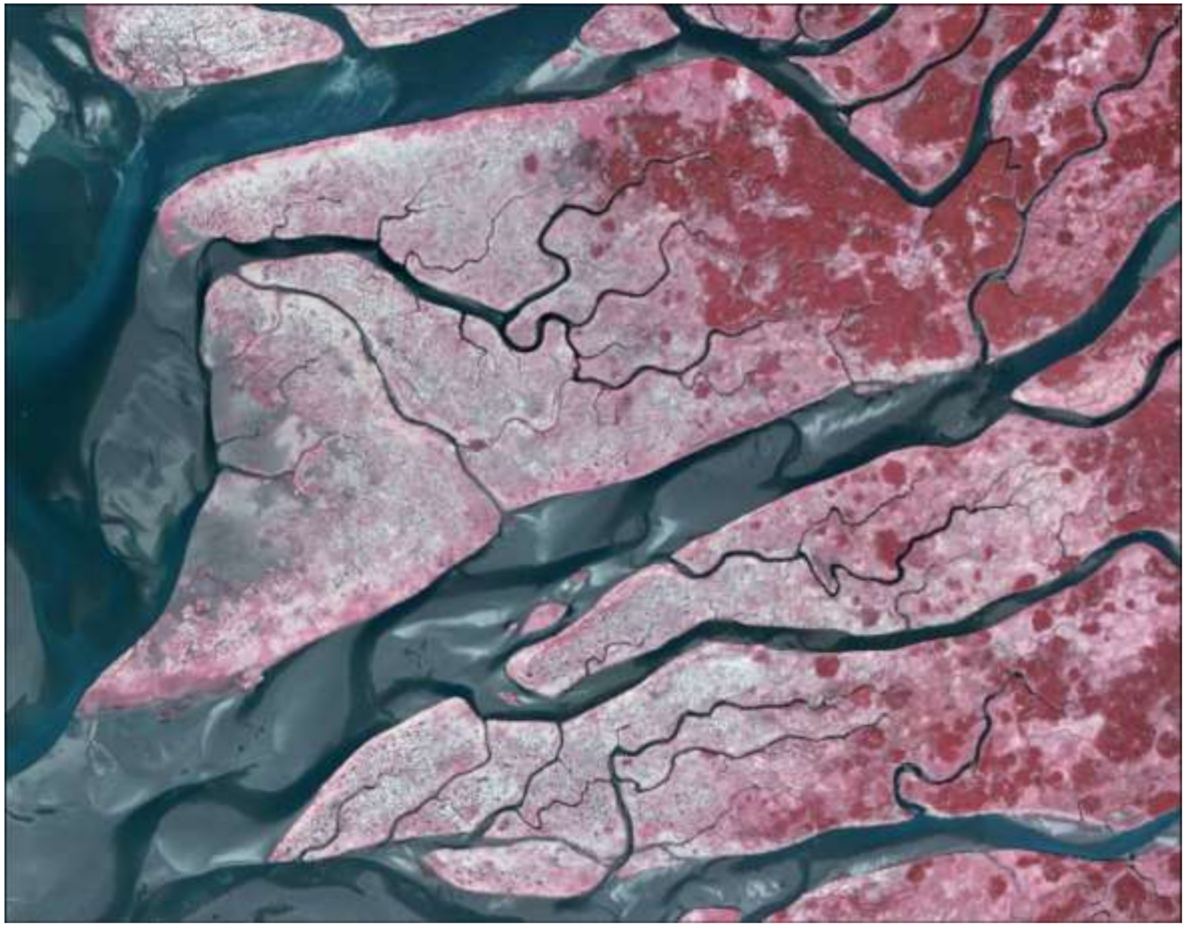
Geographic Variation in Puget Sound Tidal Channel Geometry

