

Accounting for Uncertainty When Measuring Ecosystem Services



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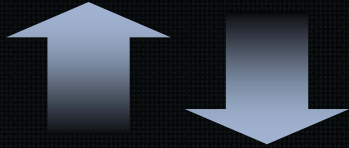
We use ecological models for many purposes:

- To help inform decisions,
- To understand consequences of previous decisions,
- To predict future issues/needs/opportunities,
- To measure transactions (e.g., markets/exchanges)

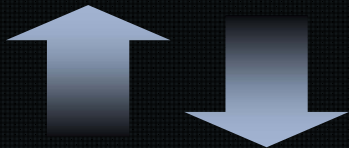




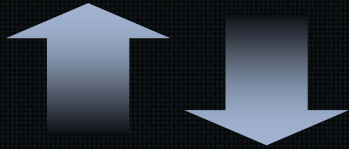
VALUE



SERVICES



FUNCTIONS

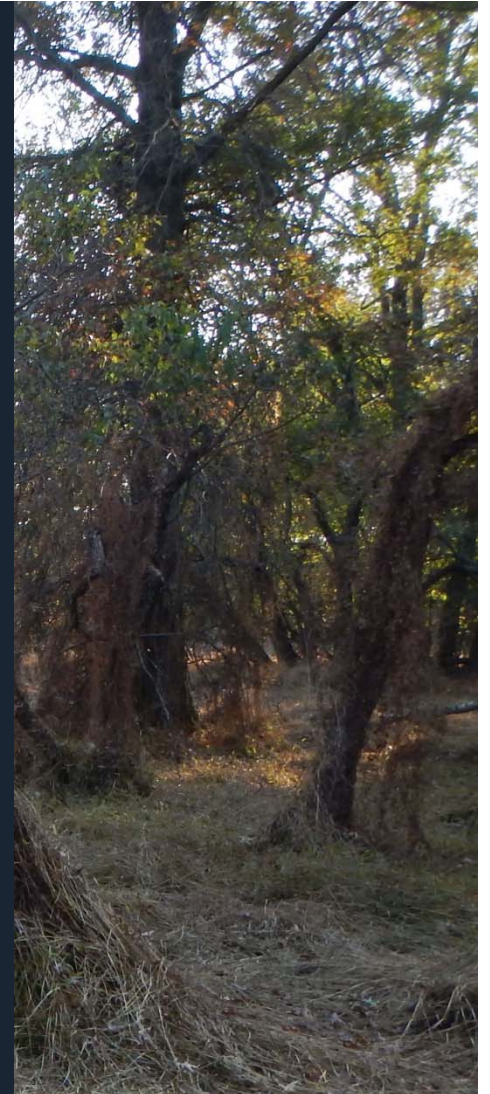


LANDSCAPE
ATTRIBUTES

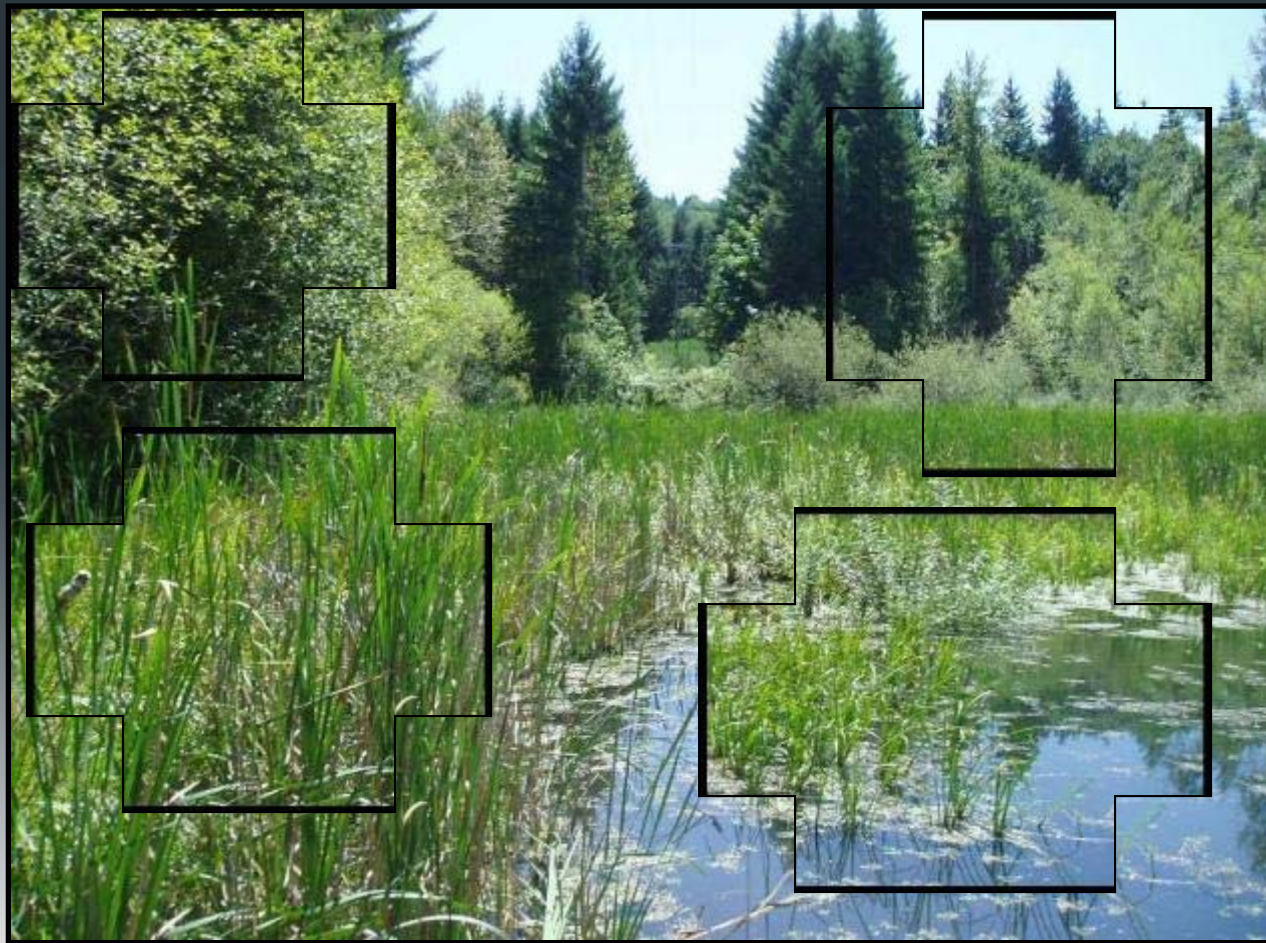
e.g., Water Regulation -
Moderating Flows

