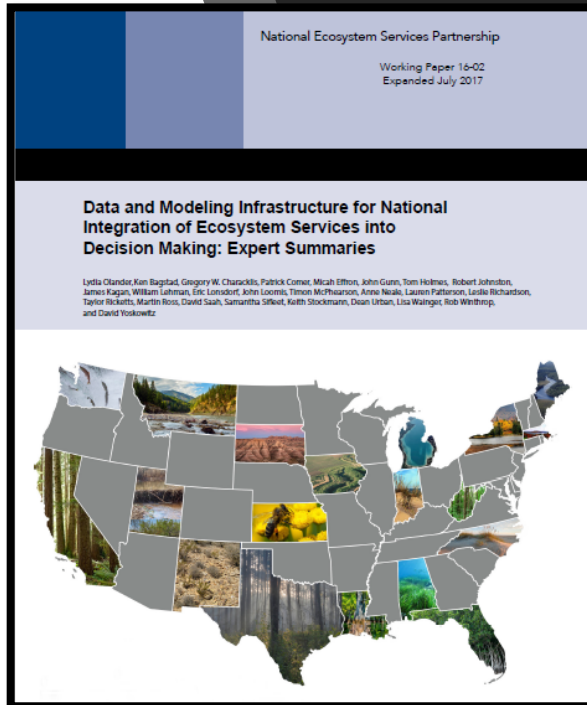
- Detailed descriptions of **>150 ecological models (>50 informative model descriptors** – covering purpose, approach, and environmental use)
- Detailed descriptions of **ecological model variables (40 additional descriptors)**
- **Variable Relationship Diagrams**, conceptual diagrams for each model



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 Ecological Models

EcoService Models List

Search Ecological Models ()

Search Using: Pre-defined Filters Next Search

Search Criteria: [Show Search Criteria](#)

[Clear all Selections](#)

[Save Search Criteria](#)

Filter based on: [Hide Filters](#)

- EM Source/Collection [i](#)
- EM Environmental Sub-Class [i](#)
- Ecosystem Service [i](#)
- EM Location [i](#)
- Variable Classification [i](#)
- Predictor Variable [i](#)

Filter based on: [Hide Filters](#)

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- Variable Classification [i](#)
- Predictor Variable [i](#)
- Response Variable [i](#)
- Time Dependence [i](#)
- Time Continuity [i](#)
- Spatial Extent Area [i](#)
- Spatial Distribution [i](#)
- Computational Approach [i](#)
- Determinism [i](#)

Ecosystem Service ✕

Ecosystem Services are defined as outputs of ecological functions or processes that directly or indirectly contribute to social welfare, or have the potential to do so in the future. Filter on one or both of two ecosystem service classification systems (CICES or NESCS) to limit the EMs displayed; multiple selections are allowed.

Show 10

- EM ID
- EM-12

- Statistical Estimation [i](#)
- Model Calibration Performed [i](#)
- Model Goodness of Fit Reported [i](#)
- Model Validation Performed [i](#)
- EM Uncertainty Analysis Performed [i](#)
- EM Sensitivity Analysis Performed [i](#)
- Ecological Scale [i](#)
- Organismal Scale [i](#)

Ecosystem Services (CICES)	Ecosystem Services (NESCS)	Year	Authors	Bibliographic Title
<input checked="" type="checkbox"/> [Ecosystem] Regulation & Maintenance	<input checked="" type="checkbox"/> Forests <input checked="" type="checkbox"/> Agroecosystems	2008	Guzy, M. R., Smith, C. L., Bolte, J. P., Hulse, D. W. and Gregory, S. V.	Policy research using agent-based modeling to assess future impacts of urban expansion into farmlands and



