Assessing the Transferability of Ecological Models to New Settings

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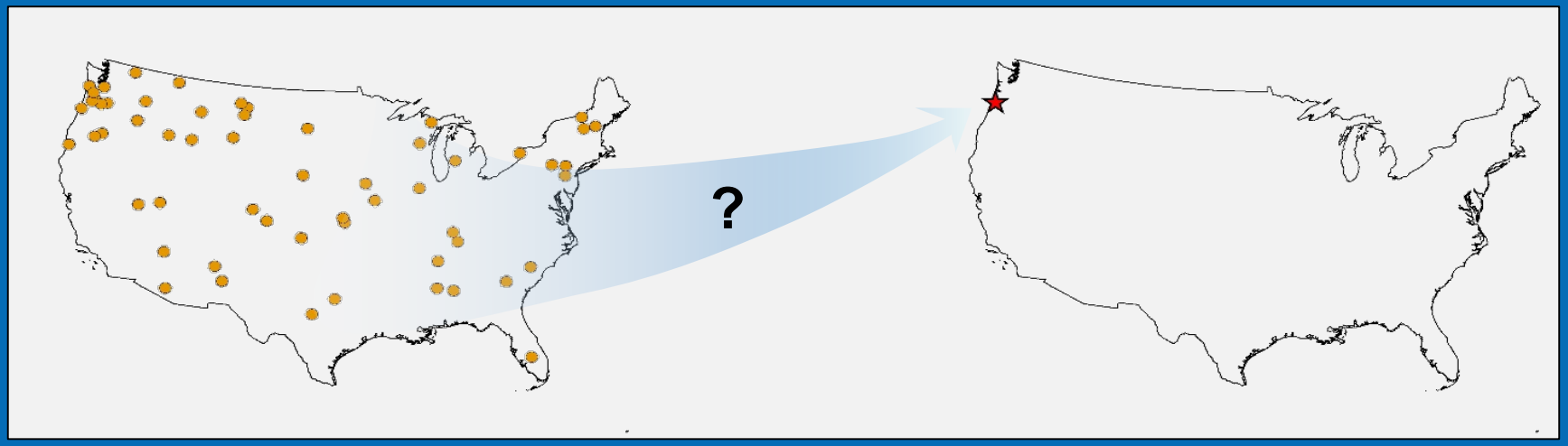

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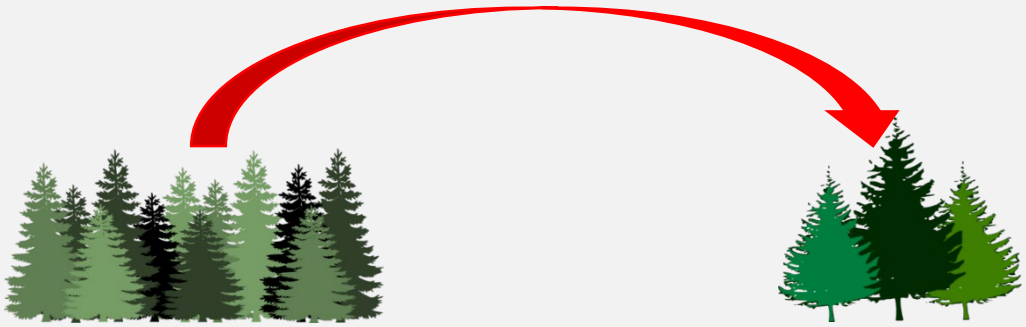
***Problem*:**

Models useful to calculate ecological endpoints at data-poor locations, aka, model transfer

Model transfer practices often ad-hoc, poorly documented

- can result in inaccurate or indefensible results
- lack of transparency → lack of trust
- wasted resources

