Using tidal landform scaling for habitat restoration planning, design, and monitoring

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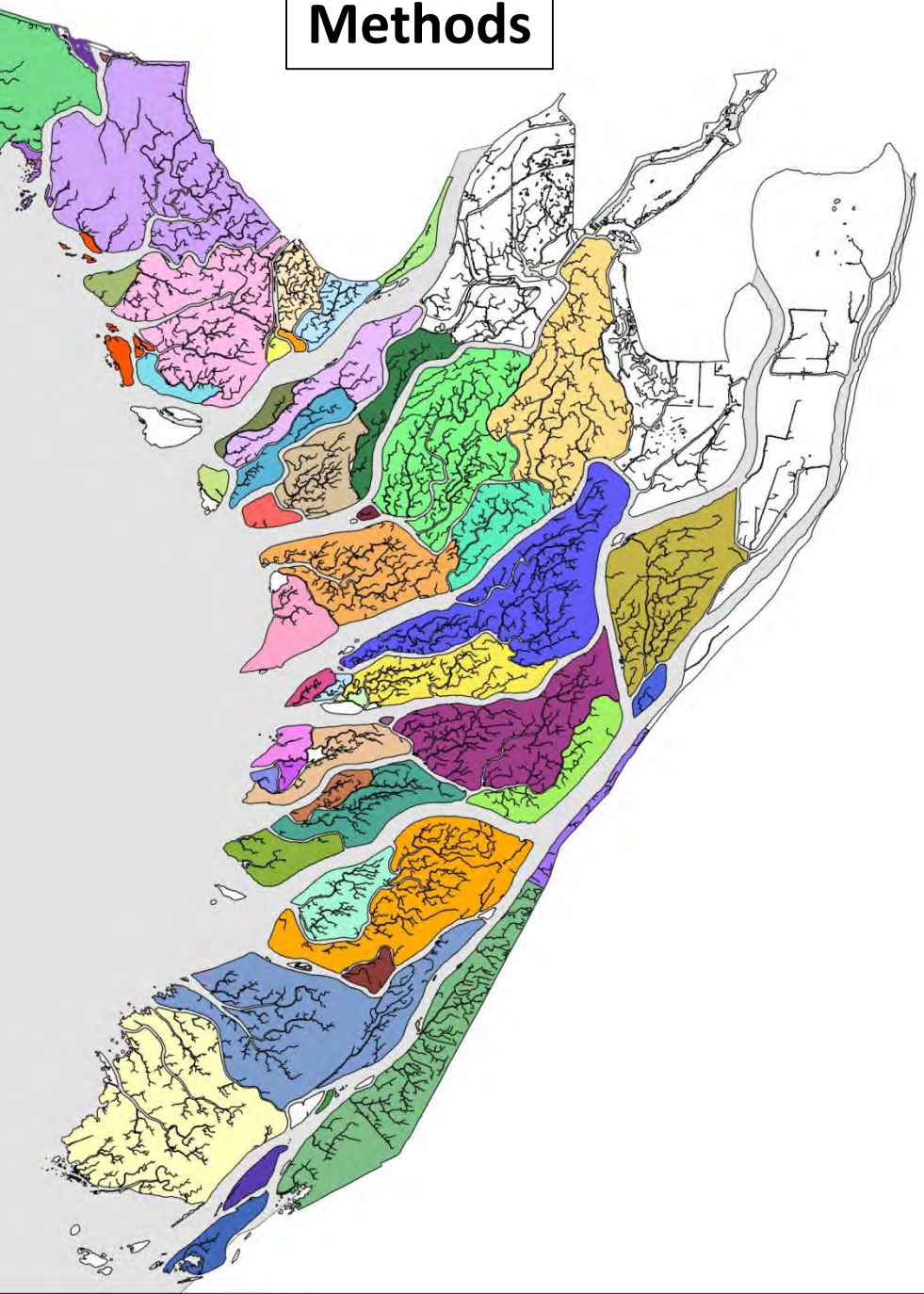
Methods



Allometry of marsh islands and channel geometry.

Landscapes are fractal, scaling relationships are power functions that can be linearized by log transformation,

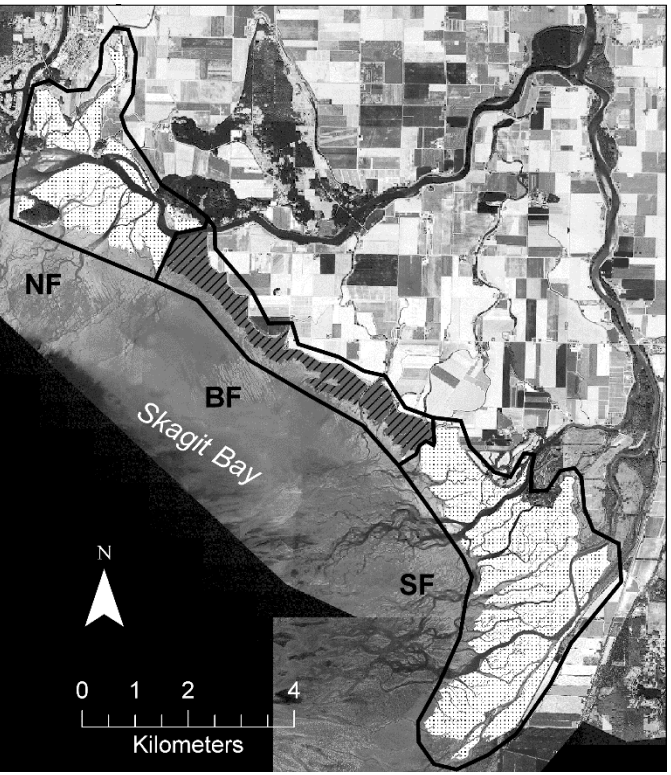
$P = cA^b \rightarrow \log(P) = \log(c) + b \log(A)$