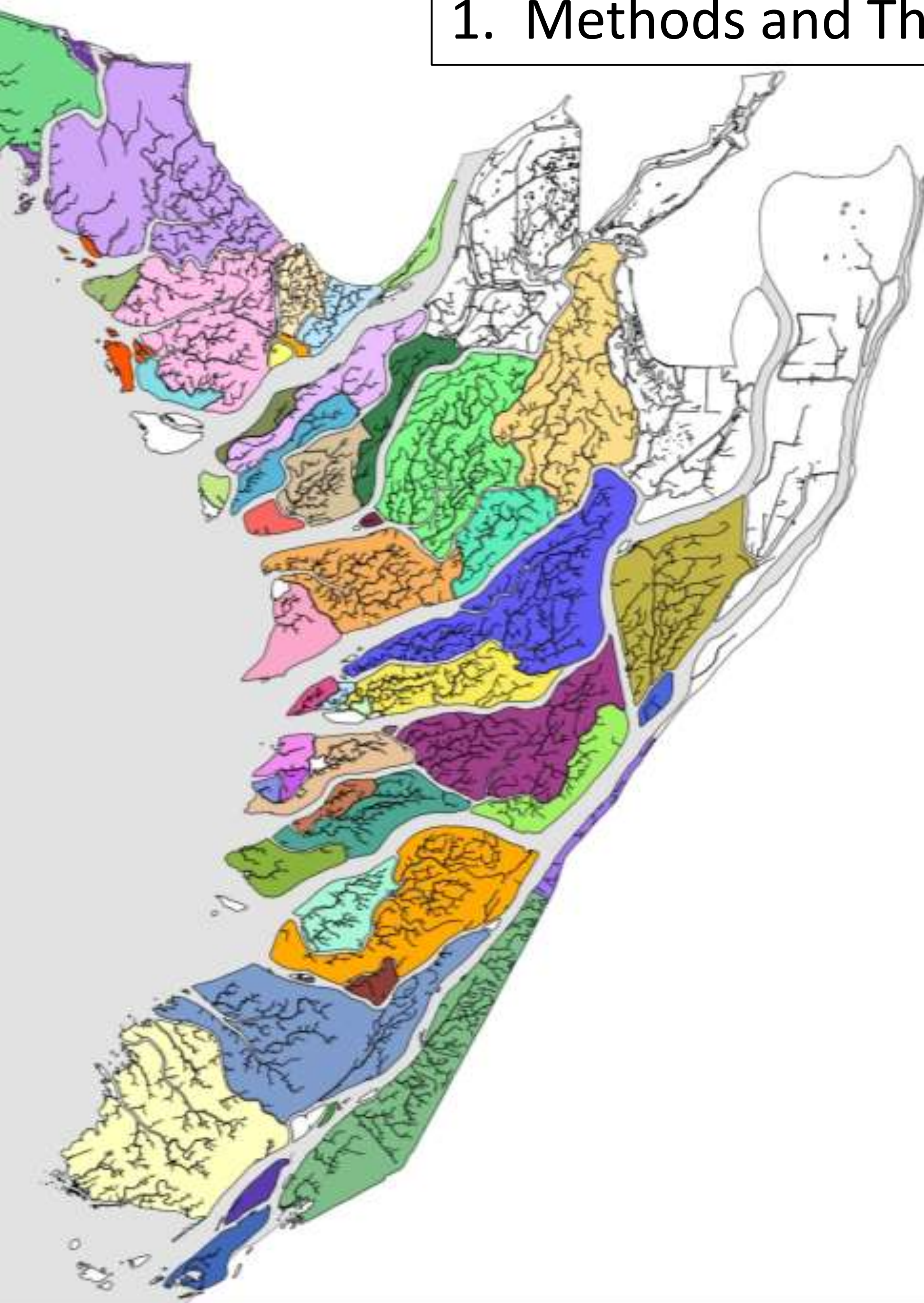
Developing a Tool for Restoration Planning, Design, and Monitoring

This work funded by the WDFW ESRP



W. Gregory Hood
Skagit River System Cooperative

1. Methods and Theoretical Background



Allometry of marsh islands and channel geometry.

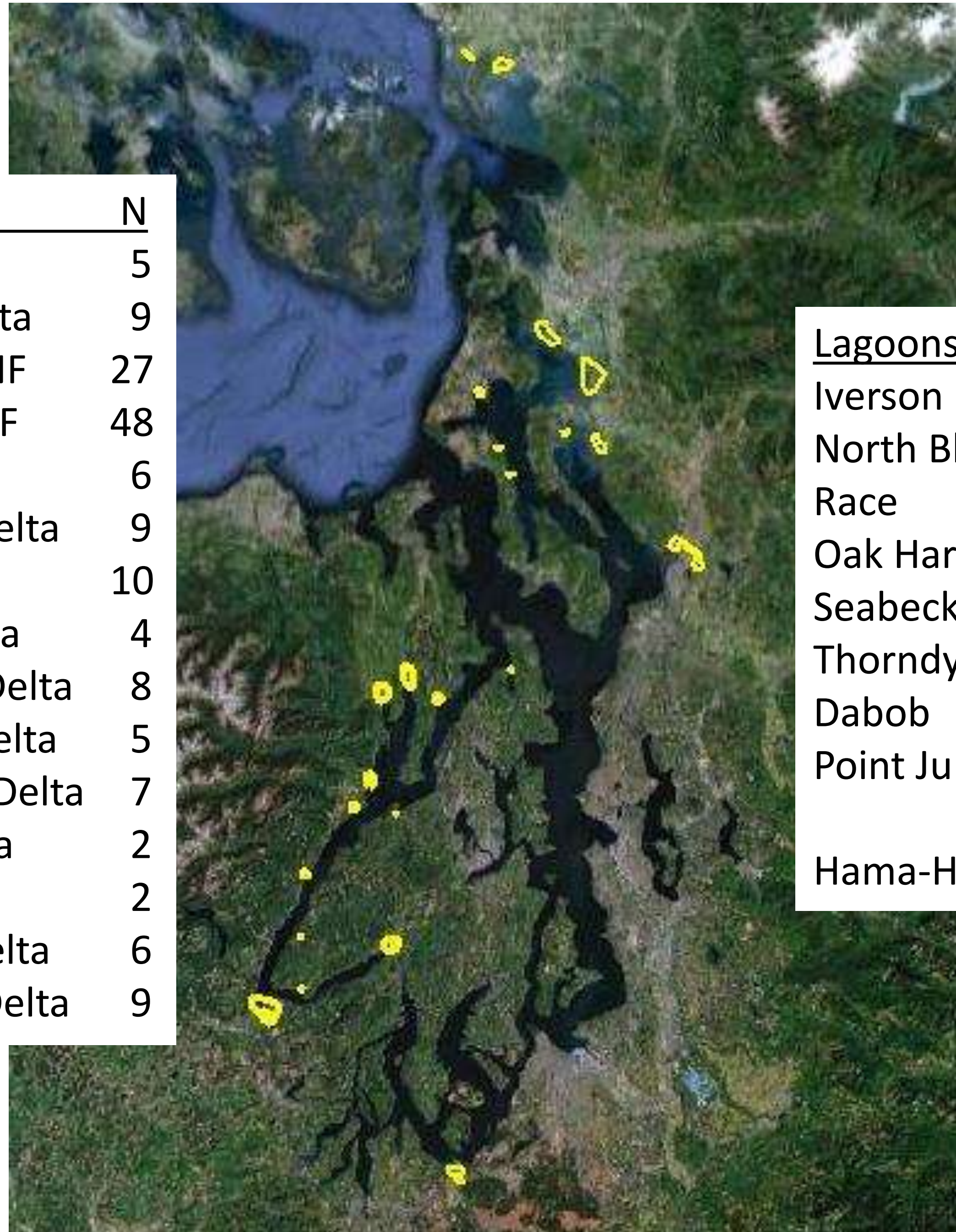
Landscapes are fractal, i.e., scaling relationships exist between different landscape elements, e.g., marsh islands and tidal channels.