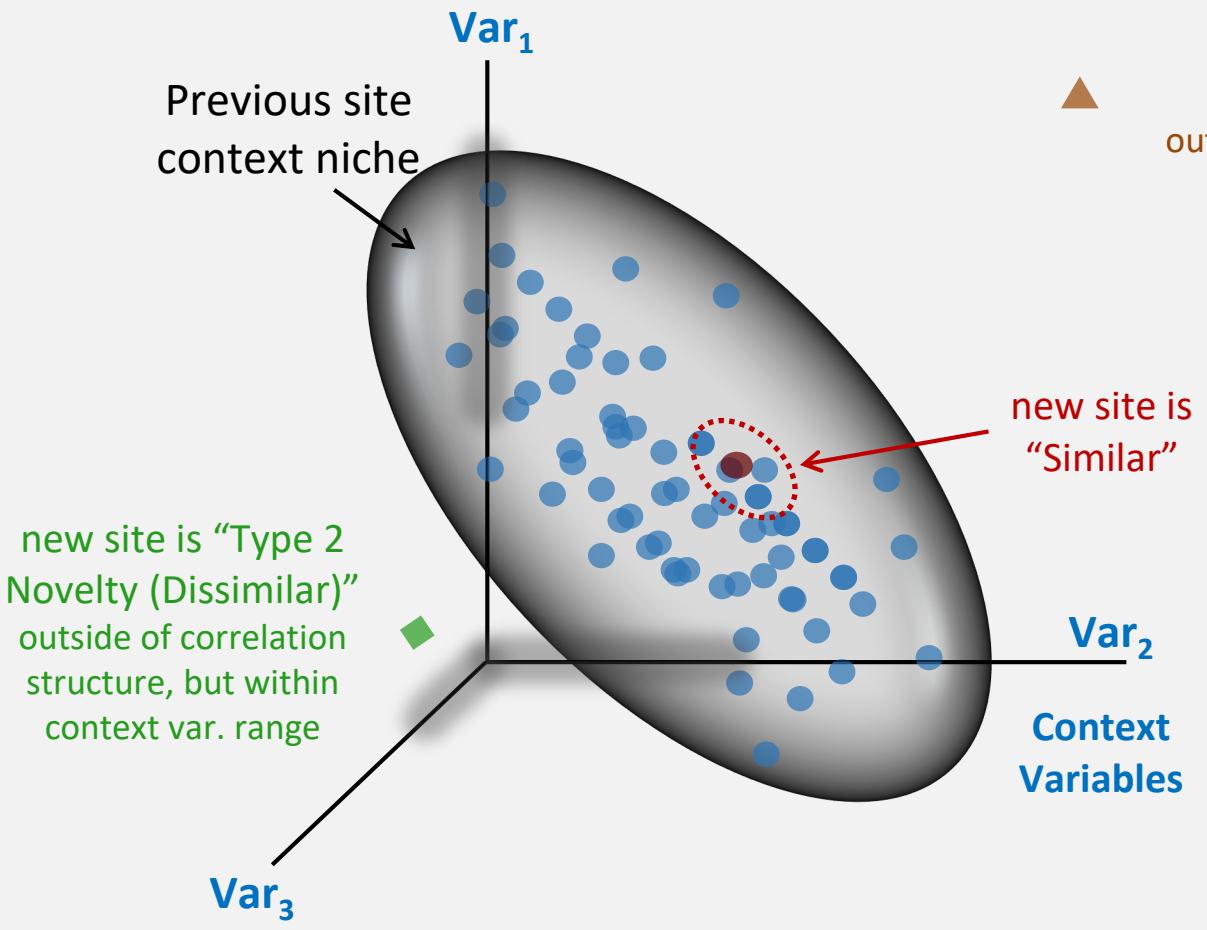
***Goal*:** A practical methodology to assess
whether a model can be defensibly transferred to a new site



Previous sites

New site

Key concept: a model that worked at "previous" sites will work at a "new" site if the previous & new sites have the same *context niche*



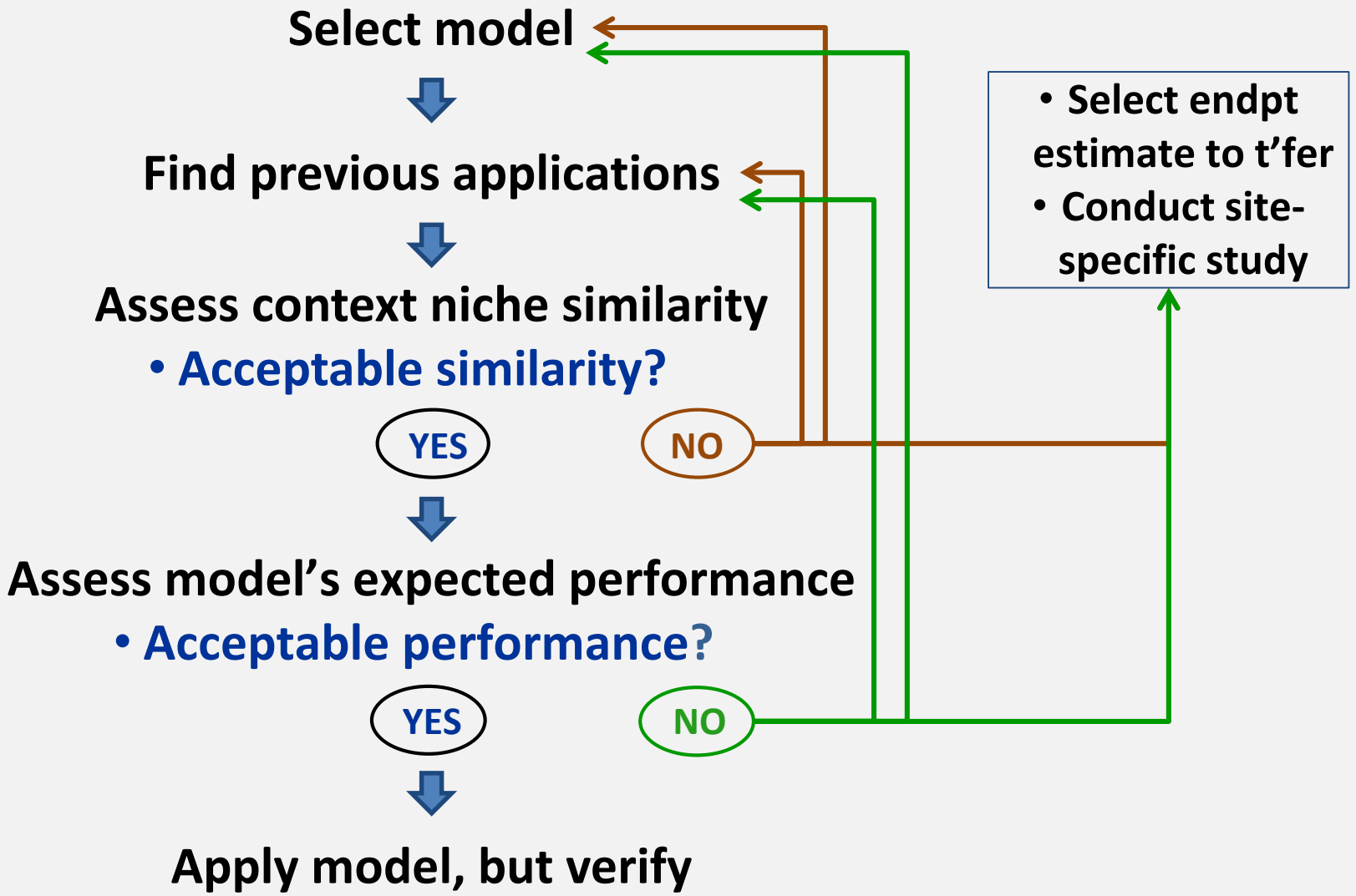
new site is "Type 1 Novelty (Dissimilar)" outside of context var. range