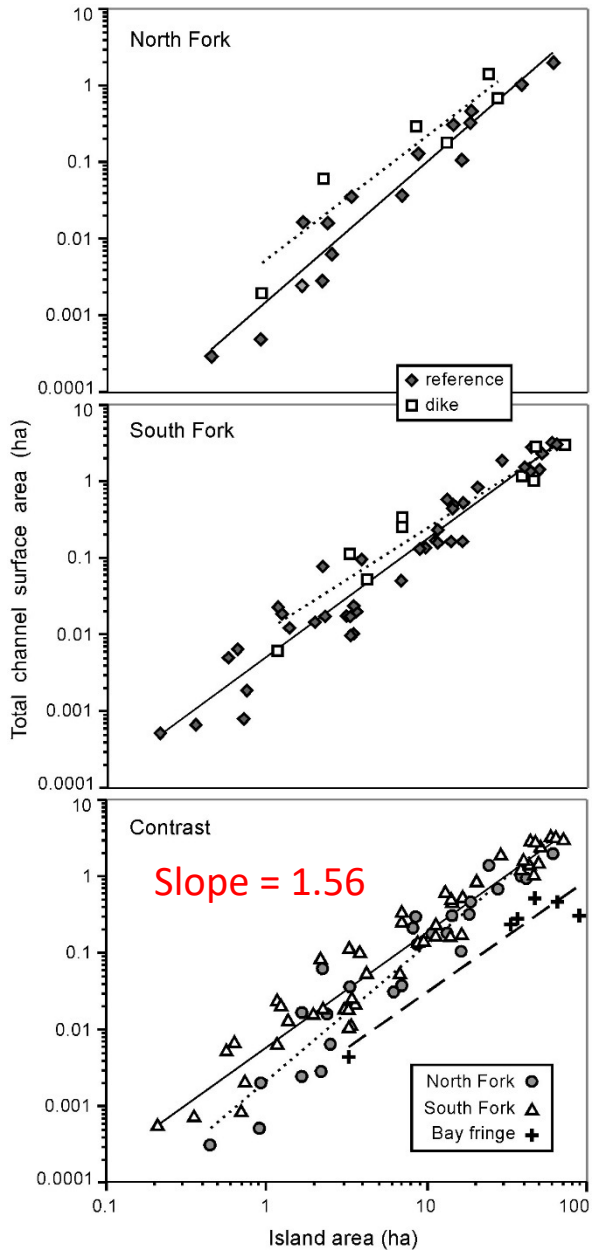
Benefit: Prediction of a suite of useful channel geometries.

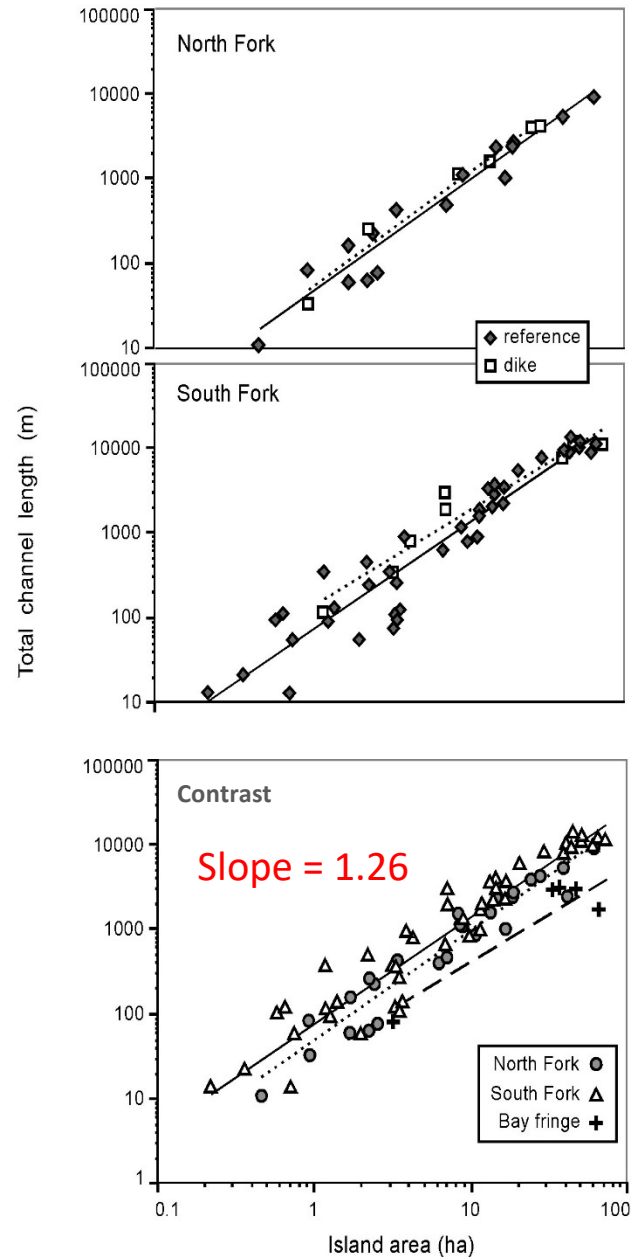
<u>Prediction is necessary</u>:

for planning and design
to evaluate outcomes (monitoring)
to better understand our system

Application: [1] Diagnosis, [2] Planning





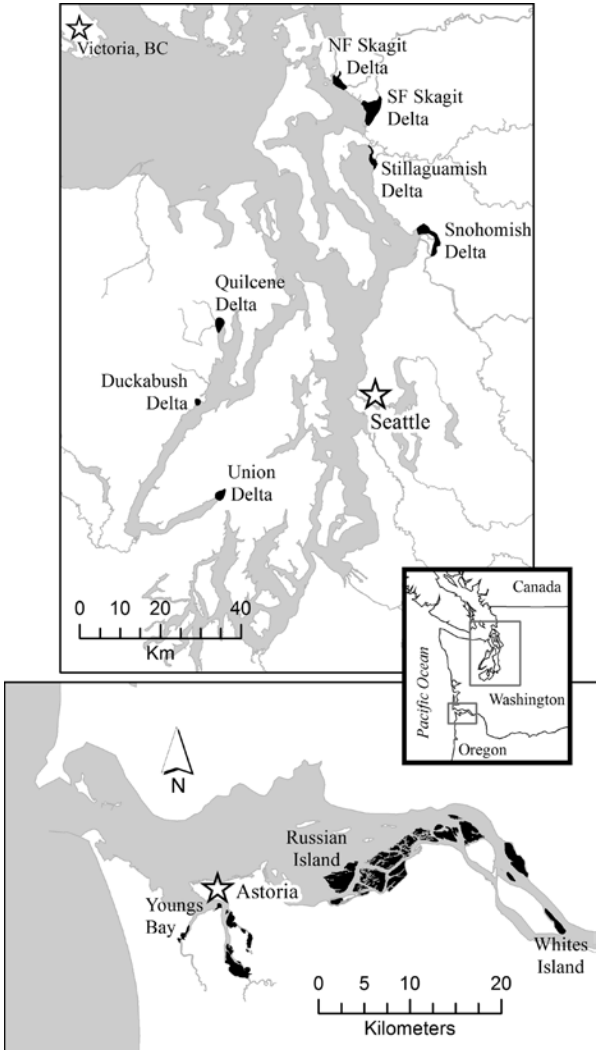


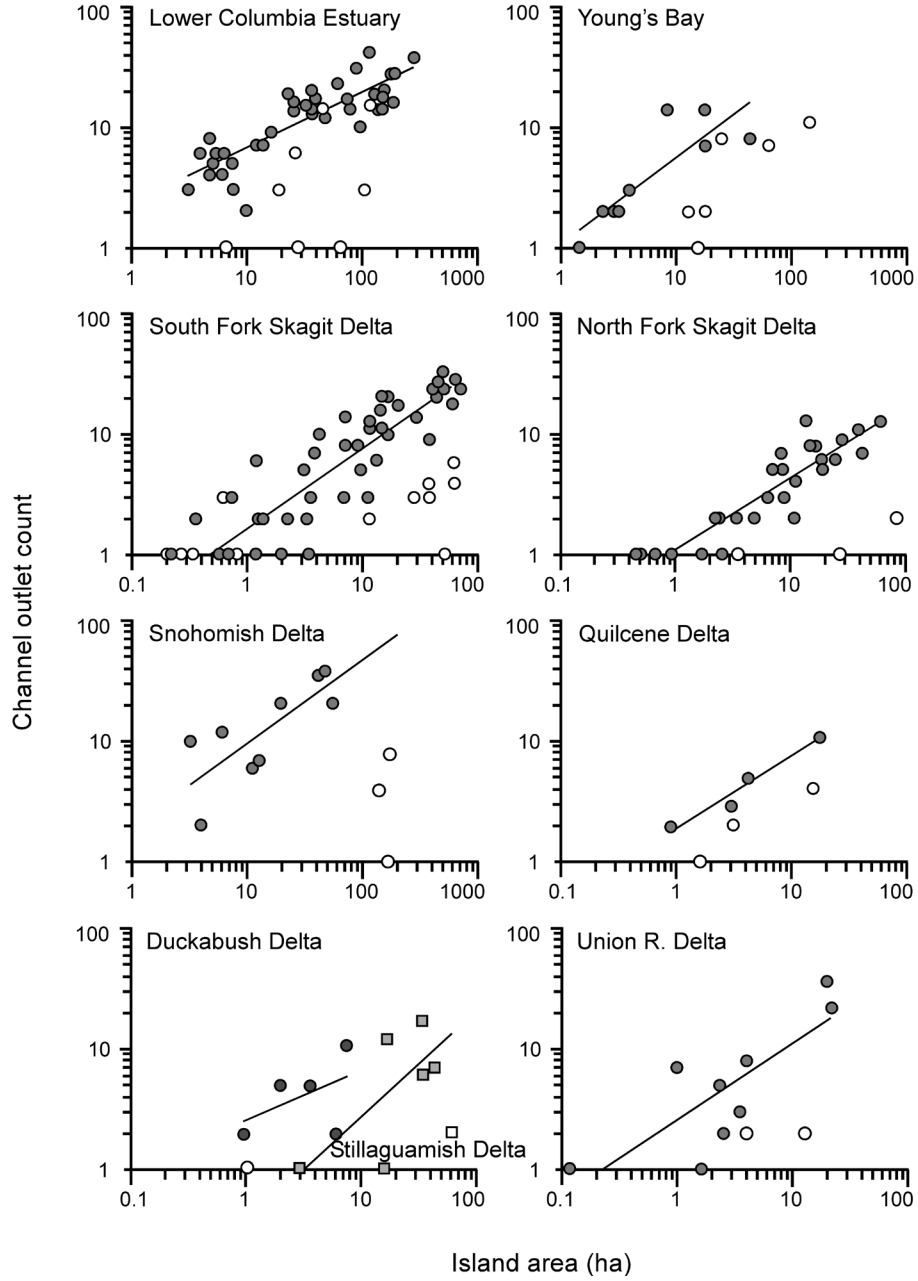