Note: 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 not typical of hydraulic geometry.

Goal: Develop predictive models for habitat restoration design and planning

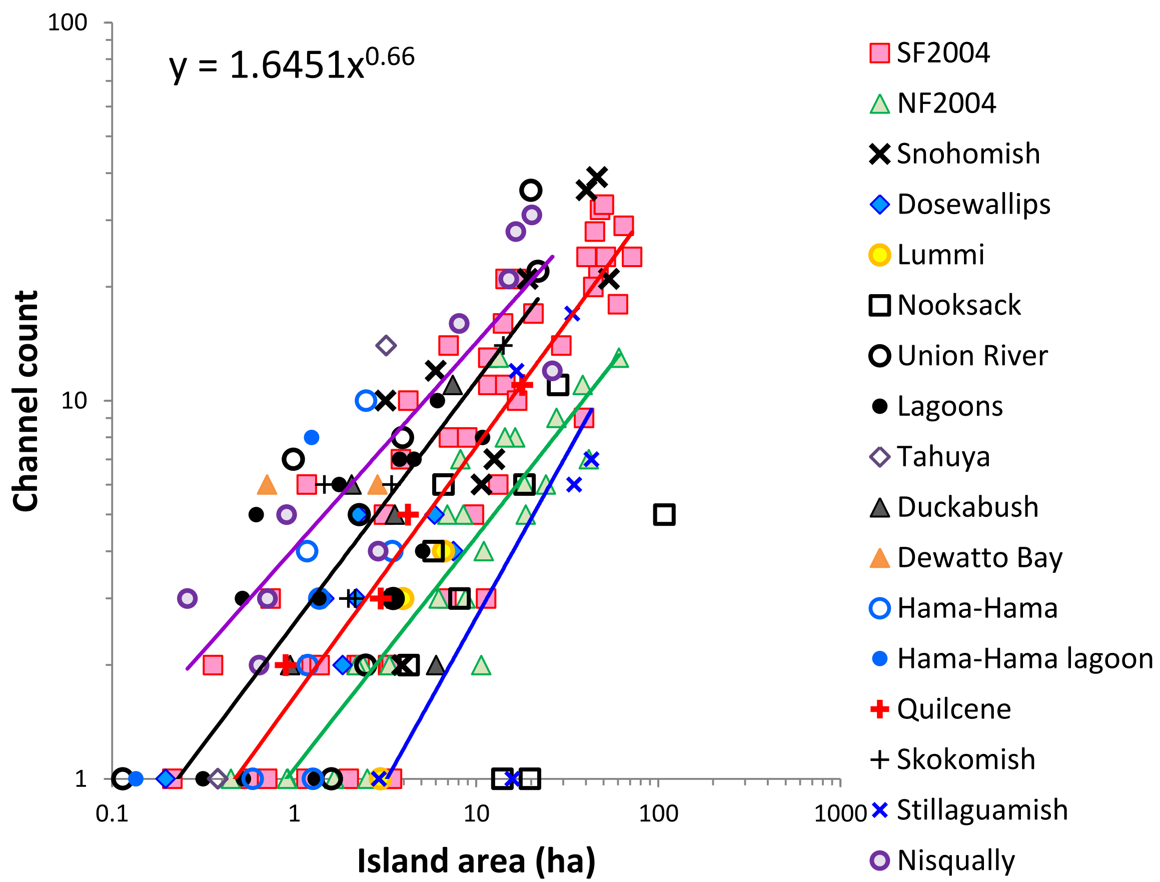


Deltas	N
Lummi	5
Nooksack Delta	9
Skagit Delta NF	27
Skagit Delta SF	48
Stillaguamish	6
Snohomish Delta	9
Nisqually	10
Quilcene Delta	4
Dosewallips Delta	8
Duckabush Delta	5
Hama-Hama Delta	7
Dewatto Delta	2
Tahuya Delta	2
Skokomish Delta	6
Union River Delta	9

