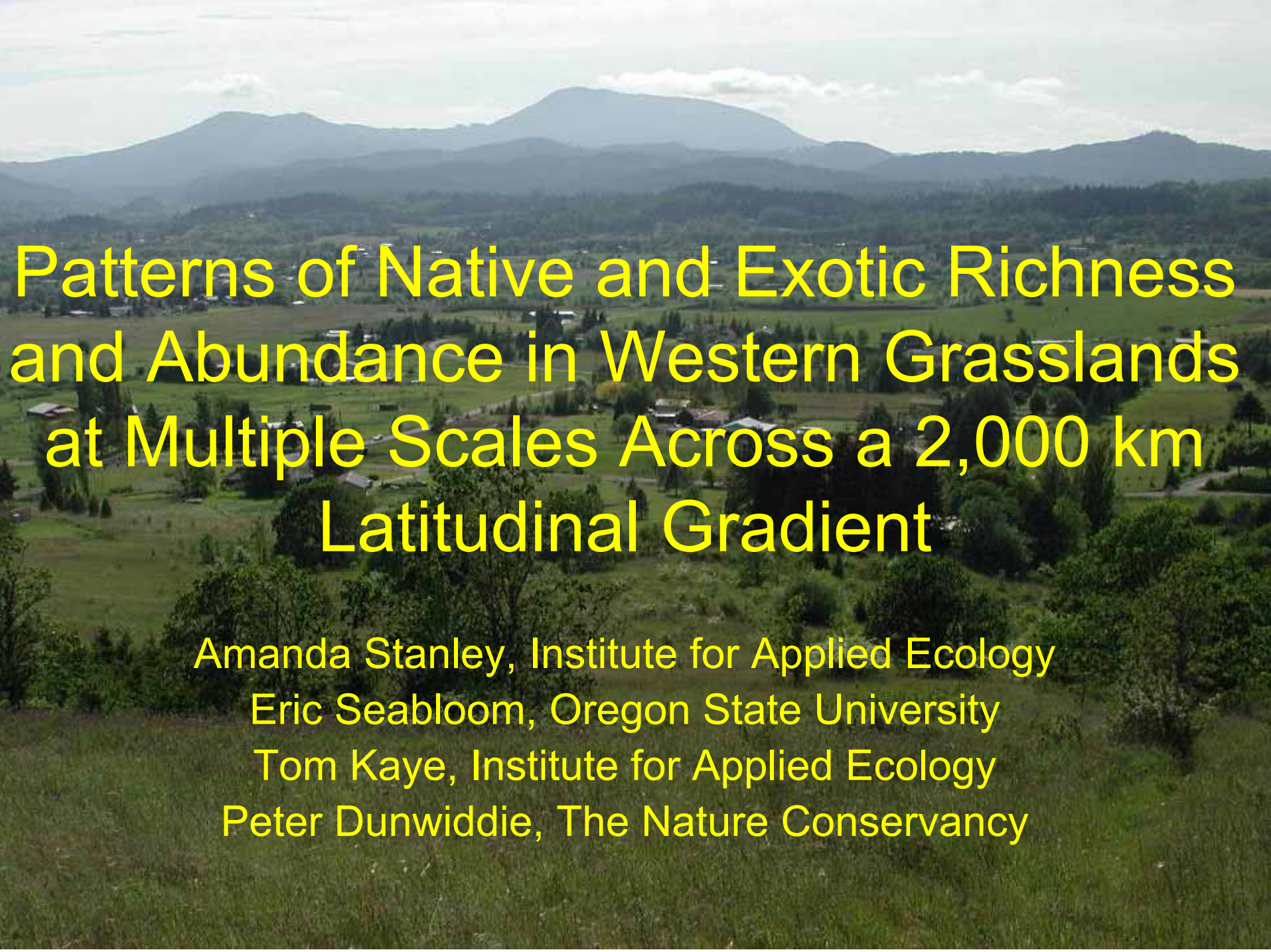
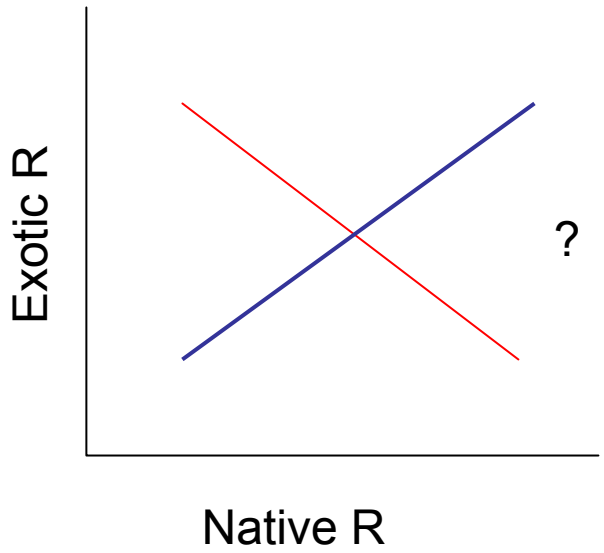