Transferability Q's

Is your "new" site similar, to "previous" sites?

How well did the model perform at sites with similar context?

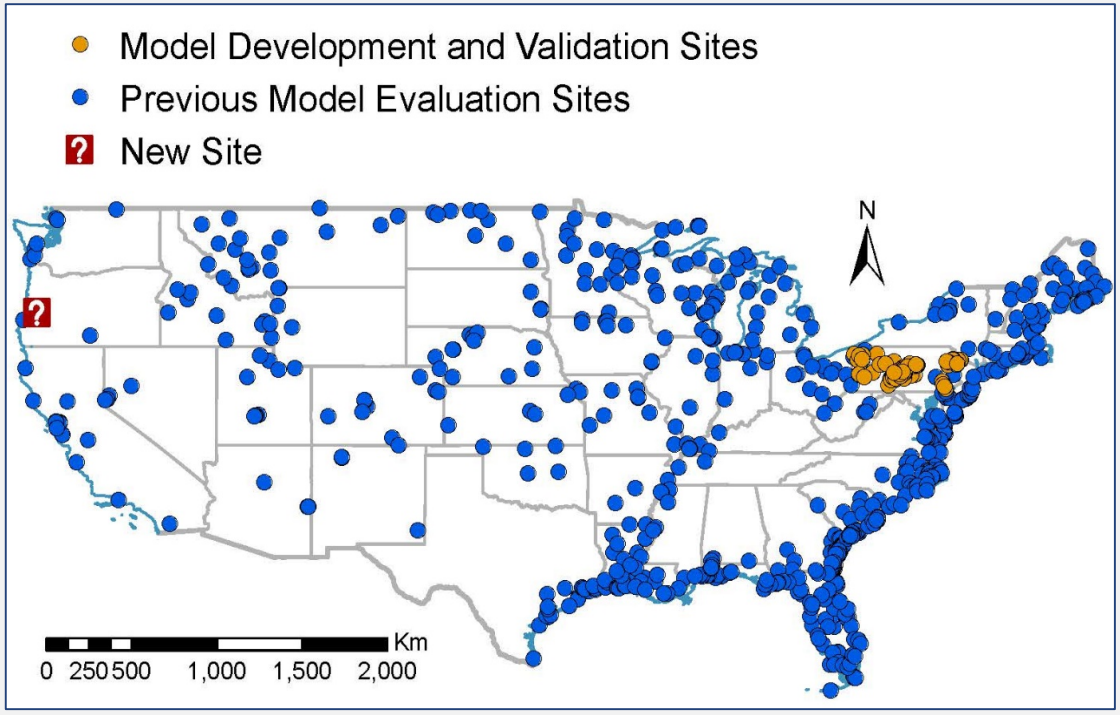
Model Transferability Assessment Framework



Example: Should the *CoC Model* [1] be used to assess wetland condition in a southern Oregon wetland?

$$CoC = 8.16 - 0.73(pH) - 0.29(LDI)$$

- CoC[2] – wetland condition index based on plant spp.
- LDI[3] - landscape development index (disturbance)