e.g., Infiltration

e.g., Substrate
Composition



Models try to provide a useful understanding of the world around us . . .

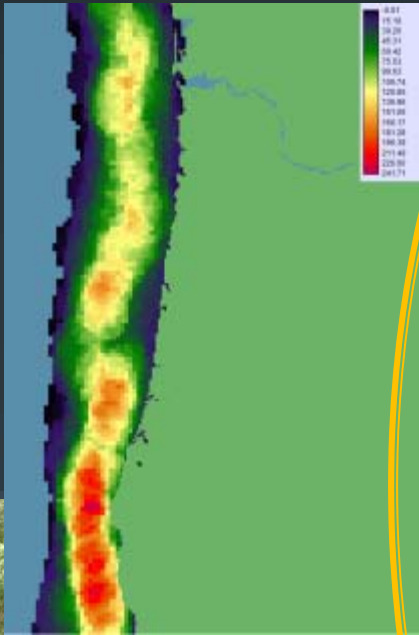




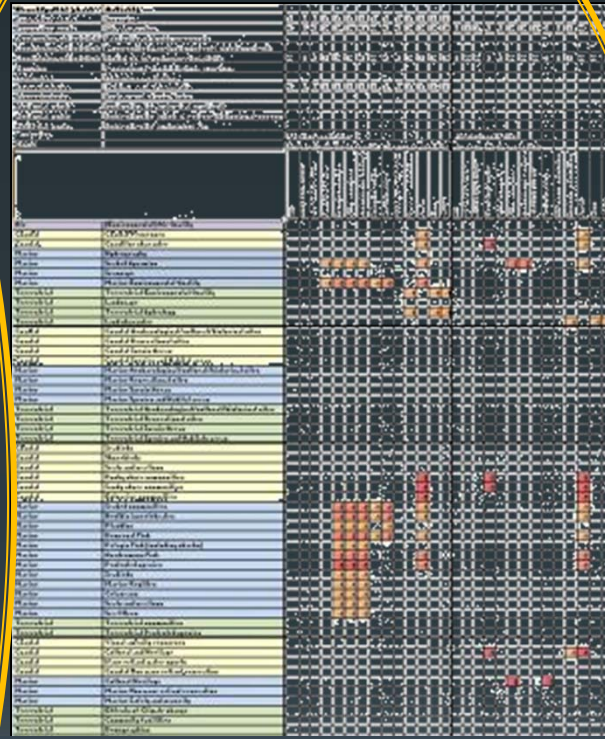
CONSISTENCY

It's only a virtue if you are not a screwup.