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



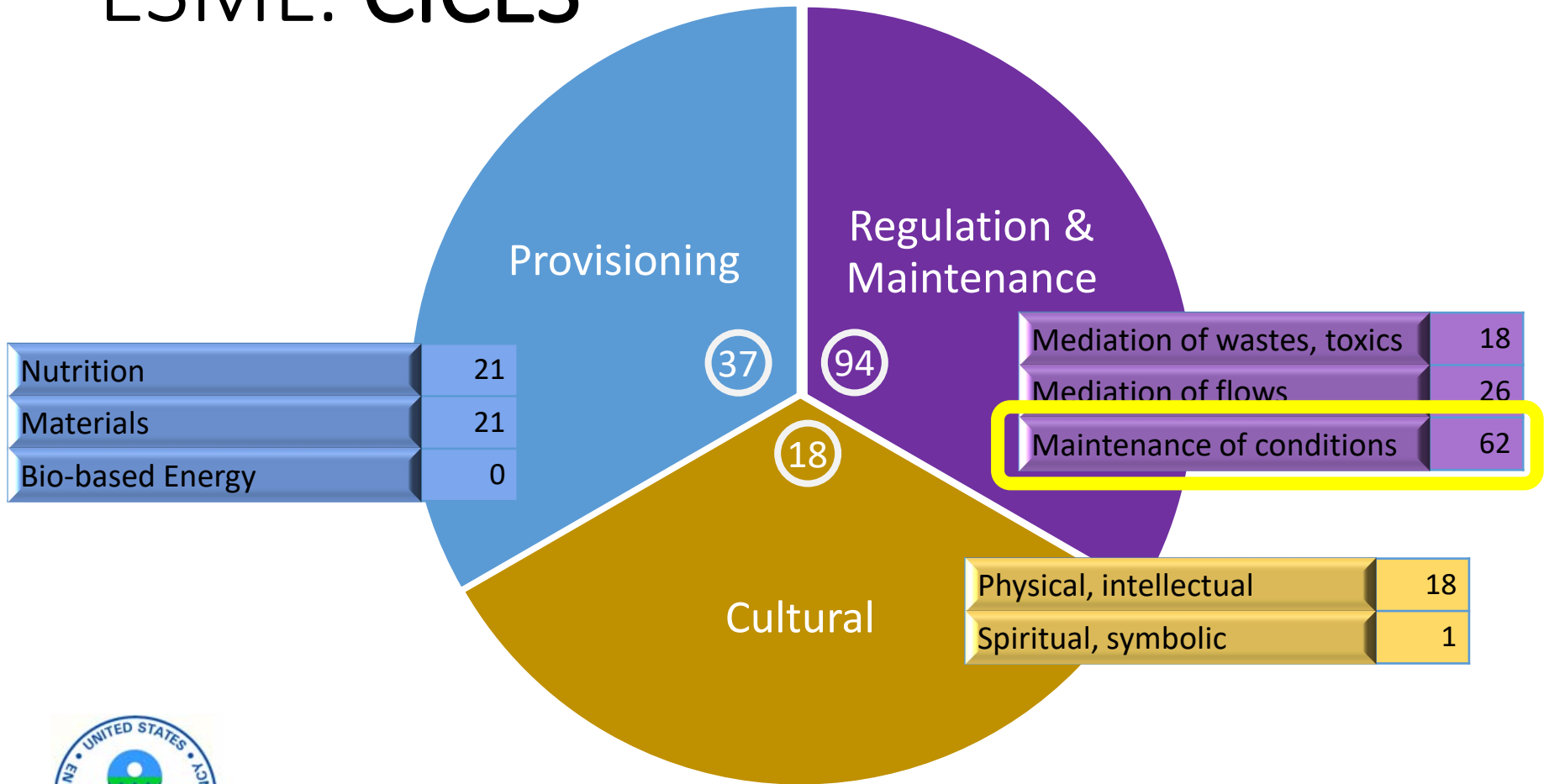
Ecosystem Service Classification Systems

National Ecosystem Service Classification System (NESCS)

- Based on EPA's Final Ecosystem Goods and Services Classification System (<https://gispub4.epa.gov/FECS/>)
- 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



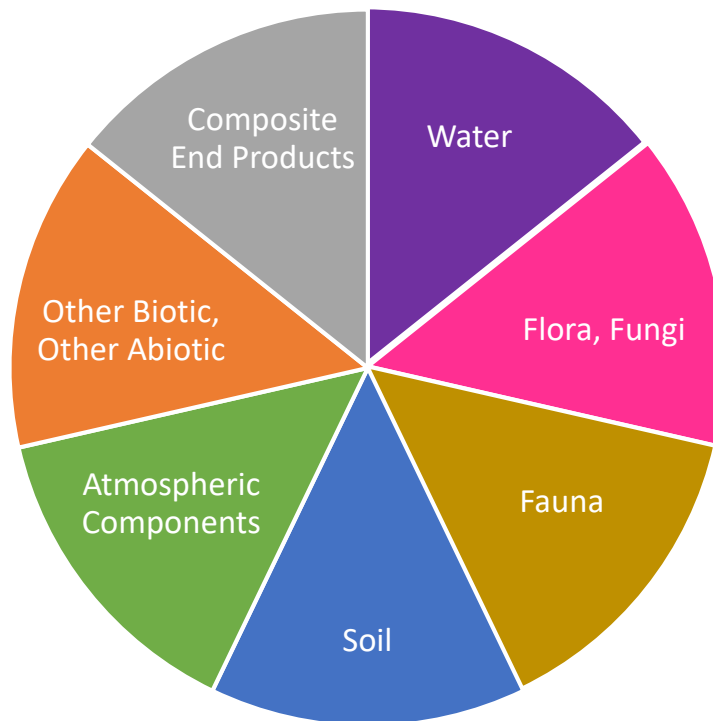
Detail of CICES category, “Maintenance of physical, chemical, biological conditions”