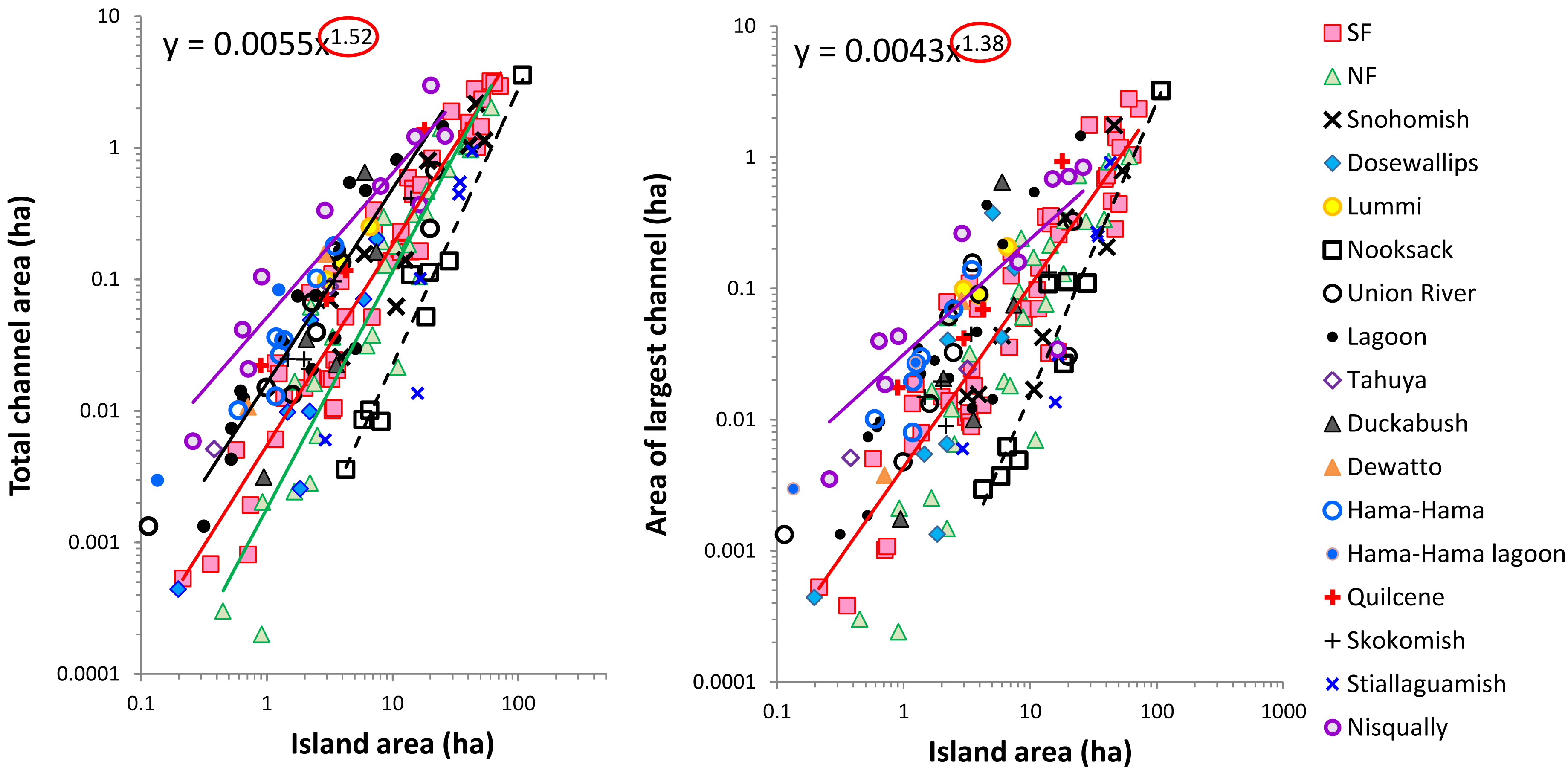
Lagoons	N
Iverson	1
North Bluff	1
Race	1
Oak Harbor	2
Seabeck	2
Thorndyke	3
Dabob	6
Point Julia	1
Hama-Hama	2