[1] *Moon et al. (2017)*

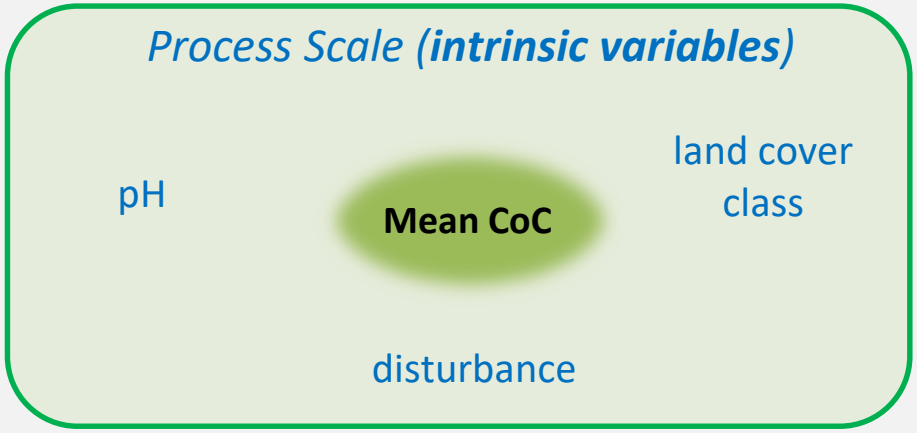
[2] *Lopez & Fennessy (2002)*

[3] *Brown & Vivas (2005) & Lane et al. (2012)*

Assess Context Similarity (1)

Select Model Context Variables: Intrinsic & Extrinsic

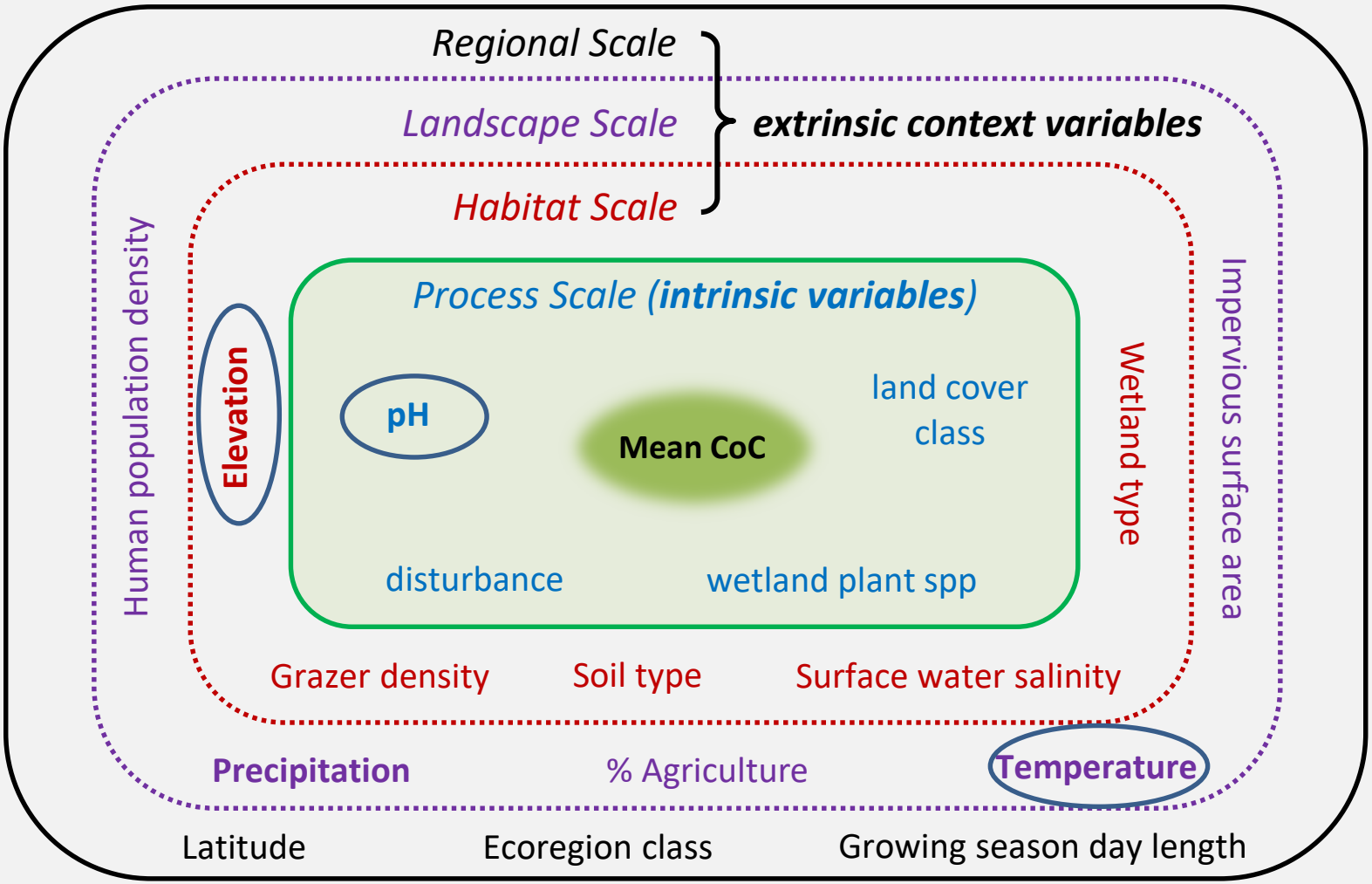
Model Context Variables = biophysical variables that are reasonably expected to influence the process being modeled