Raw Data

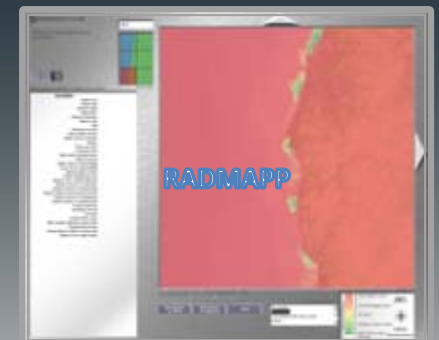


Models



$$Score = \prod_{j=1}^m (a_{Kj})^{w_j}, \text{ for } K = 1, 2, 3, \dots, m$$

User Interface





Uncertainty Associated with Model Construction



Uncertainty sources from the models:

Model sensitivity/coarseness

Model completeness

Model accuracy



Transpiration Function Phase 2

Water Regime Switch		
Water Regime State	Inundation State	Score
No	Seasonal	1
No	Permanent	1
No	Occasional	1
No	None	1
Inundated	Seasonal	0.7
Inundated	Permanent	0.6
Inundated	Occasional	0.9
Inundated	None	1
Saturated	Seasonal	0.9
Saturated	Permanent	0.8
Saturated	Occasional	1
Saturated	None	1

Dominant Stand Type	
State	Score
Deciduous (Broad leaf)	1
Deciduous (Needle)	0.6
Evergreen (Broad leaf)	1
Evergreen (Needle)	0.6
Mixed	0.8
N/A	1

Canopy Cover Herbs	
State	Score
Not present	0
<10%	0.005
10-30%	0.02
30-60%	0.045
60-90%	0.075
>90%	0.1

Canopy Cover Shrubs	
State	Score
Not present	0
<10%	0.015
10-30%	0.06
30-60%	0.135
60-90%	0.225
>90%	0.3

Canopy Cover Trees	
State	Score
Not present	0
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10-30%	0.12
30-60%	0.27
60-90%	0.45
>90%	0.6

Mean Avg. Temp.	
State	Score
<32	0
32-40	0
40-45	0
45-50	0
50-55	0
55-60	0.25
60-65	0.5
65-70	0.75
>70	1

Mean High Temp.	
State	Score
<32	0
32-40	0
40-45	0
45-50	0
50-55	0
55-60	0.25
60-65	0.5
65-70	0.75
>70	1

Wind Class	
State	Score
NA	0
1	0.25
2	0.50
3	0.75
4	1
5	1
6	1
7	1

Solar Rad.	
State	Score
0-3	0
4-5	0.17
5-6	0.34
6-7	0.51
7-8	0.68
8-9	0.85
10-14	1



Water Regime Modifier (WRM)

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30-60%	0.27
60-90%	0.45
>90%	0.6

Canopy Cover Trees (CCt)

Canopy Cover Trees	
State	Score
<33%	0.2
33-66%	0.4
>66%	0.6

Canopy Cover Trees (CCt)