Patterns of Native and Exotic Richness and Abundance in Western Grasslands at Multiple Scales Across a 2,000 km Latitudinal Gradient

Amanda Stanley, Institute for Applied Ecology
Eric Seabloom, Oregon State University
Tom Kaye, Institute for Applied Ecology
Peter Dunwiddie, The Nature Conservancy

Native-exotic richness relationships

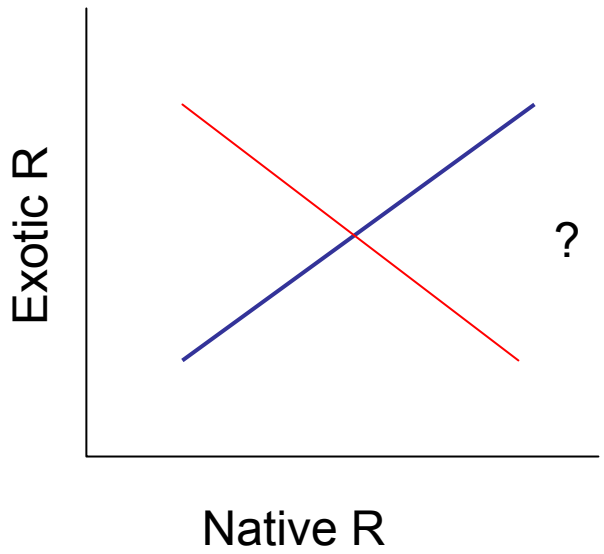


Biotic resistance: Fewer exotic species can establish in highly diverse native communities

Abiotic control: Hotspots of native diversity are hotspots of exotic diversity

i.e., native and exotic plant communities have a similar response to the environment

Linking ecological theory and land management



- Are areas with the highest native diversity ‘protected’ from invasion, or the most vulnerable?
- How relevant is this theoretical debate to on-the-ground conservation? Does the number of exotic species really matter?

Questions about invasion ecology

- Establishment
  - Is there a positive or negative relationship between native and exotic richness?
- Spread
  - Does this relationship change with scale?
  - Does the same exotic community occur everywhere?
- Impact
  - Does the number of exotic species provide a good index for the impact of exotic species?

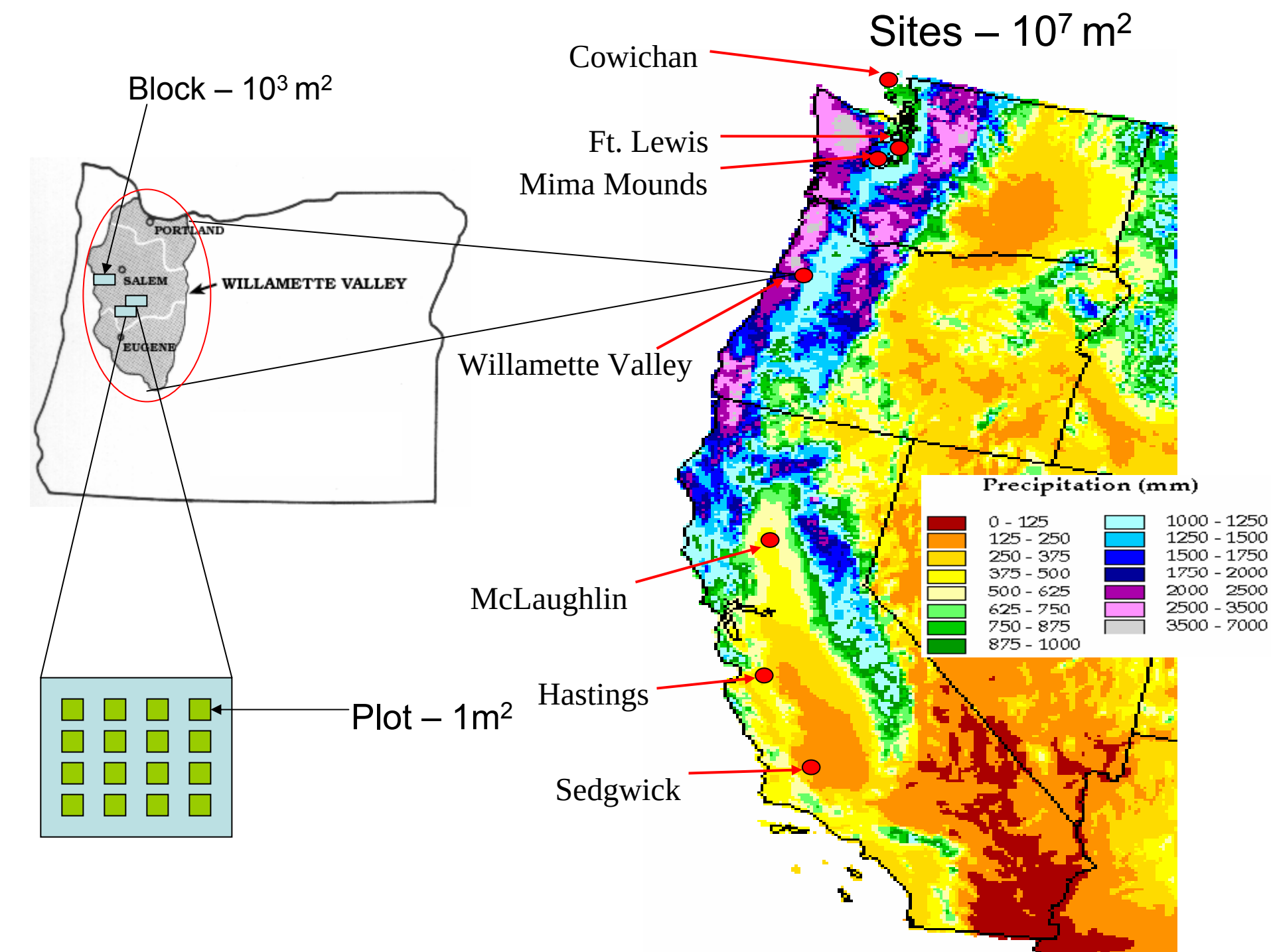
- Plant community data from western grasslands from southern CA to BC
- vascular plant species and percent cover
- Soil NO_3, pH, organic matter; latitude, rainfall