Intrinsic Context Variables: predictor variables in CoC model

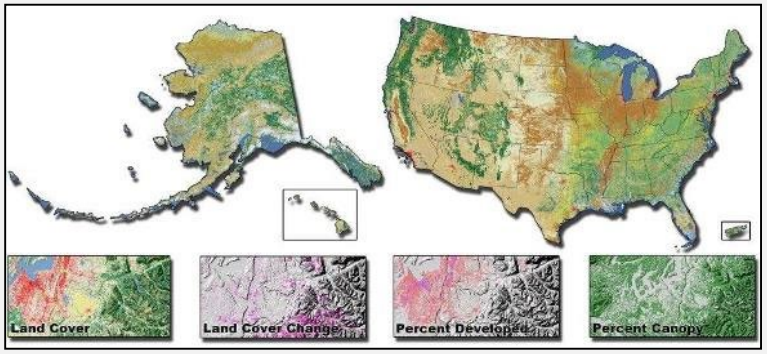
Assess Context Similarity (1)

Select Model Context Variables: Intrinsic & Extrinsic

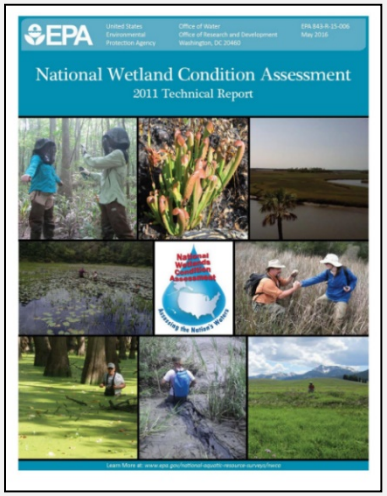


Assess Context Similarity (2)

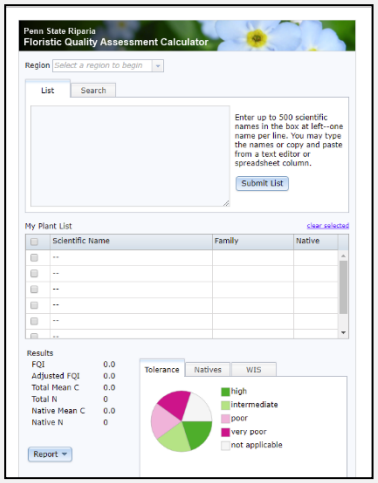
Quantifying Context Variables



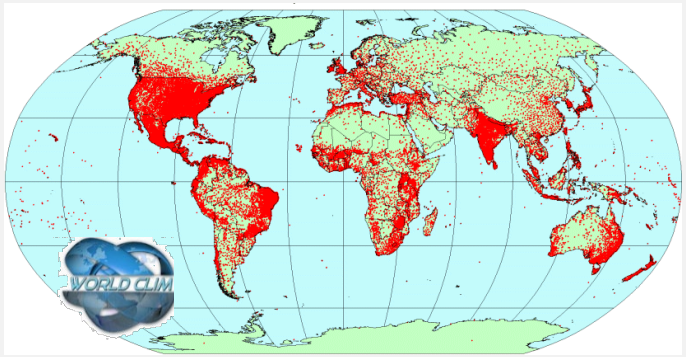
USGS National Land Cover Database



US EPA National Wetland Condition Assessment 2011



Penn State Riparia Floristic Quality Assessment Calculator



WorldClim – Global climate data

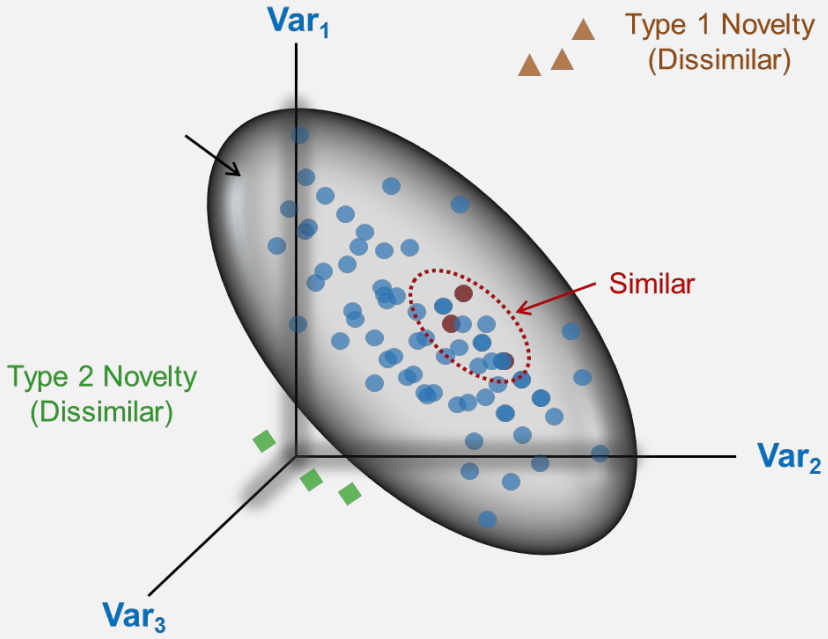
Assess Context Similarity (3)
Setting Acceptability Criteria