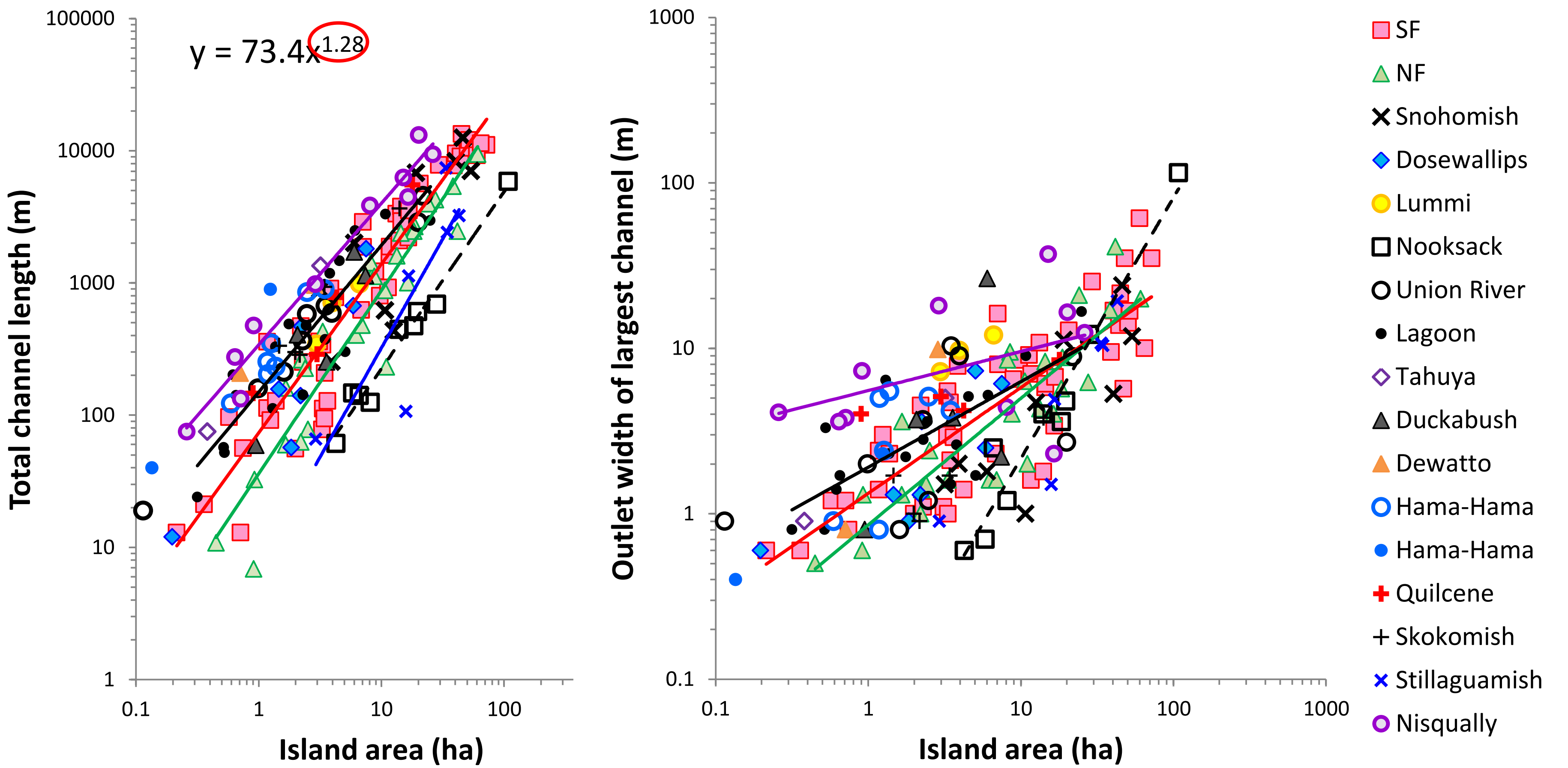
2. Puget Sound Results

- **Similar scaling functions** between marsh island area and a suite of channel planform metric for tidal marshes **throughout Puget Sound**



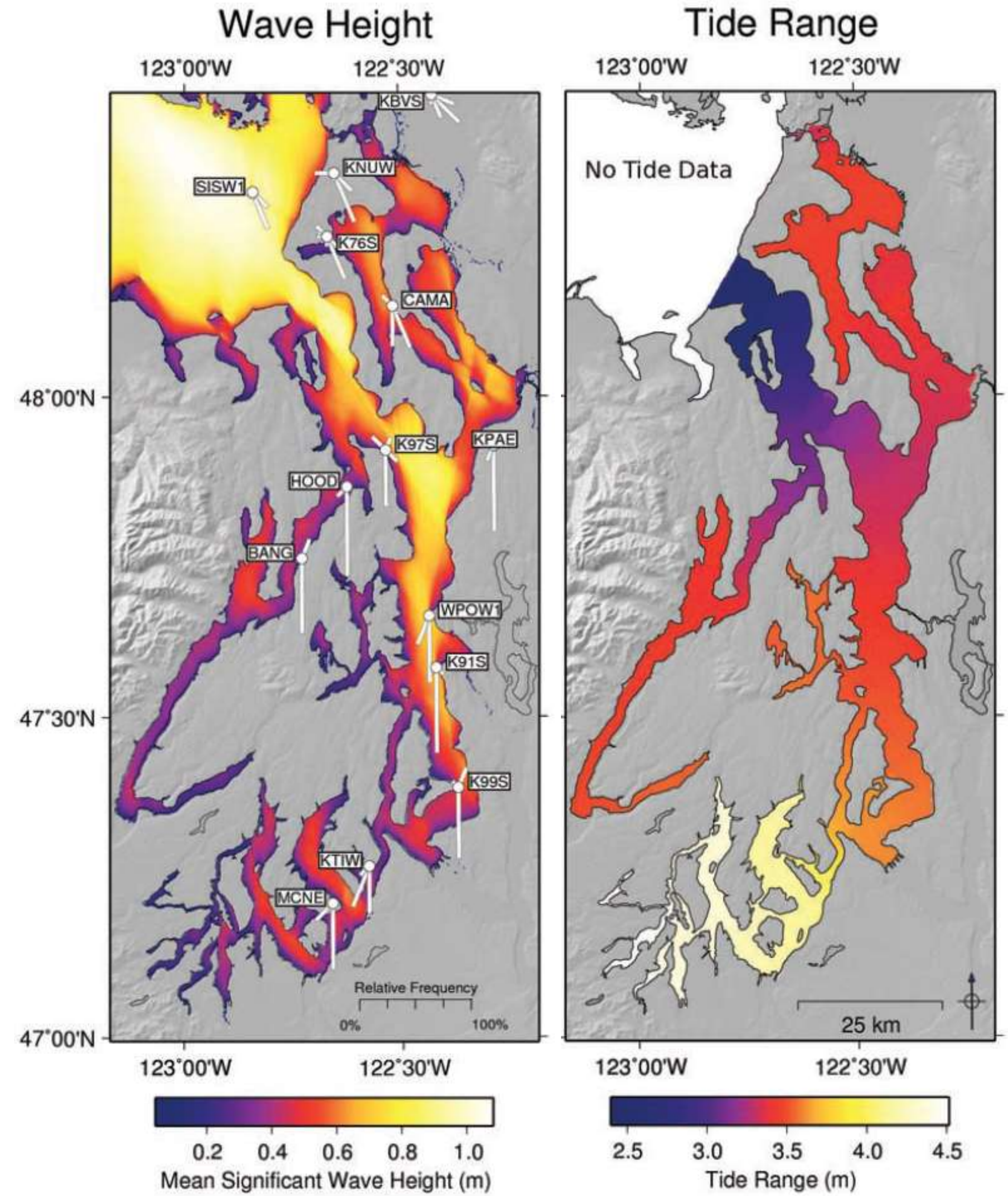
➢ **Non-linear cumulative effects** are evident for total channel length, total channel surface area, and the surface area of the largest channel draining a marsh island (i.e., **allometric exponents > 1.0**)