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

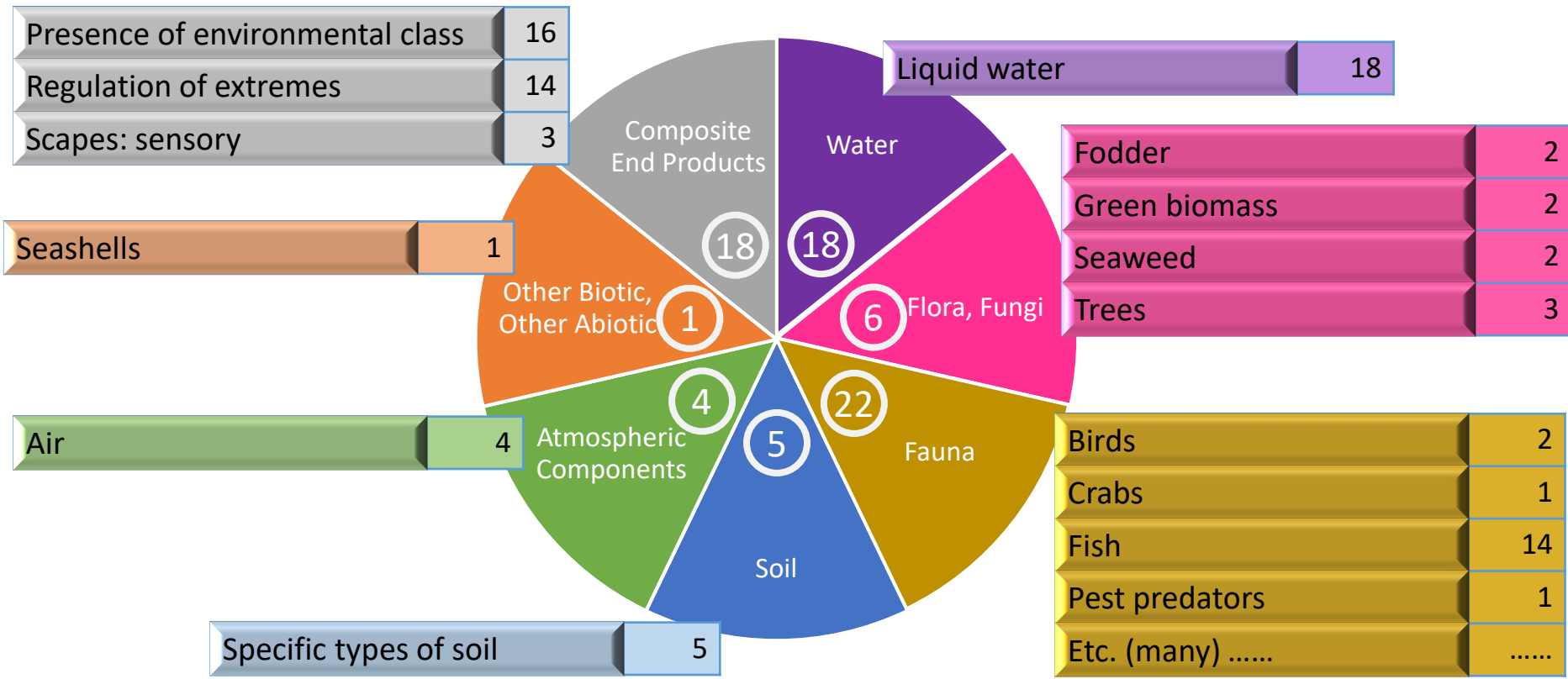
Note 1: NESCS identifies these 7 End-product categories for each of 14 different environments. The environments are combined for this presentation.