Multiple spatial scales:

Plot – 1 m^2

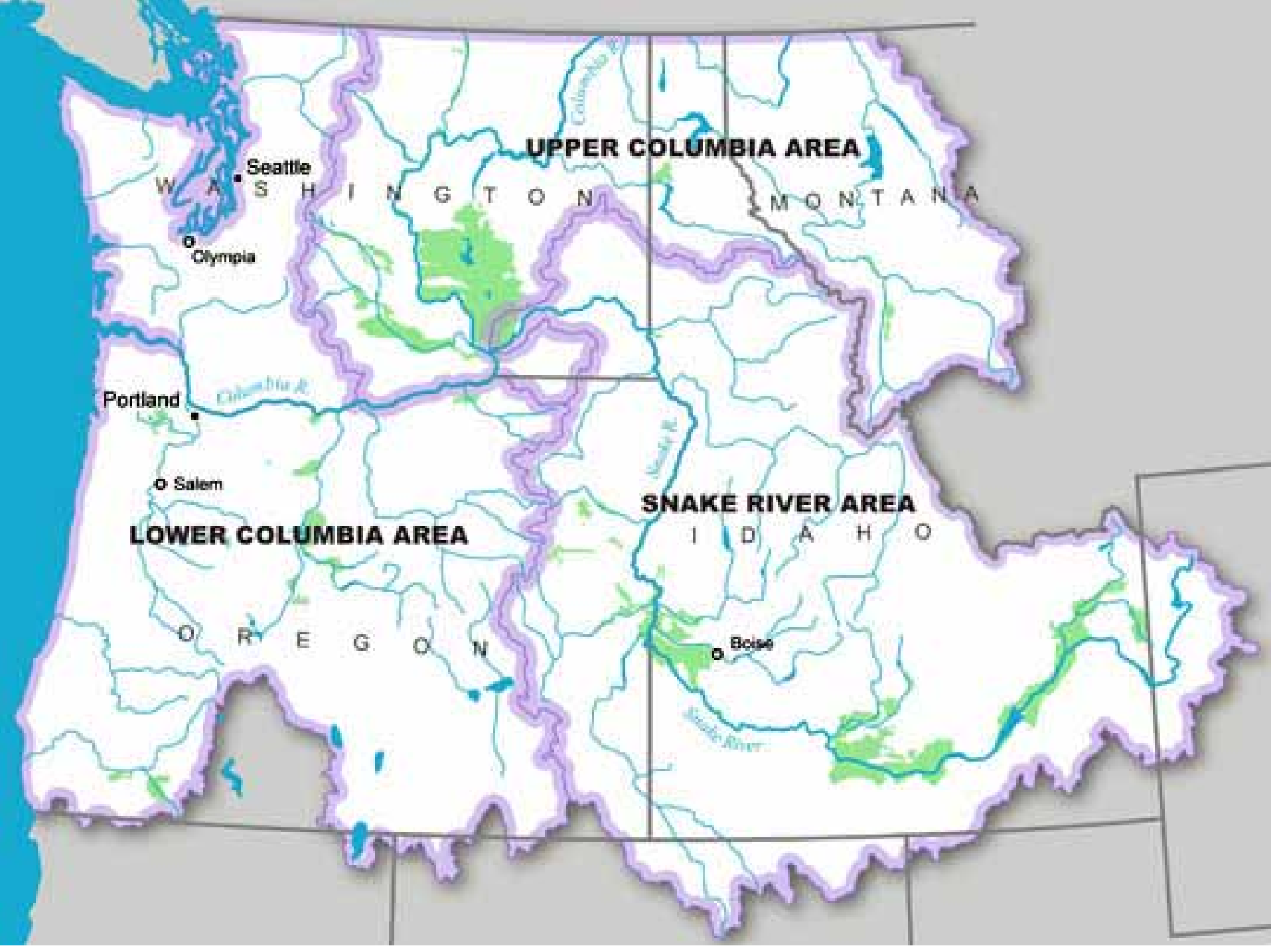
Block – 10^3 m^2

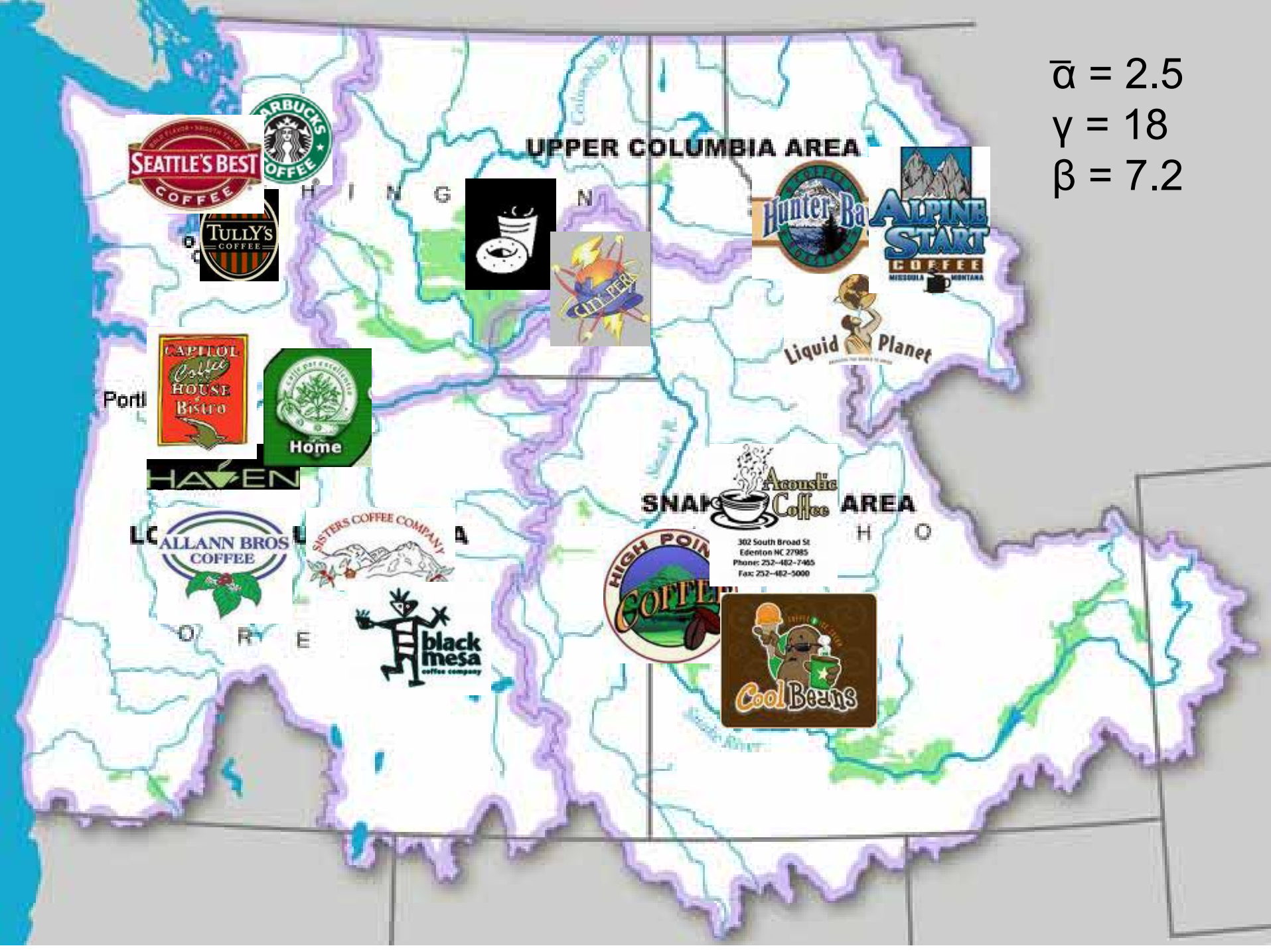
Site – 10^7 m^2

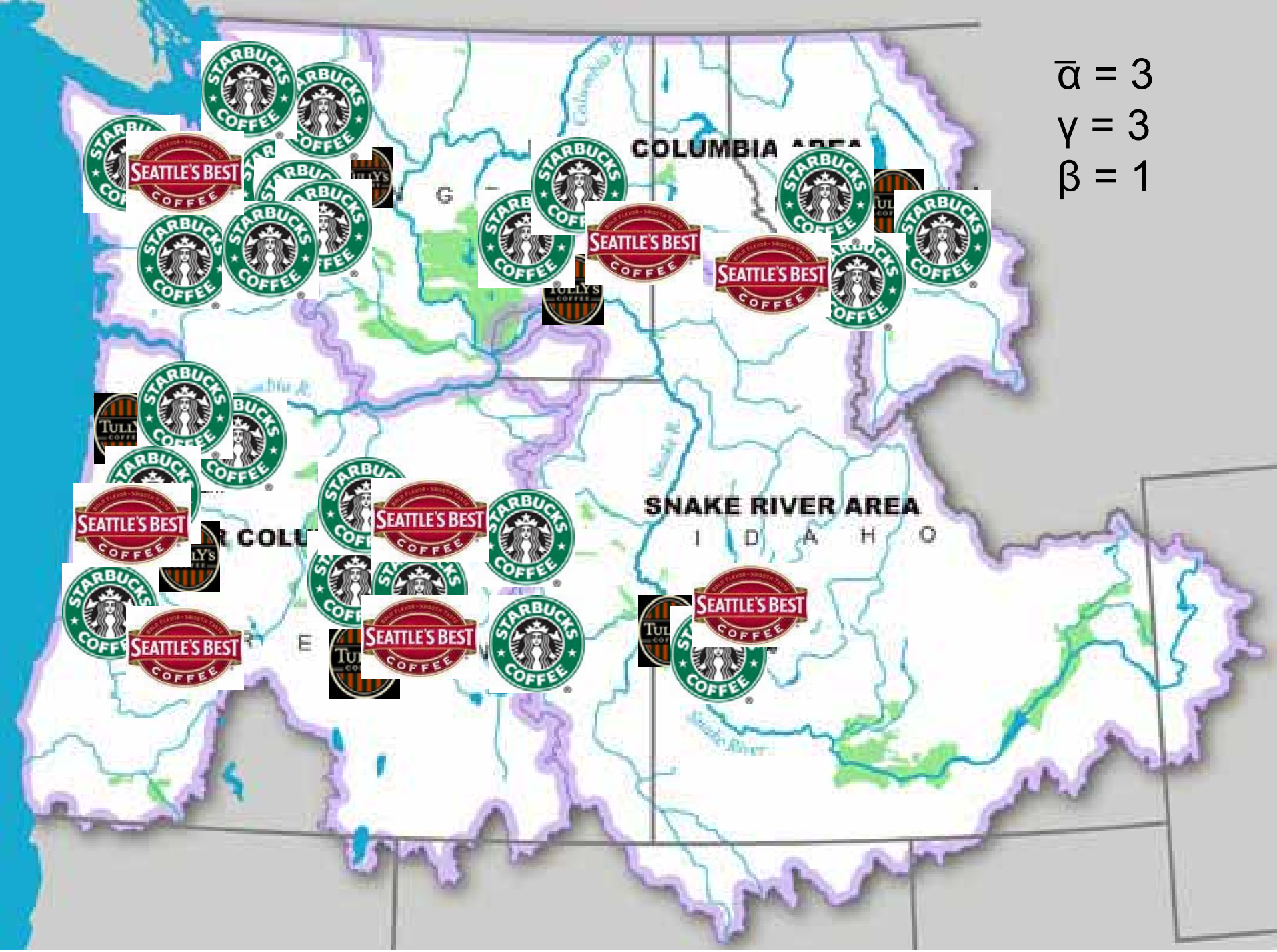

Sites – 10⁷ m²
Block – 10³ m²
Cowichan
Ft. Lewis
Mima Mounds
Willamette Valley
McLaughlin
Hastings
Sedgwick
Plot – 1m²
PORTLAND
SALEM
EUGENE
WILLAMETTE VALLEY
Precipitation (mm)
0 - 125
125 - 250
250 - 375
375 - 500
500 - 625
625 - 750
750 - 875
875 - 1000
1000 - 1250
1250 - 1500
1500 - 1750
1750 - 2000
2000 2500
2500 - 3500
3500 - 7000