Non-additive cumulative effects

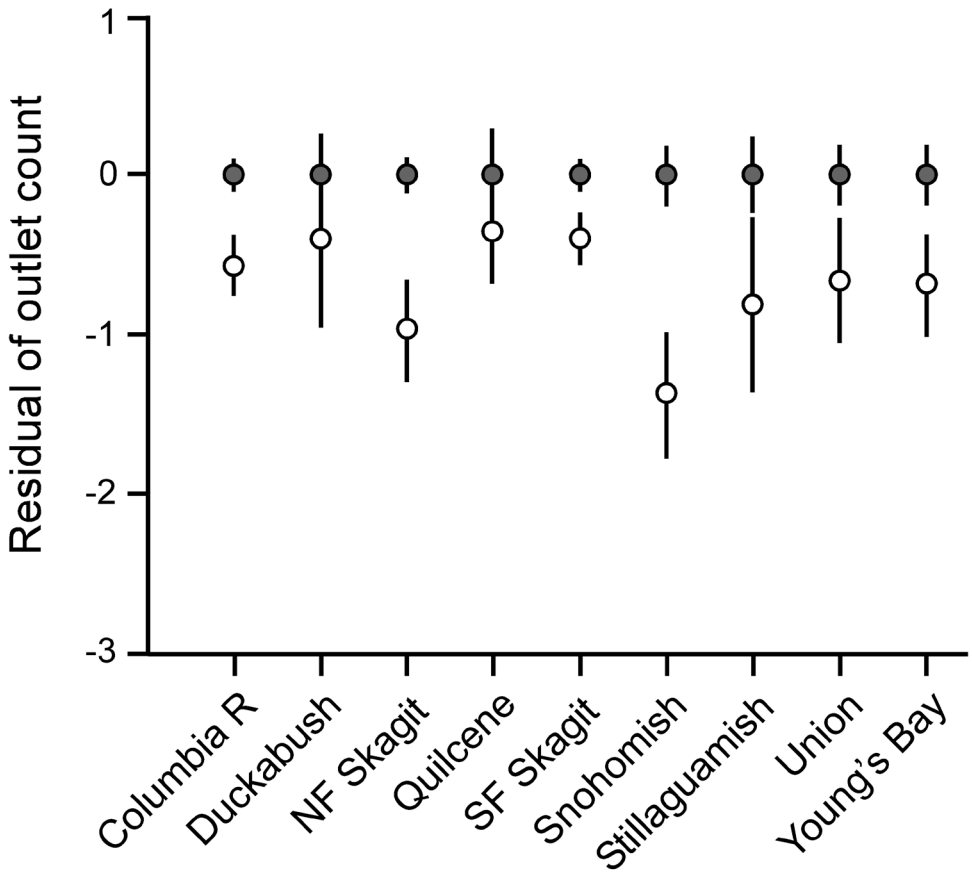
SLOSS

Application: [3] Restoration Design, [4] Monitoring/evaluation

How many tidal channels,
how many dike breaches?