Transp. Score
TRANSP)
= ((WRM x VEG) x TP x



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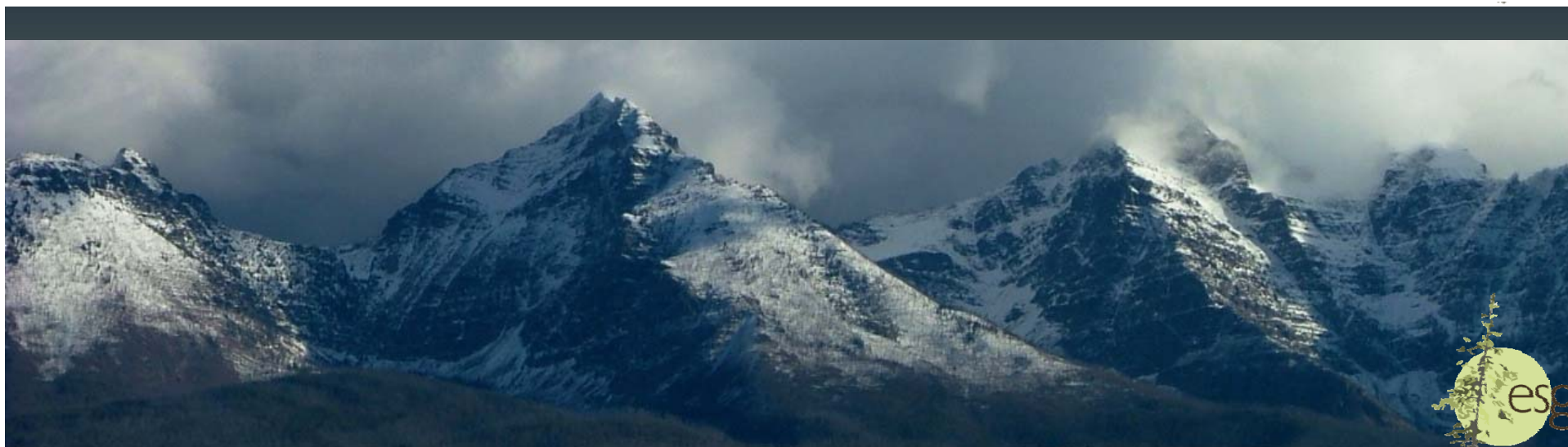
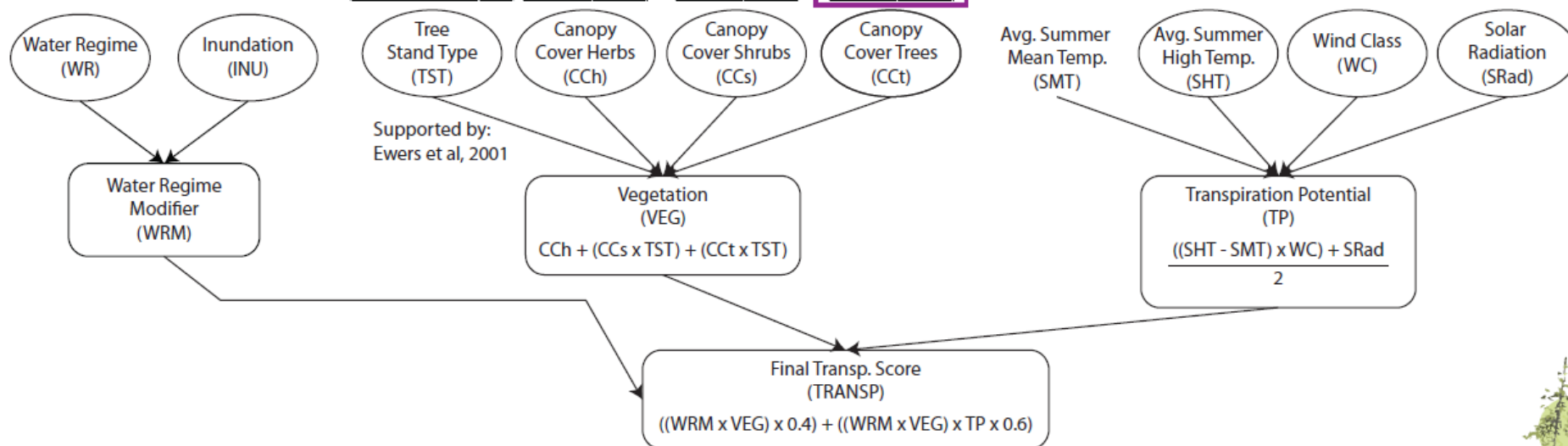