y = 73.4x^1.28
Total channel length (m)
Island area (ha)
100000
10000
1000
100
10
1
0.1
1
10
100
Outlet width of largest channel (m)
Island area (ha)
1000
100
10
1
0.1
0.1
1
10
100
1000
SF
NF
Snohomish
Dosewallips
Lummi
Nooksack
Union River
Lagoon
Tahuya
Duckabush
Dewatto
Hama-Hama
Hama-Hama
Quilcene
Skokomish
Stillaguamish
Nisqually

3. Examining regression intercepts



Finlayson 2006

Stepwise multiple regression of ANCOVA elevations (y-intercepts) with wave height (Finlayson 2006), drainage basin area (Czuba et al. 2011), and tide range (NOAA).

Parameter	Predictor	P-value	R^2
Channel count	Tide range, wave height	< 0.0007	0.77
Total channel area	Wave height, tide range	<0.002	0.72
Total channel length	Wave height, tide range	<0.0005	0.79
Total magnitude	Wave height, tide range	<0.002	0.84
Area of largest channel	Wave height	<0.004	0.56
Length of largest channel	Wave height, tide range	<0.002	0.72
Magnitude of largest channel	Wave height, tide range	<0.004	0.82
Tributary count of largest channel	Wave height, tide range	<0.003	0.71

TIDE +, WAVE -

4a. Application to Restoration Design and Planning

chment 8 **Conceptual Restored Wetland Types**

Smith Island Conceptual Design vs. Model Predictions

	Predicted (95%//80% CL)	Planned
Channel Count	46 (14//22)	8
Total Length	47,172 (11,095//18,566)	14,021
Largest chan. L	14,034 (3,231//5,448)	9,060
Largest chan. Tribs	41 (10//17)	23
Total Area	13.0 (56.0//33.3)	14.1
Largest chan. A	4.9 (29.1//15.5)	10.0

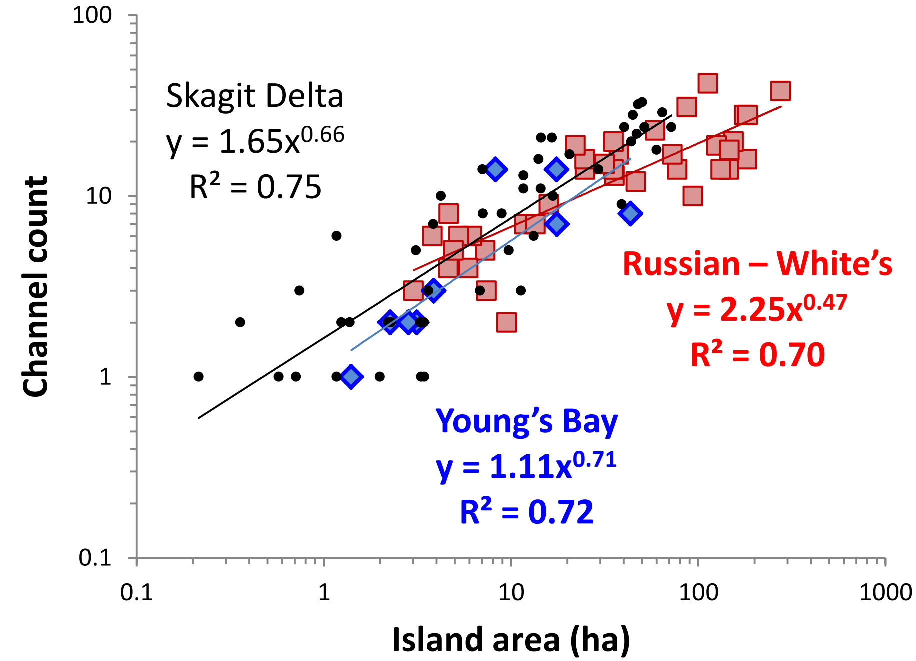
Thanks to Bob Aldrich
Snohomish Co. Public Works Dept.