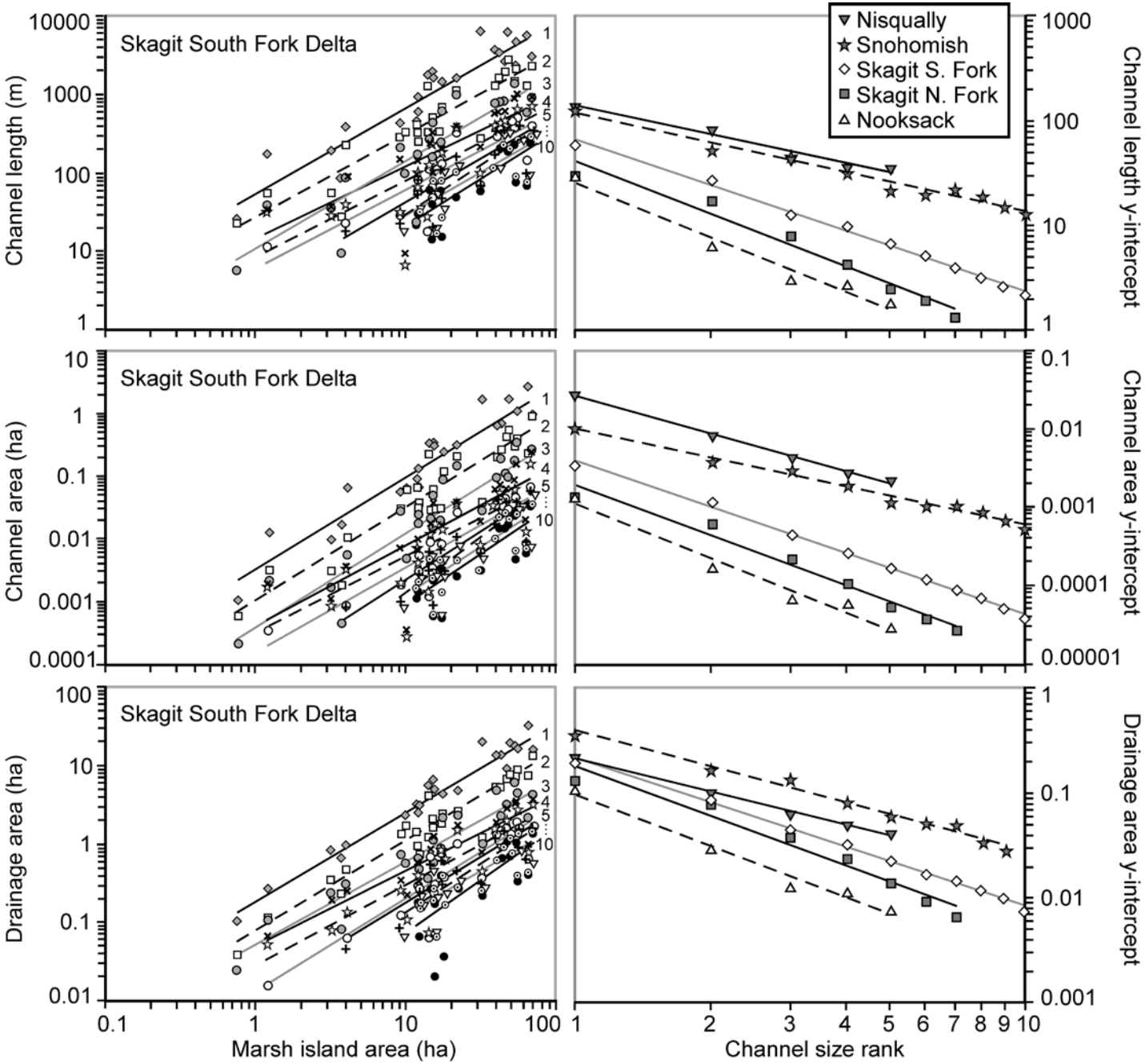
We are underestimating the number of dike breaches necessary to mimic reference marsh systems by 5-fold. This likely affects fish access to tidal channel networks.