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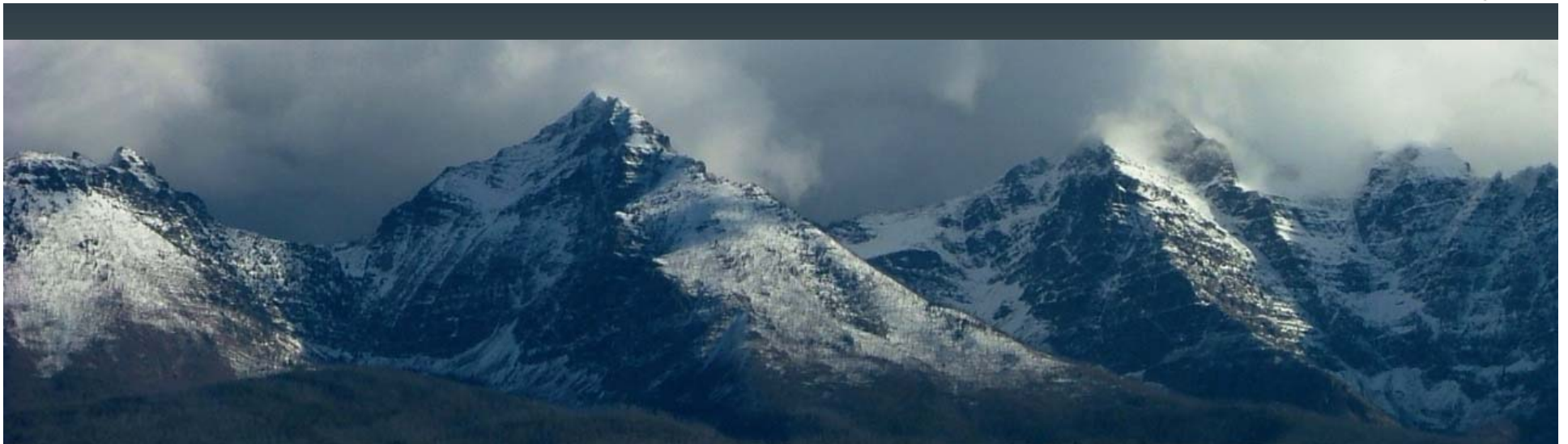
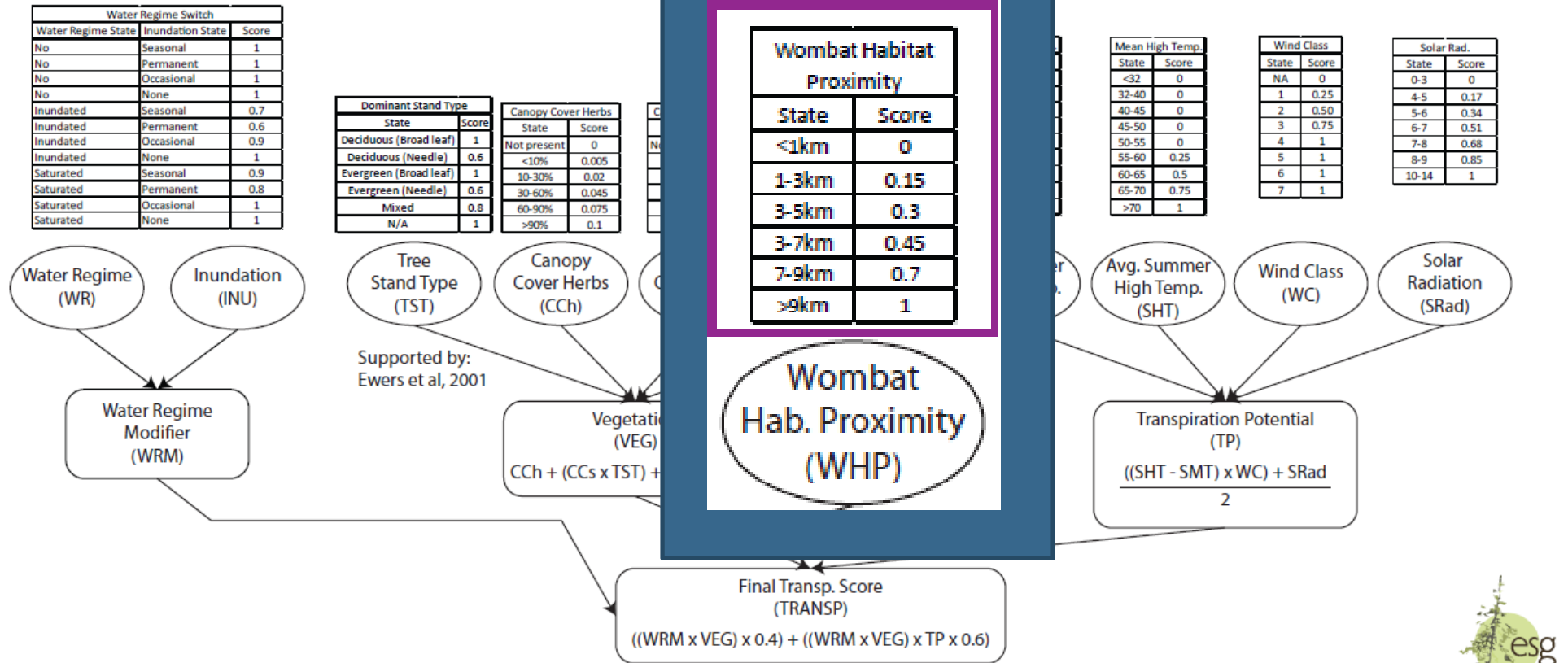
Model sensitivity/coarseness