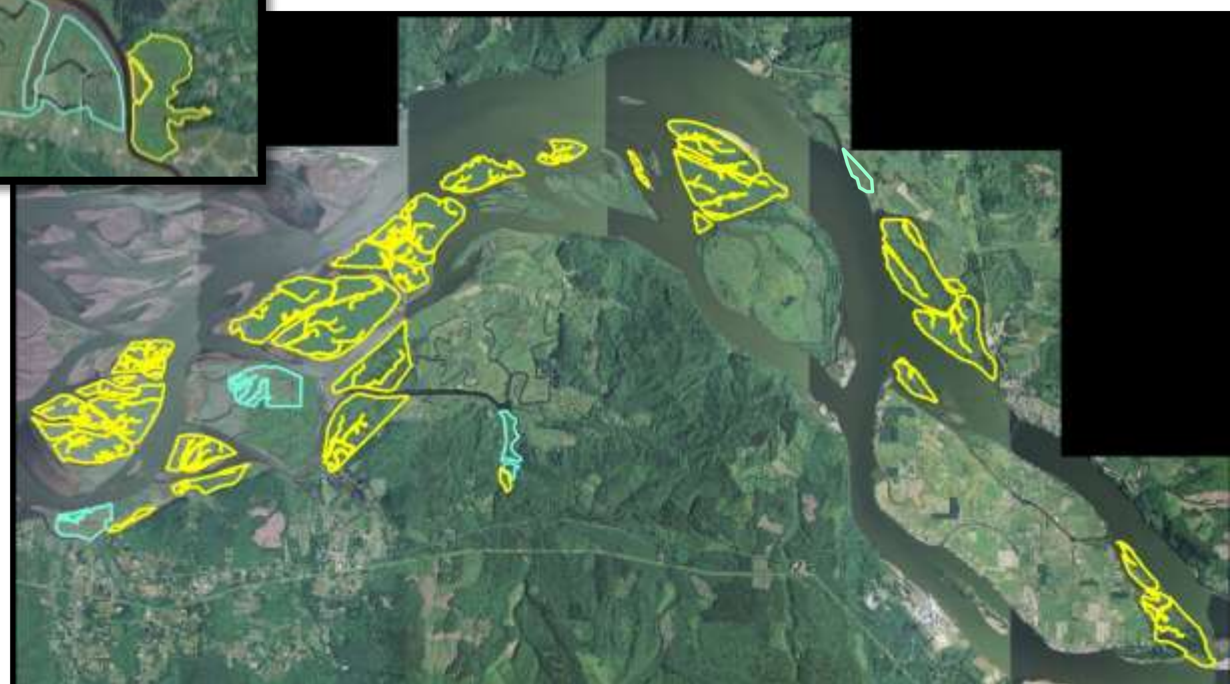
N**on-linear cumulative effects** have significant implications for restoration planning, e.g., **"splitting the baby" negotiations, SLOSS decisions, mitigation for loss.**

E.g.,

Site size	Total Channel Area	Total Channel Length
100 ha	**5.81 ha**	**24,173 m**
50 ha	2.03 ha	10,093 m
65 ha		*14,080 m*
75 ha	*3.78 ha*	

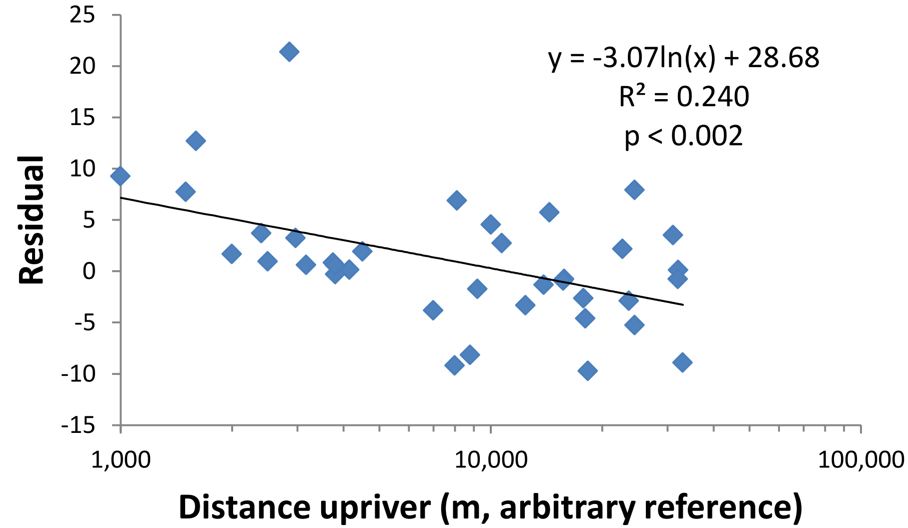
4b. Application to Restoration in the Columbia River Estuary!