Context Niche Similarity Analysis: ExDet[1] (Extrapolation Detection Tool)

Metrics: Novelty Type 1 & 2 dissimilarity (NT1, NT2) of "new" site

Criteria: user sets value(s) of the metrics

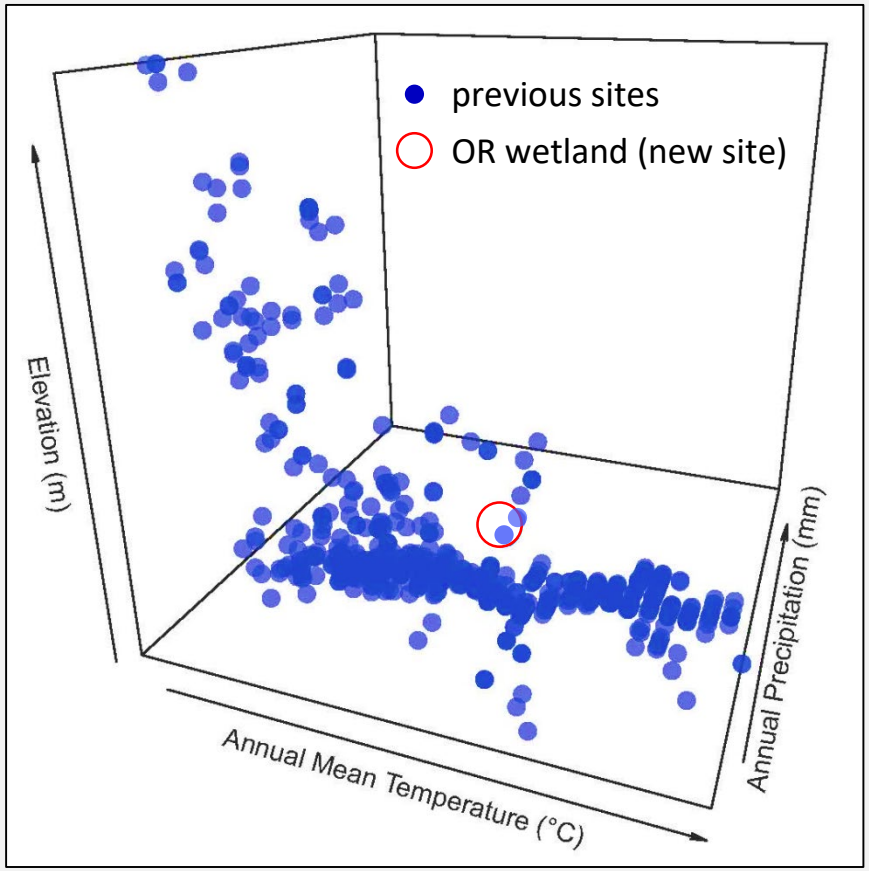
This study NT1 ≤ 1.0 (OR site has similar context var. range)
NT2 ≤ 1.0 (OR site context within correlation structure)



[1]Mesgaran et al (2014) & Moon et al. (2017)
http://www.climond.org/exdet

Assess Context Similarity (4)

Context Similarity Analysis



Results of Similarity Analysis (ExDet)

	$NT1_{OR}$	$NT2_{OR}$
Criteria	≤ 1	≤ 1
Observed	0	0.08

Decision:

OR wetland site is similar to "previous" sites

Proceed to determine expected error

If context niches not similar:
select a different model, use an estimate of endpt, or do site-specific study

Assess Model's Expected Performance (1)
Set acceptability criteria

1. Select most similar "previous" sites to compare to "new" site
   - subset of all sites; similarity metric (var. range, % of sites, etc)
2. Select "model error" and "uncertainty" metrics
   - error: *f* {observed vs predicted}; difference, r^2
   - uncertainty: variance in error; (SD, CoV)
3. Set tolerance thresholds for error & uncertainty metrics

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This study

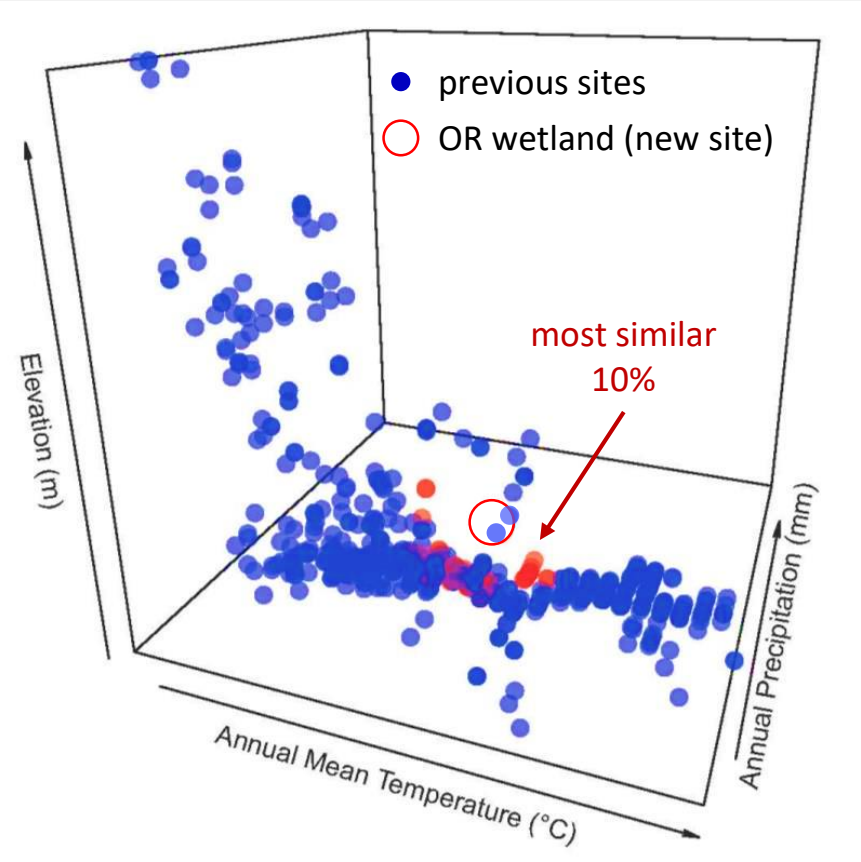
Most similar sites = 10% with context values closest to OR site