Diversity metrics

- α – local richness (R)
- γ – regional species pool (cumulative R)
- β – variation in species composition between localized sites $\beta = \gamma / \bar{\alpha}$


UPPER COLUMBIA AREA
Seattle
W A S H I N G T O N
M O N T A N A
Olympia
Columbia R.
Portland
Columbia R.
Salem
LOWER COLUMBIA AREA
SNAKE RIVER AREA
I D A H O
O R E G O N
Boise
Snake River

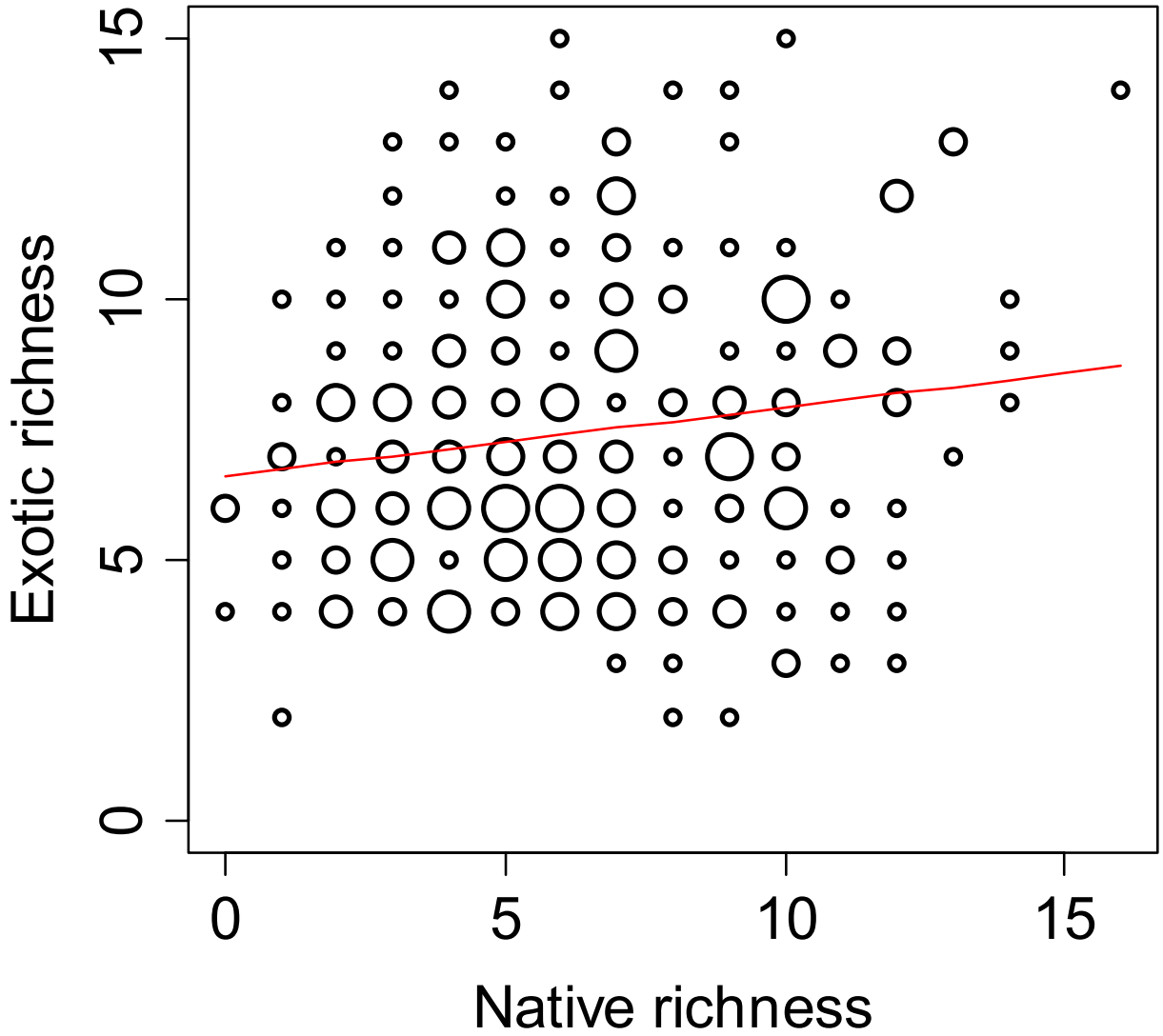

UPPER COLUMBIA AREA
SEATTLE'S BEST COFFEE
TULLY'S COFFEE
Hunter Ba
ALPINE START COFFEE
Liquid Planet
CAPITOL Coffee HOUSE Bistro
Home
Acoustic Coffee
302 South Broad St
Edenton NC 27985
Phone: 252-482-7465
Fax: 252-482-5000
ALLANN BROS COFFEE
SISTERS COFFEE COMPANY
black mesa coffee company
Cool Beans
$\bar{\alpha} = 2.5$
$\gamma = 18$
$\beta = 7.2$