Smith Island Conceptual Design
vs.
Model Predictions for Channel Count

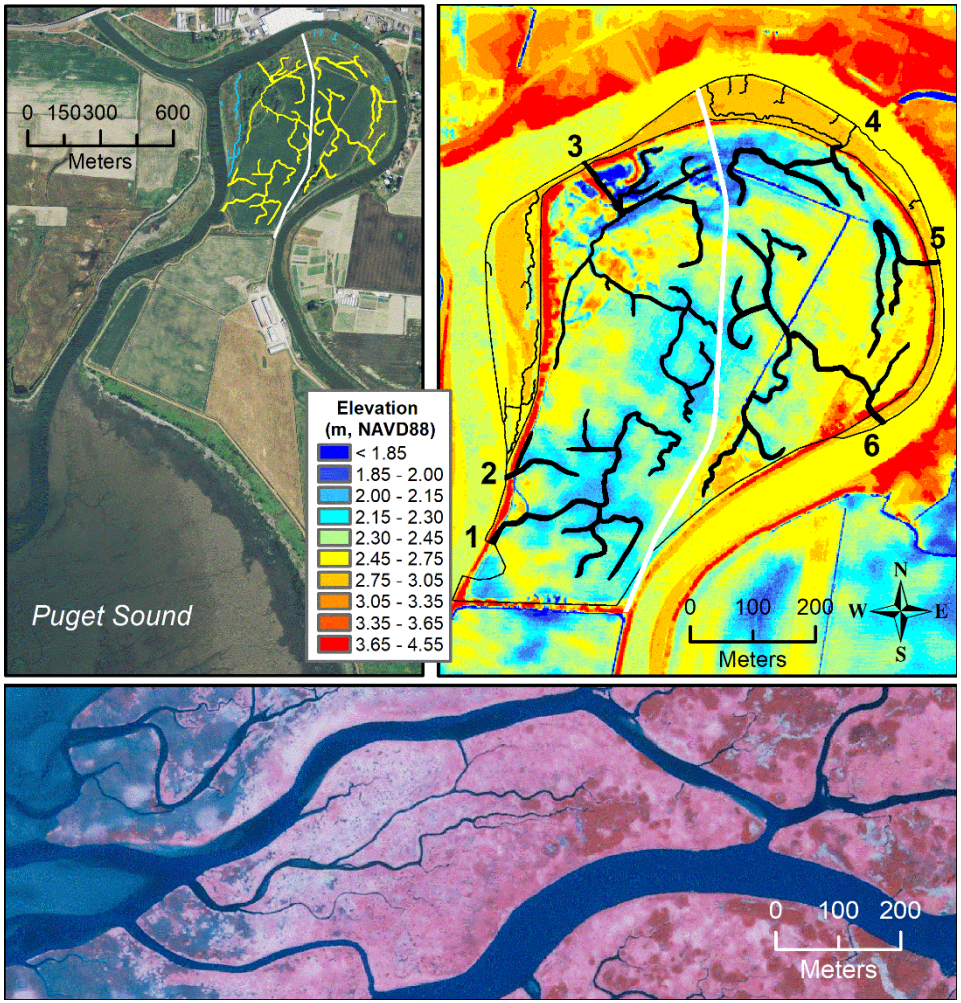
Predicted (95%; 80% CL)	46 (14; 22)
Planned	8

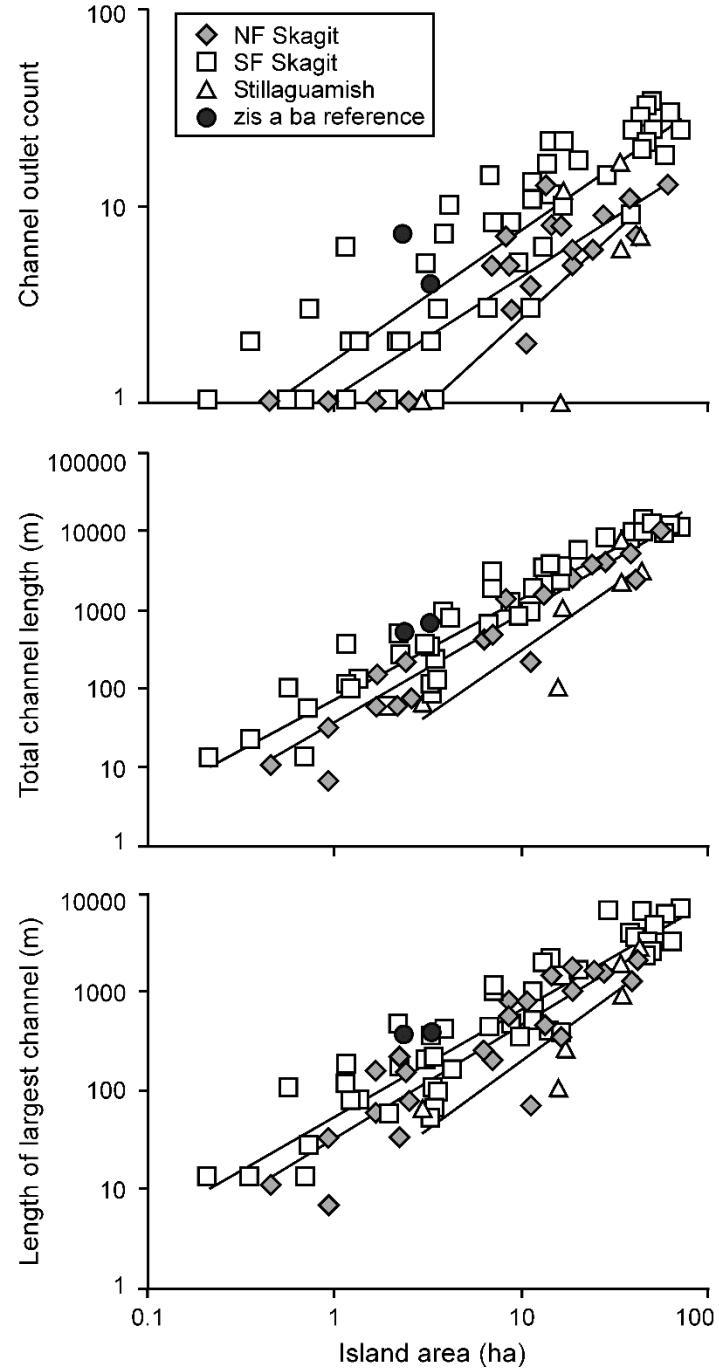
Thanks to Bob Aldrich
Snohomish Co. Public Works Dept.