Error: mean (predicted CoC - measured CoC) ≤ 2

Uncertainty: CV of mean error ≤ 20%

Assess Model's Expected Performance (2)

Est. model error at "most similar" sites



Model Error ≡
mean (measured CoC – predicted CoC)

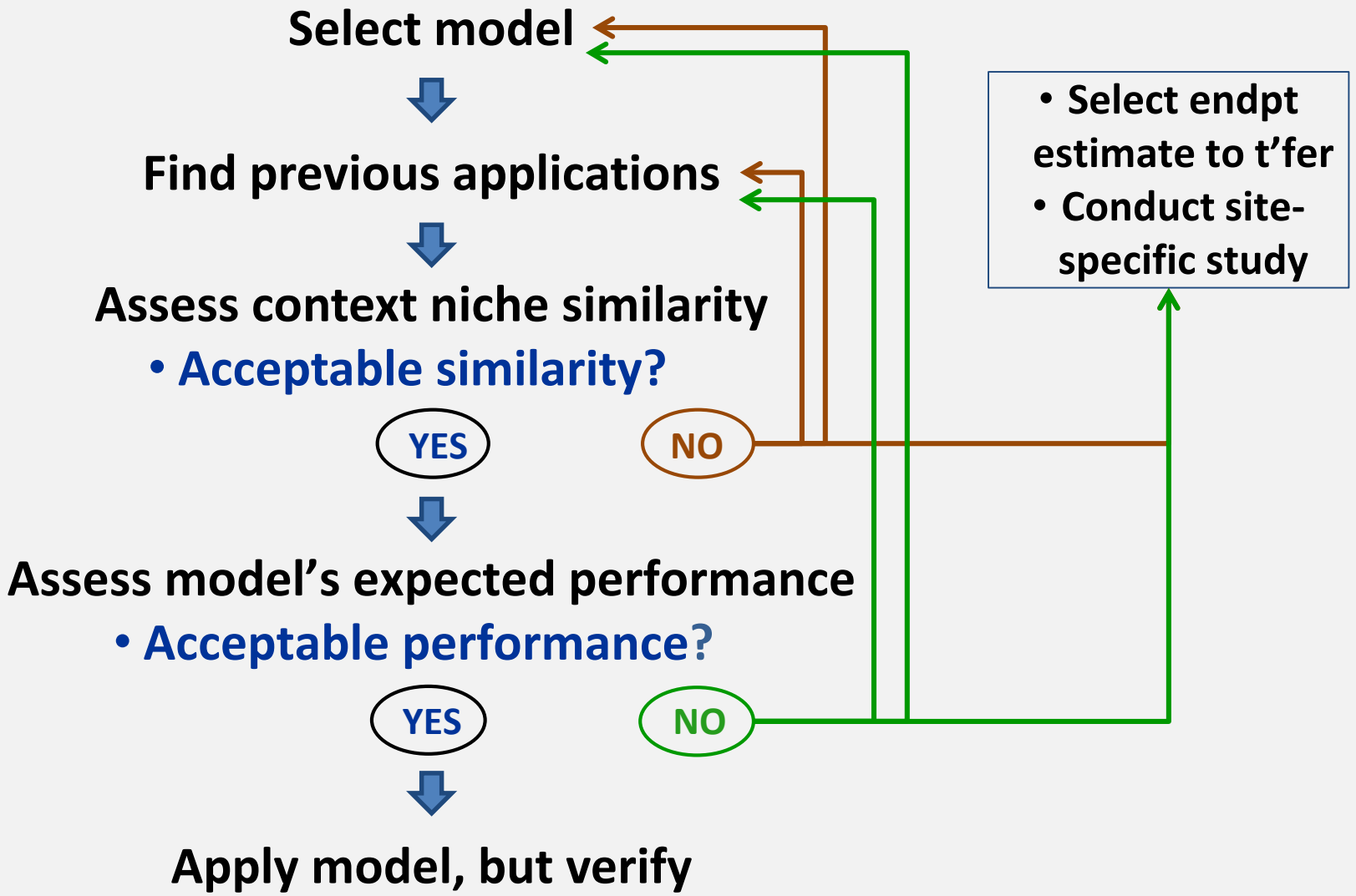
	Error (mean)	Uncertainty (CV)
Criteria	≤ 2	≤ 20%
Observed	1.26	105.82