$\bar{\alpha} = 3$
$\gamma = 3$
$\beta = 1$
COLUMBIA
SNAKE RIVER AREA
I D A H O

Establishment

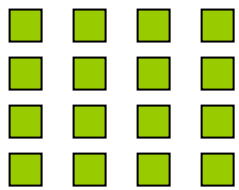
- Is there a positive or negative relationship between native and exotic diversity?

Plot scale

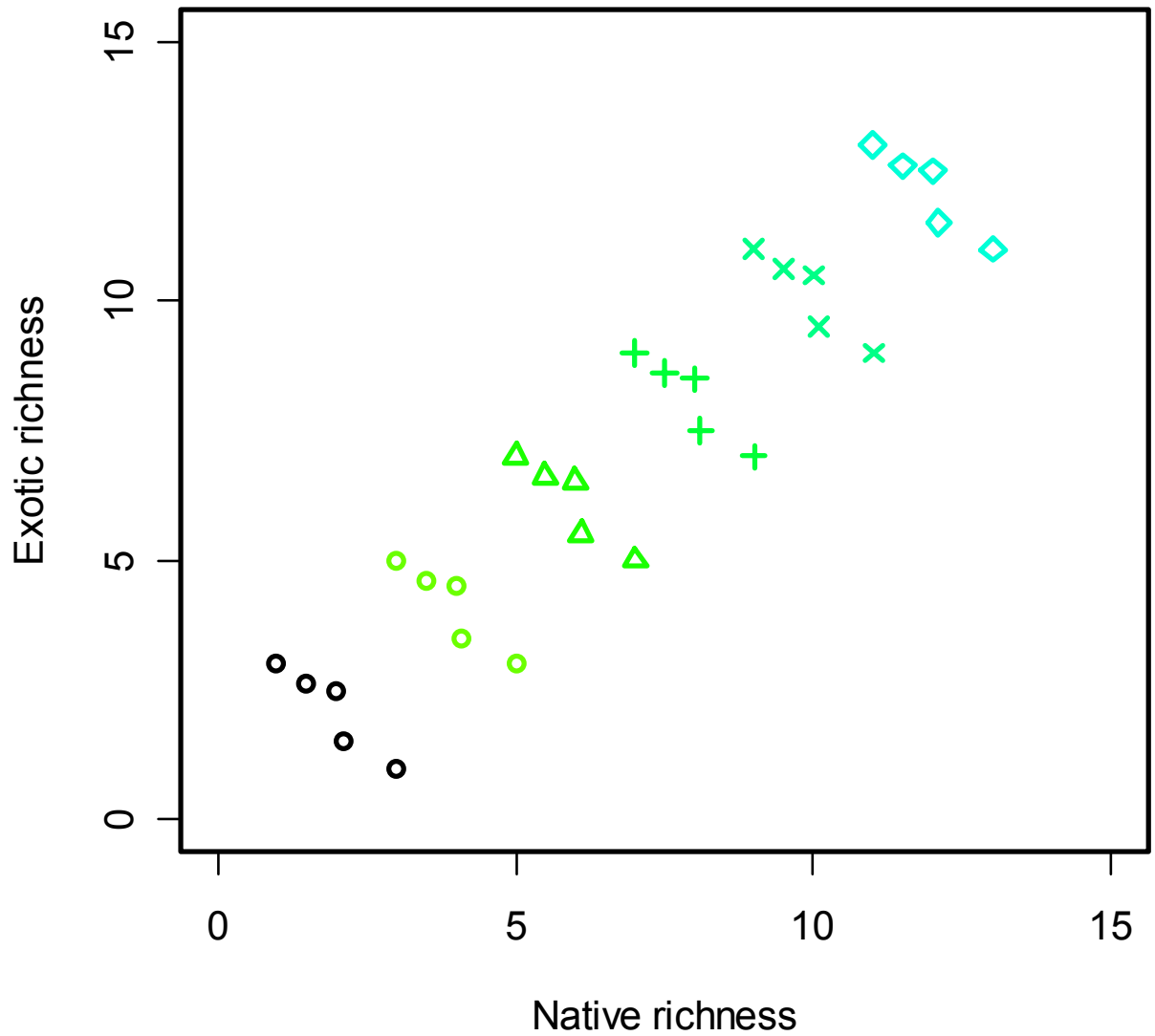