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

[Clear all Selections](#)

Save Search Criteria

Ecological Models (EMs) (3) (matching results)

Compare Selected EMs

Save Selected EMs to My EMs

[Export Data to Spreadsheet](#) (FREE VIEWERS)

Compare EMs

Which comparison is best for me?

Compare Criteria:

[Hide Criteria](#)

- EM Variables by Variable Role
- EM Variables by Category
- All EM Descriptors
- EM Descriptors by Modeling Concepts

Filter based on:

EM Source/Collection

EM Environmental Sub-Class

Ecosystem Service

Clear Selections

CICES (v.4.3) [EXIT](#)

NESCS (Preliminary version April

2015 (PDF) (14 pp, 2.4 MB, [About PDF](#))

[EXIT](#)

NESCS

[View Classification Scheme \(XLSX\)](#) (29 KB)

Clear Selections

Environmental Sub-Class:

Near Coastal Marine and Estuaries

End Product Class:

Type a value or select from list



Which comparison is best for me?

EM Variables by Variable Role

One quick way to compare ecological models (EMs) is by comparing their variables. Predictor variables show what kinds of influences a model is able to account for, and what kinds of data it requires. Response variables show what information a model is capable of estimating.

This first comparison shows the names (and units) of each EM's variables, side-by-side, sorted by variable role. Variable roles in ESML are as follows:

- Predictor Variables
 - Time- or Space-Varying Variables

Variable Relationship Diagram for:

EM-142/EnviroAtlas - Annual water recharge by tree cover

PD: Predictor Variables - Time- or Space-Varying

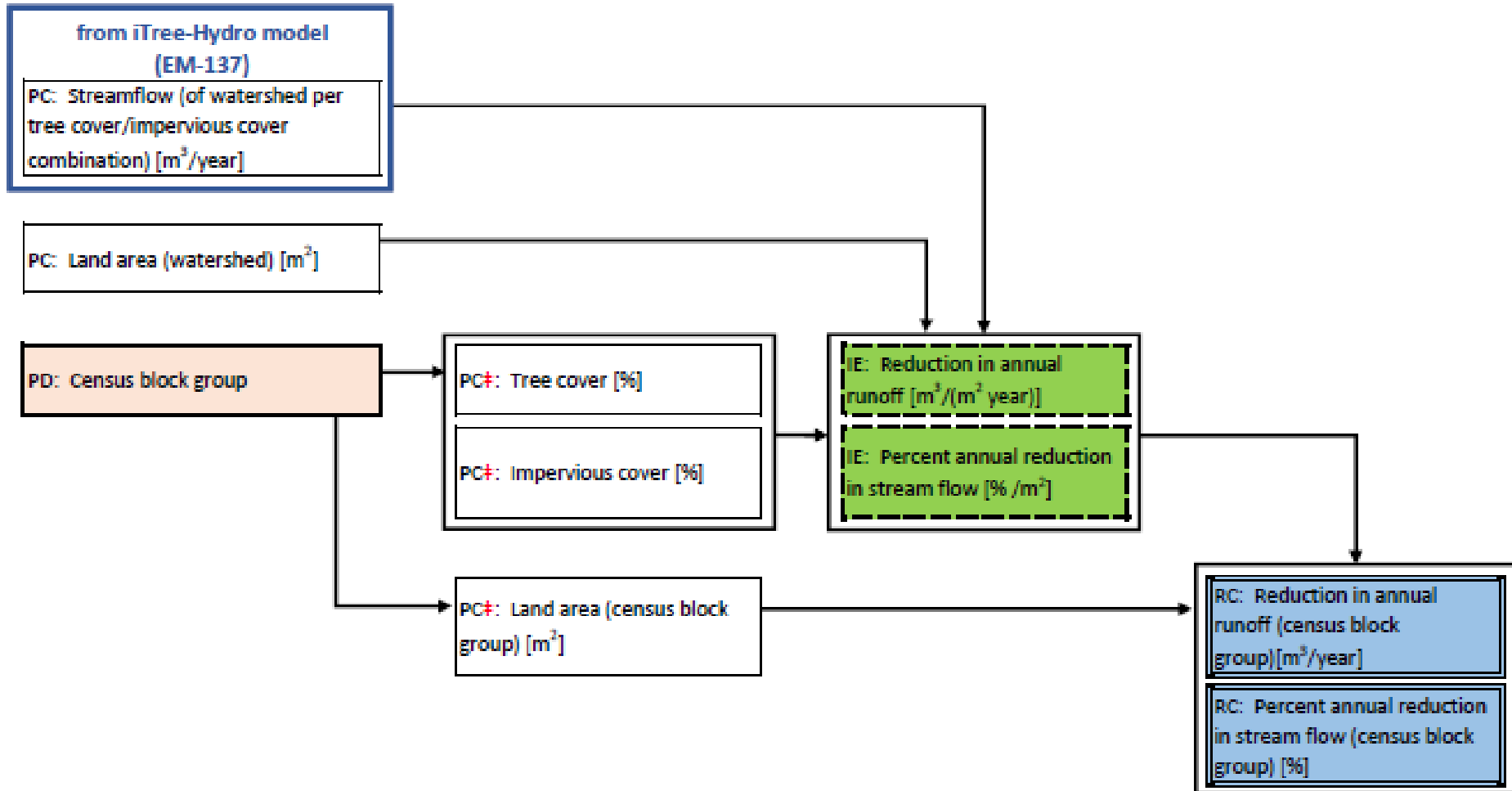
PC: Predictor Variables - Constant or Parameter