Model completeness

Model accuracy



Transpiration Function Phase 2



Addressing Model Uncertainties:

Reduce

Recognize

Resolve



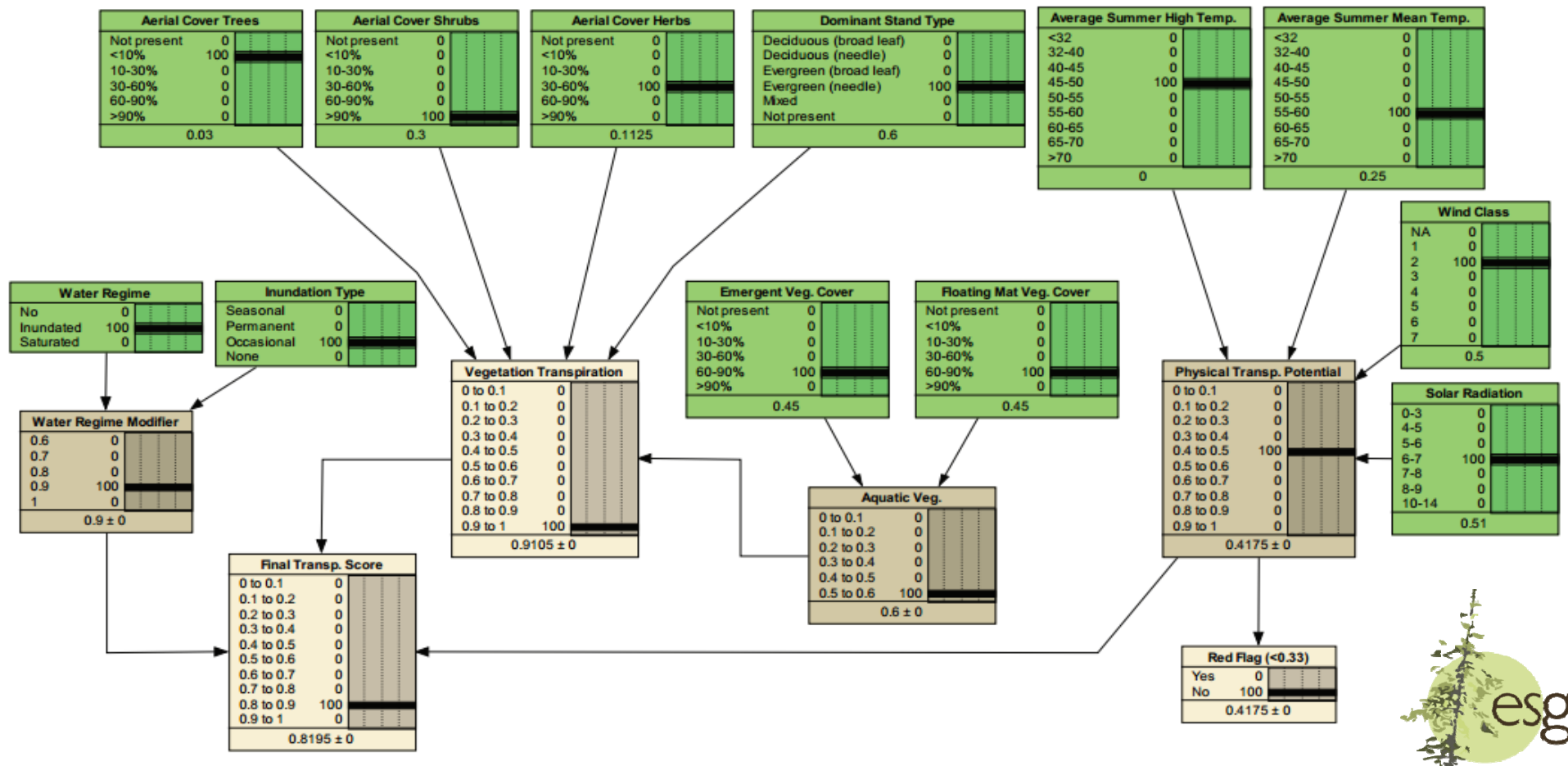
Addressing Model Uncertainties:

Reduce

- Base models on best available science (literature, expert opinion)
- Review, validate and test all models to the best extent possible



Addressing Model Uncertainties: Recognize



Addressing Model Uncertainties:

Recognize

- Produce models that account for all relevant attributes – even if you cannot measure them
- Tag areas of known uncertainty in the model (disagreement between experts, very complex systems that have been simplified, etc.)
- If possible, produce results that are either expressed as a probability or have error bars accompany the results.



Addressing Model Uncertainties:

Resolve

- Limit types of decisions that the model can be used for
- Develop models with multiple sensitivities to allow a user to balance ease of use and certainty

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State	Score
<33%	0.2
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Canopy
Cover Trees
(CCt)