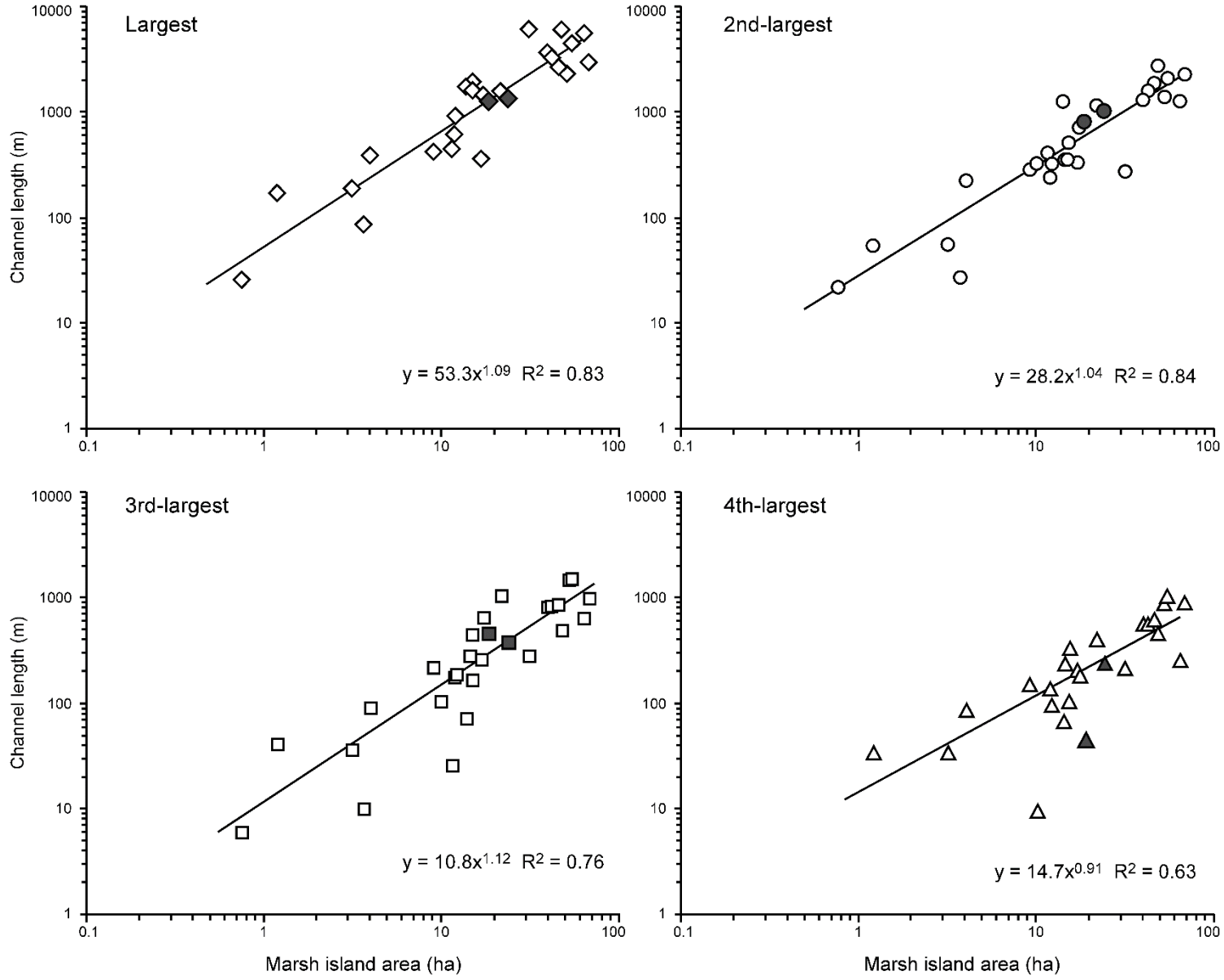
Predicting the size of tidal channels

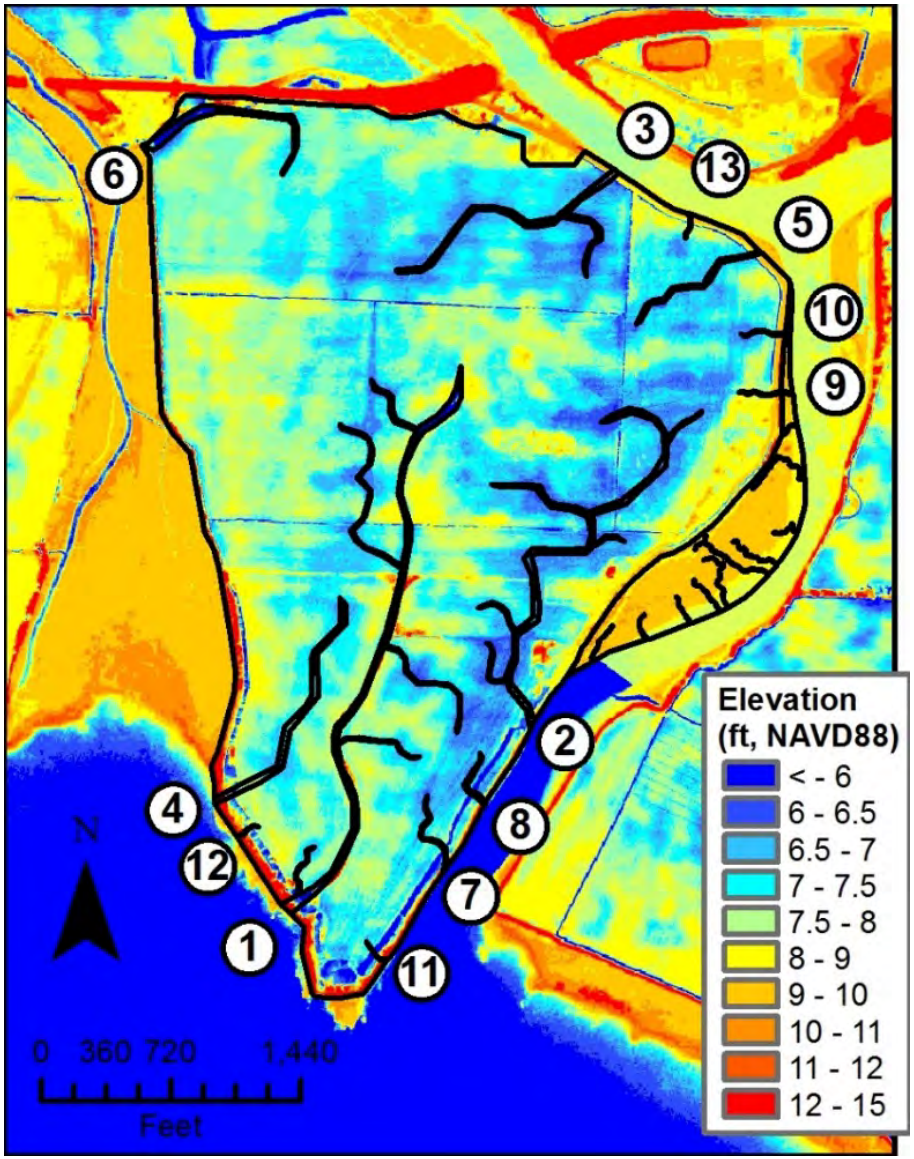


Application to restoration design: an example



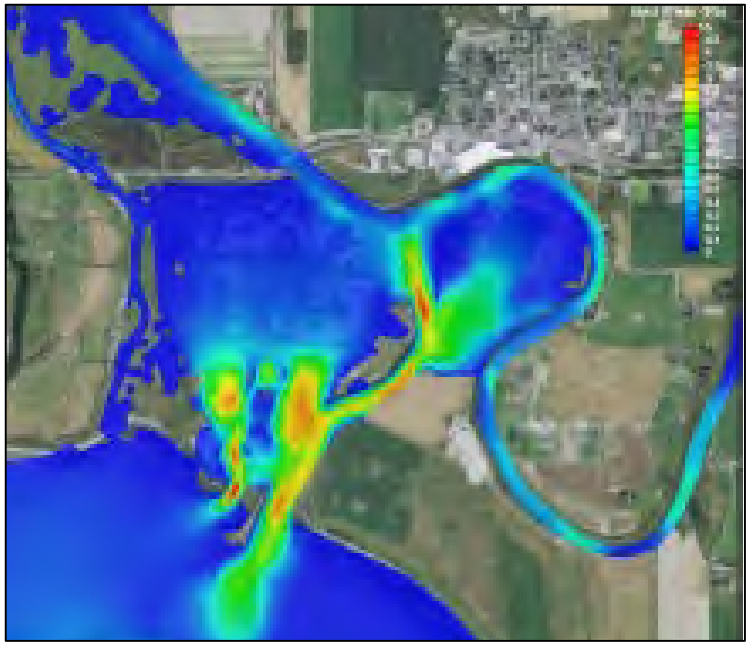



Largest
y = 53.3x^1.09 R^2 = 0.83
2nd-largest
y = 28.2x^1.04 R^2 = 0.84
3rd-largest
y = 10.8x^1.12 R^2 = 0.76
4th-largest
y = 14.7x^0.91 R^2 = 0.63
Channel length (m)
Marsh island area (ha)
10000
1000
100
10
1
0.1
1
10
100



Goal is to guide engineers and planners towards reference marsh averages…

…not to provide them with absolute or definitive design plans.



Map of bed shear stress for the full restoration design concept with no training dike; warm colors are higher values (from Khangaonkar et al., 2014).

Summary

1. Useful guidance for design; not absolute prescription because of high statistical uncertainty. Good for pushing design to meet at least the lower 80% confidence limit of a prediction.
2. Useful for development of monitoring/evaluation standards, e.g., channel outlet count.
3. Unexpected insights, e.g., non-additive cumulative effects, scaling of channelized tidal prism.
4. Diagnosis of anthropogenic impacts.
5. Further improvement → effects of tide range, fetch, sediment supply, sediment grain size, vegetation type, marsh surface elevation.

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