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





Power of the Crowd



✓
EMLSubmissionTemplate.xlsx

Fill out the EMLSubmissionTemplate.xlsx:

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

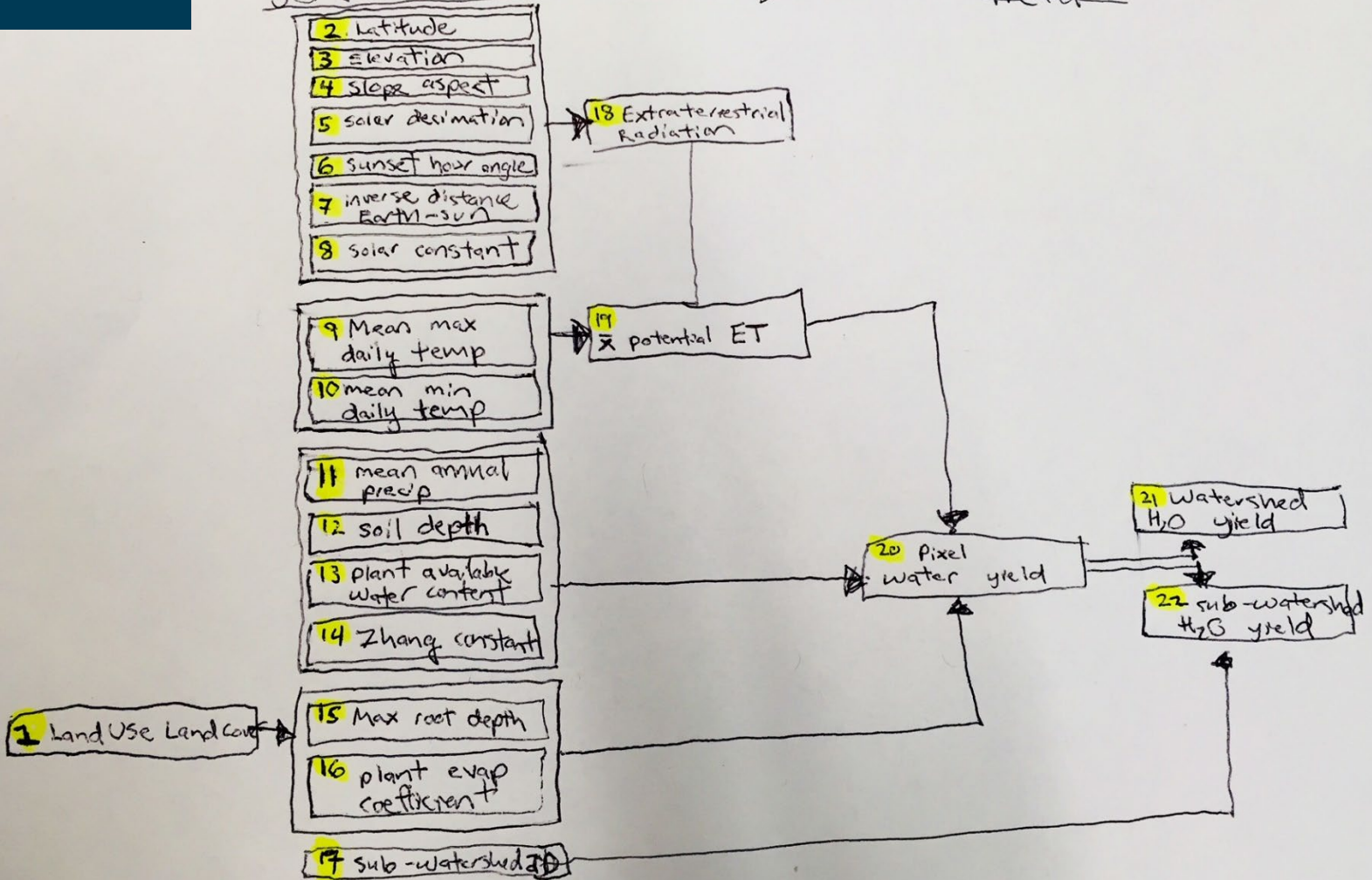
Email to ESML@epa.gov



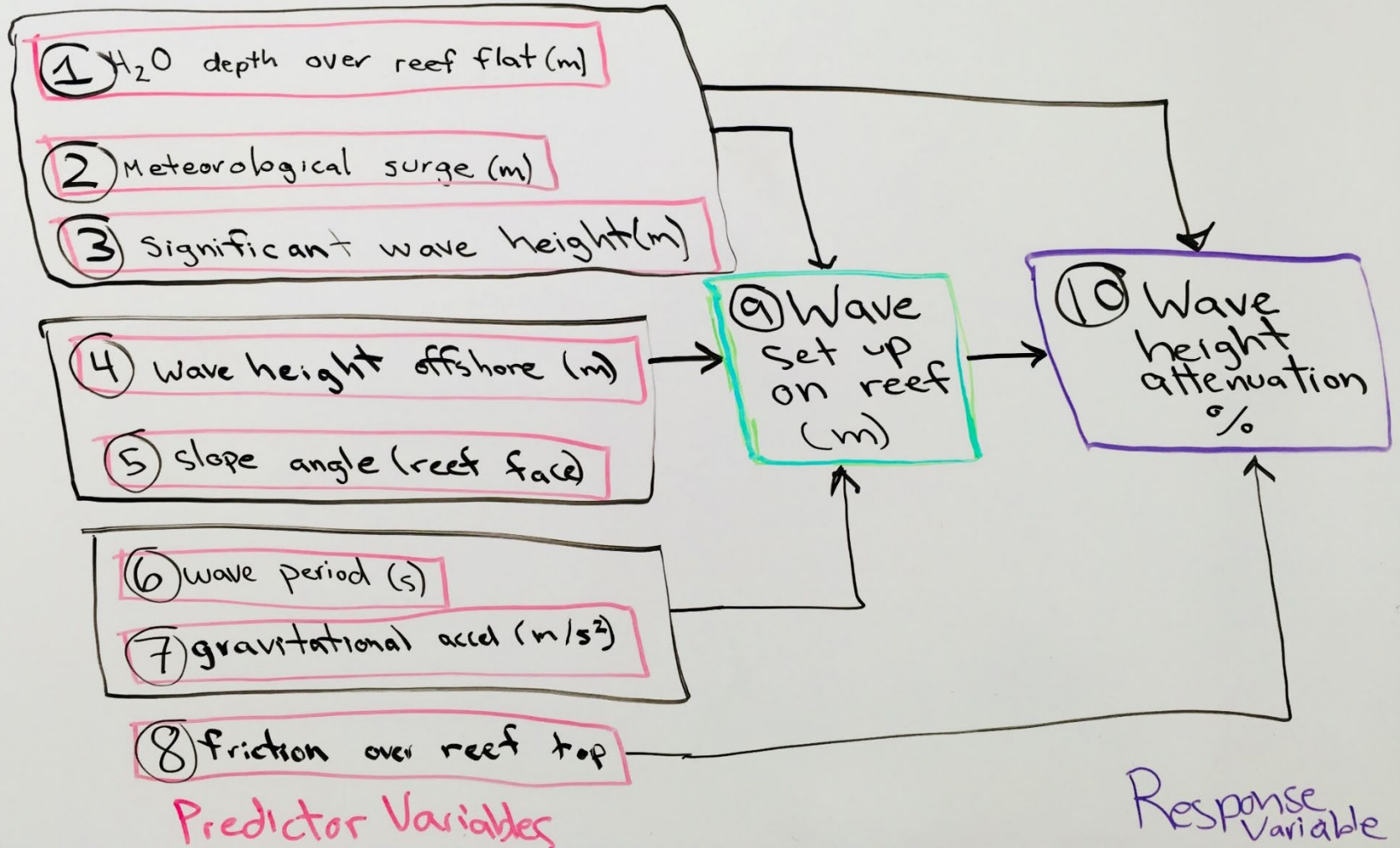


CROWD
SOURCING

INVEST (Integrated Valuation of Environmental Services and Tradeoffs) Water Yield