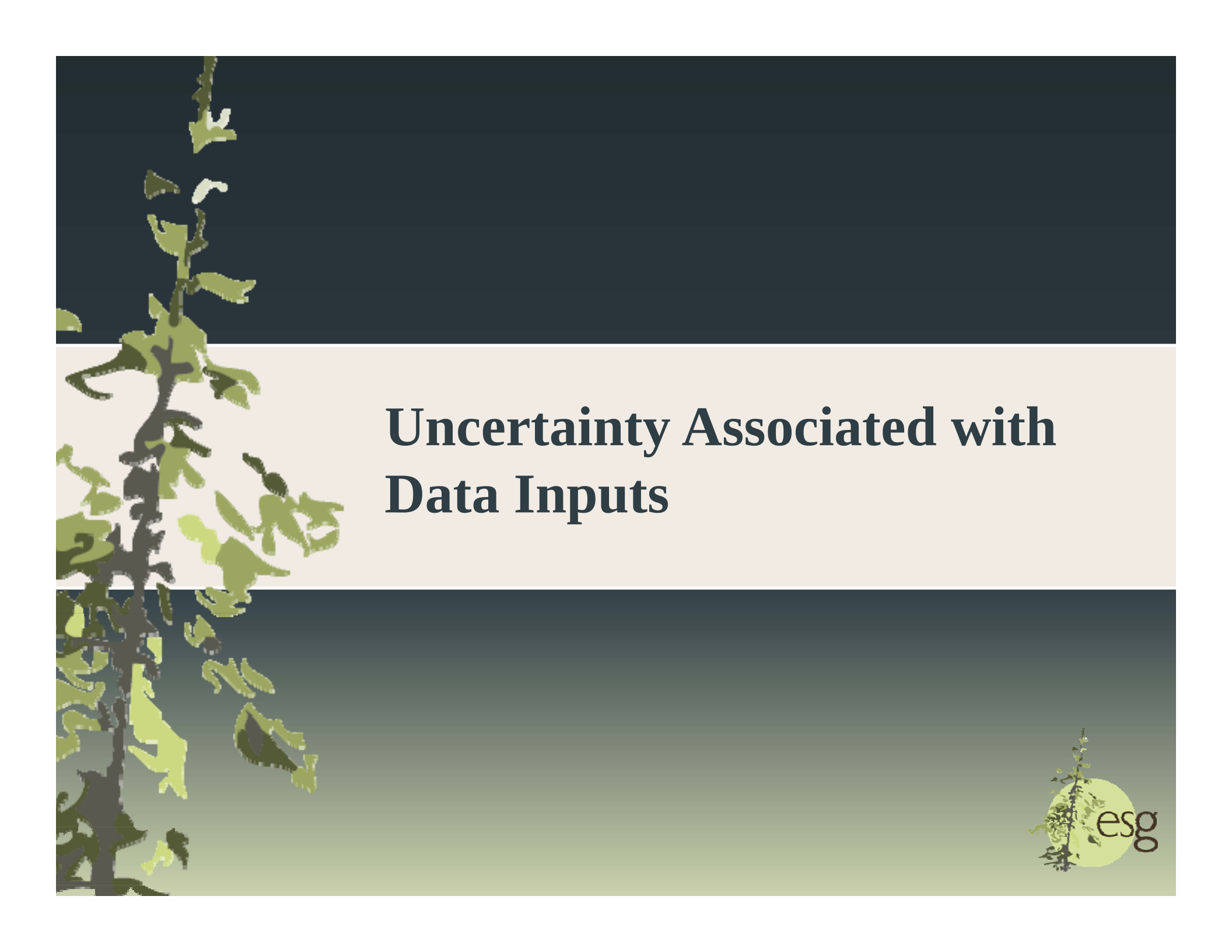
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45-60%	0.36
60-75%	0.45
75-90%	0.54
90-95%	0.57
>95%	0.6

Canopy
Cover Trees
(CCt)