Decision:

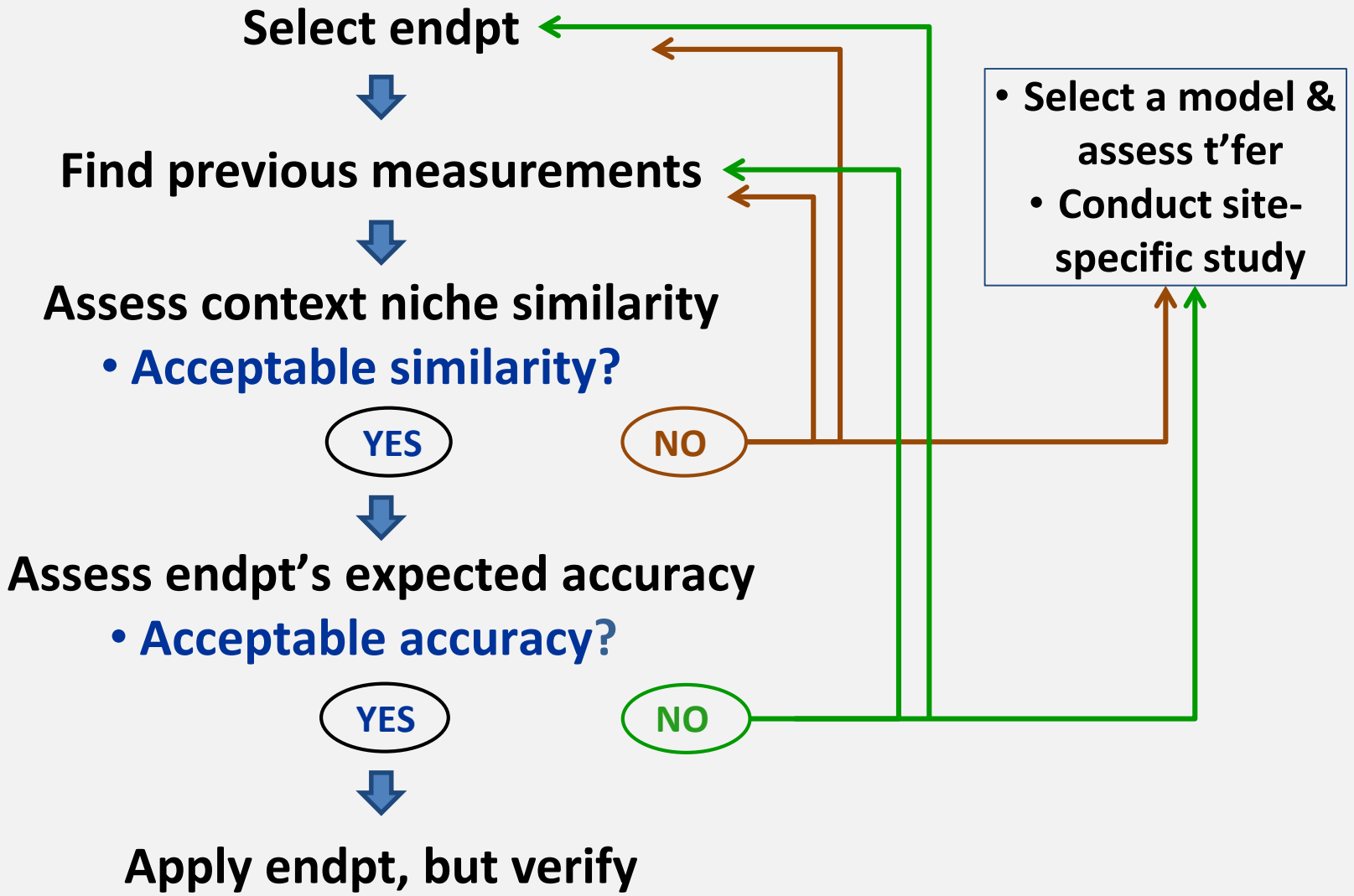
Model can be applied at OR site, but expect uncertainty in its accuracy

Invest in validation at OR site

Model Transferability Assessment Framework



Unit (or Endpt) Transfer Framework



EPA United States Environmental Protection Agency

Take-Away's

- Model transfers are necessary but fraught
- A methodology to assess a model's transferability:
  - provides consistency
  - increases legitimacy thru transparency
  - increases efficiency, reduces costs
- Framework also useful for transferability of unit values

More…

- Moon et al. (2017) *Ecosphere* 8(10):e01974
  Model application niche analysis: assessing the transferability and generalizability of ecological models
- Yates et al. (2018) *Trends in Ecol. Evol.* 33:790
  Outstanding challenges in the transferability of ecological models