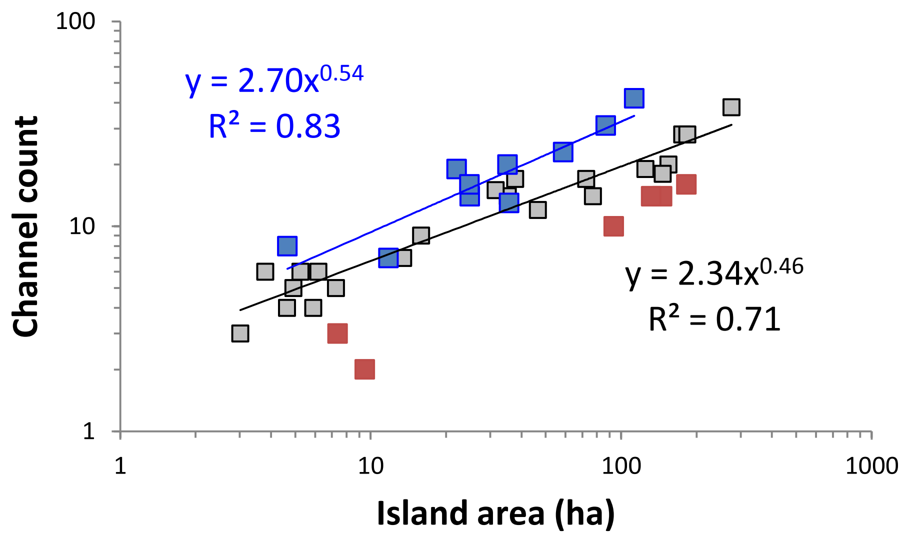


ANCOVA

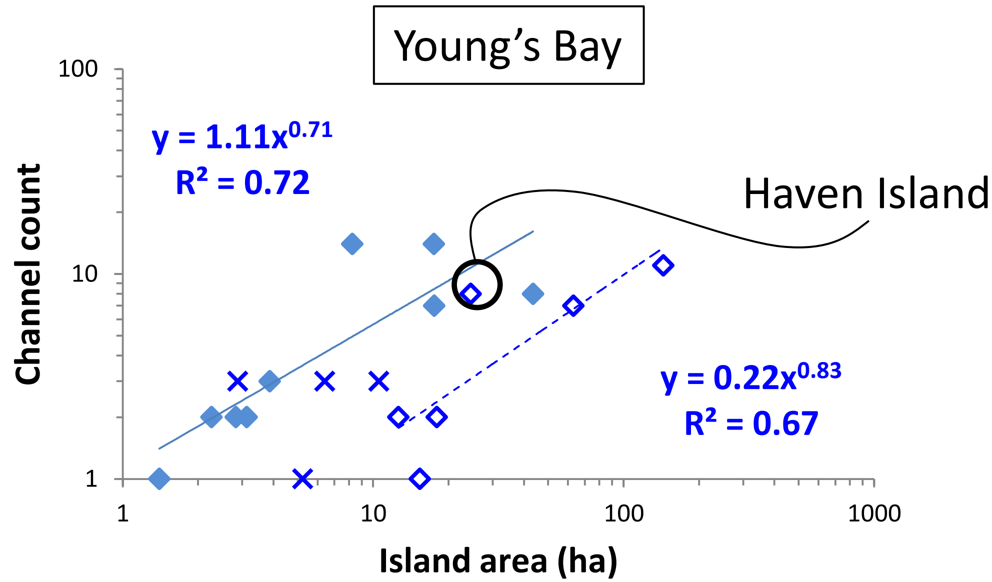
$F_{2,89}$ (slopes) = 3.17: $p < 0.05^{?}$



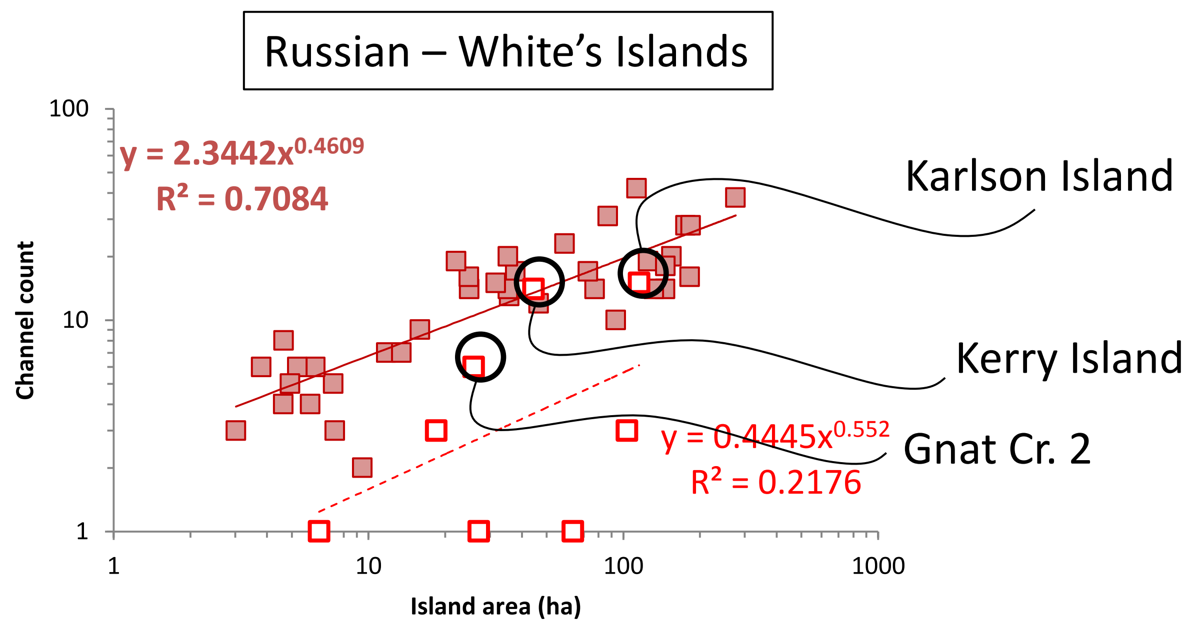
Emergent vegetation, mostly Russian Island complex



Dense forest/shrub, mostly upriver



Young's Bay
100
10
1
y = 1.11x0.71
R² = 0.72
Haven Island
y = 0.22x0.83
R² = 0.67
Channel count
1
10
100
1000
Island area (ha)



Russian – White's Islands
100
10
1
y = 2.3442x0.4609
R² = 0.7084
Karlson Island
Kerry Island
y = 0.4445x0.552
R² = 0.2176
Gnat Cr. 2
Channel count
1
10
100
1000
Island area (ha)

Summary

1. Landform allometry is useful tool for restoration planning, design, and monitoring – many reference sites possible.

2. Tidal channel geometry is affected by marsh area, tide range, and wave energy.

3. Allometry of channel count for Columbia River marshes is affected by distance upriver (≈ tide range) and forest/shrub cover.

4. Non-linear cumulative effects exist: bigger marsh area is better.

5. Restoration practitioners tend to underestimate the number of tidal channels a site should have, which may affect site accessibility.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