Uncertainty Associated with Data Inputs

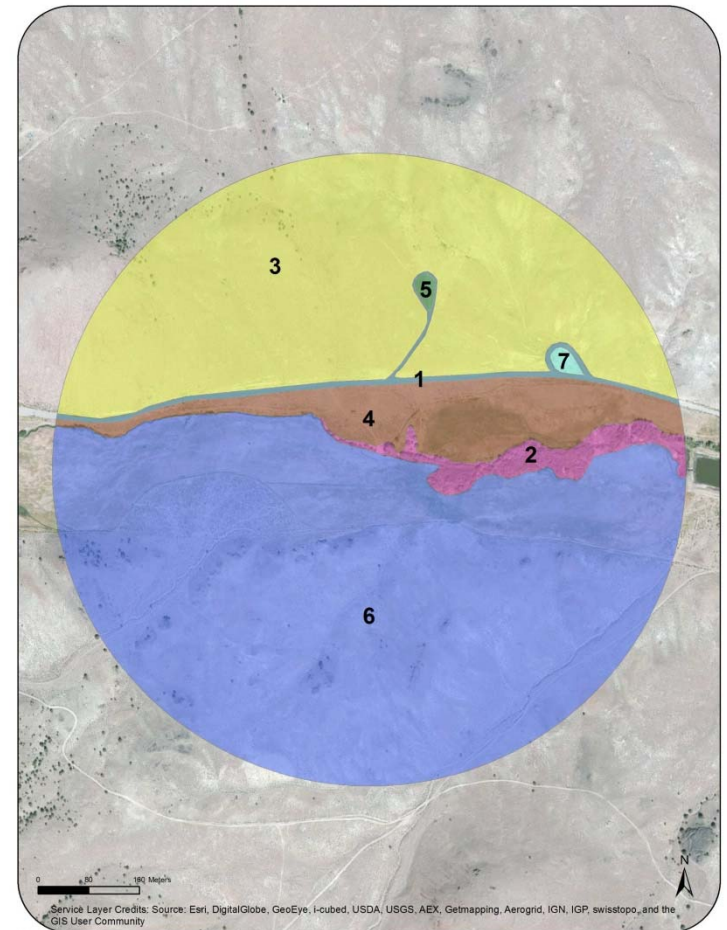
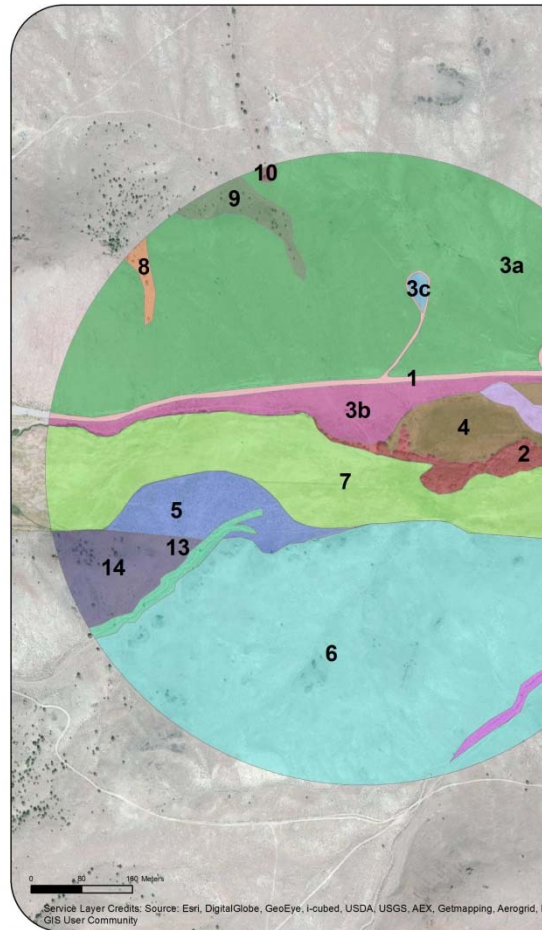
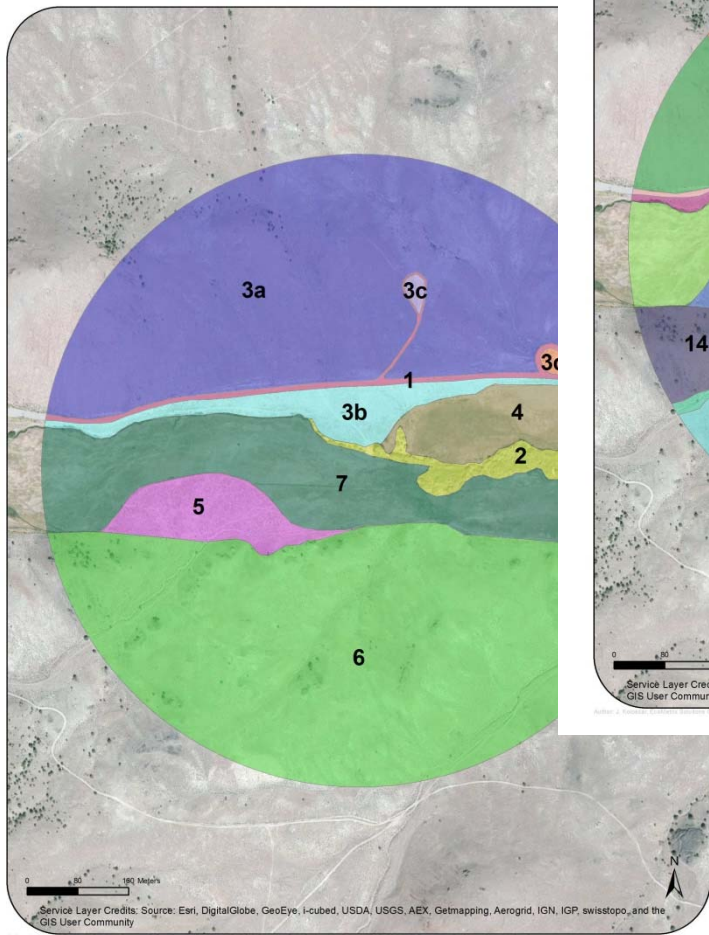


Uncertainty sources from data (with a focus on site level, field collected data):

- Sampling density (lumping/splitting map units, number of sample points, etc.)
- Sampling repeatability
- Sampling accuracy



As sites get larger, maintaining the same intensity of sampling becomes difficult



Uncertainty sources from data (with a focus on site level, field collected data):

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(CCt)

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- Sampling density (lumping/splitting map units, number of sample points, etc.)
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Addressing Data Uncertainties:

Reduce

- Develop user friendly data collection protocols
- Use an automated data collection system that prevents users from entering nonsensical data
- Develop data collection manuals to guide end users
- Don't let just any clown collect the data



Addressing Data Uncertainties:

Recognize

- Test data collection repeatability and accuracy
- Build identified or known uncertainties into models (e.g., add uncertainty node in Bayes net)



Addressing Data Uncertainties:

- Resolve
- Require users to be certified for the appropriate level of use
- Use conservative values based on potential error ranges



Concluding points:

- Uncertainty will exist within all models/decision support tools
- A good modeling process or decision support tool should:
 - Reduce uncertainty where possible (not all uncertainty can or should be eliminated),
 - Track uncertainty, and
 - Resolve how remaining uncertainty is dealt with in the decision application
- The appropriate level of uncertainty is driven by the context of the decision being made





Thank you for your time . . .