Wave Height Attenuation

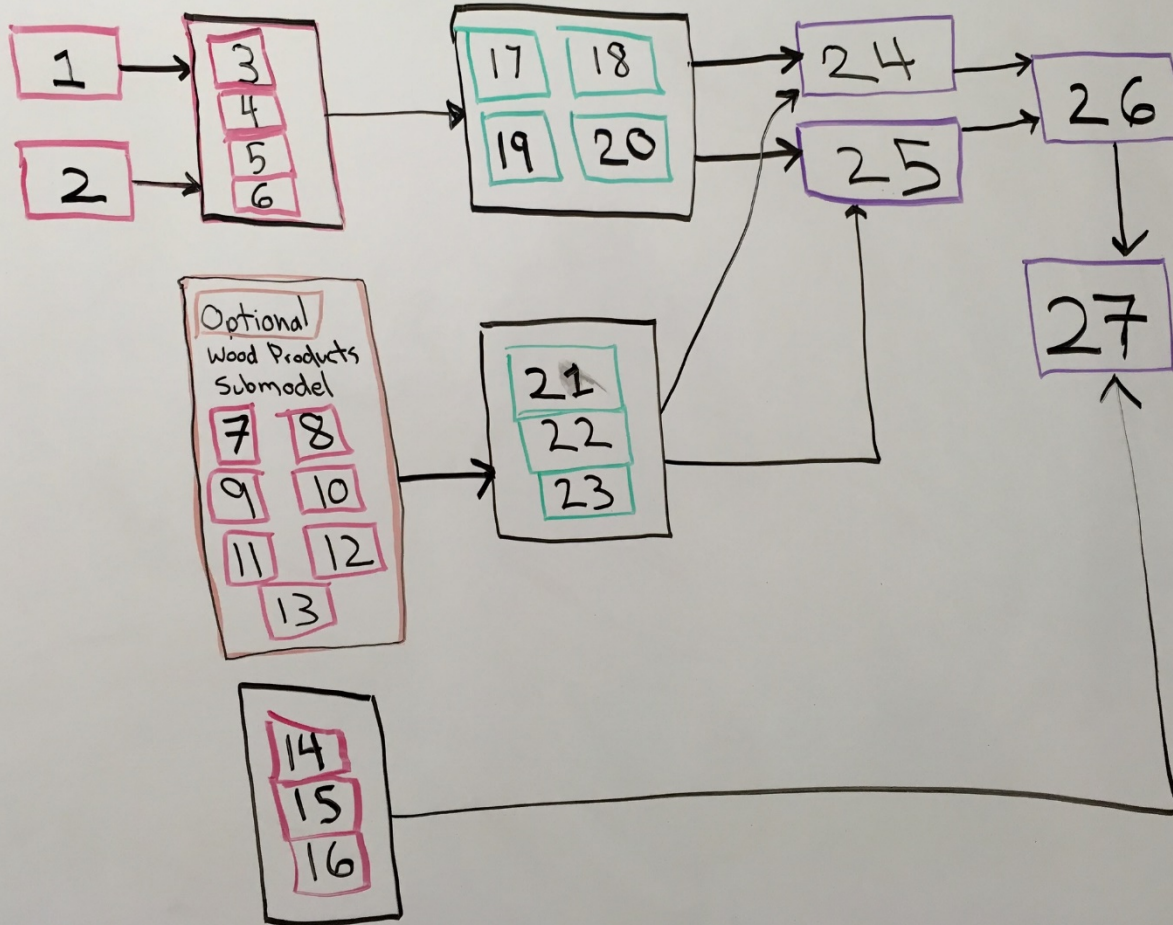


INVEST Carbon Storage & Sequestration

Predictor Variables

Intermediate

Response Variables



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!

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