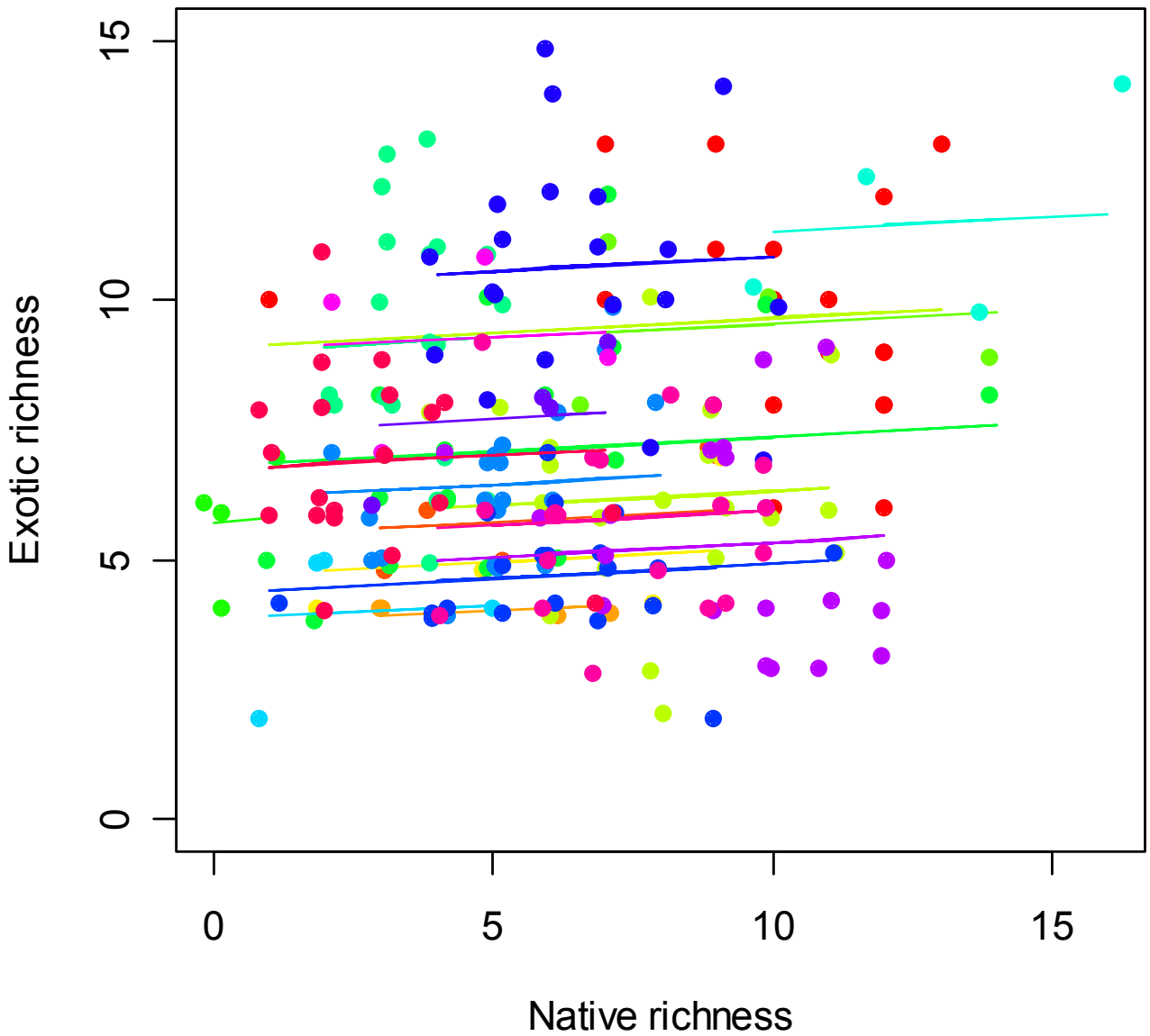
Pearson correlation: 0.17

Plot – 1 m^2



Shea and Chesson (2002): conceptual model to explain the paradox

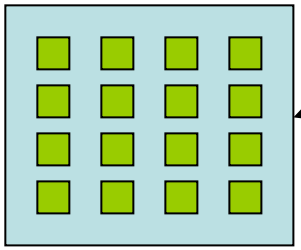



Exotic richness
0
5
10
15
0
5
10
15
Native richness

Spread

- Does native-exotic richness relationship change with scale?

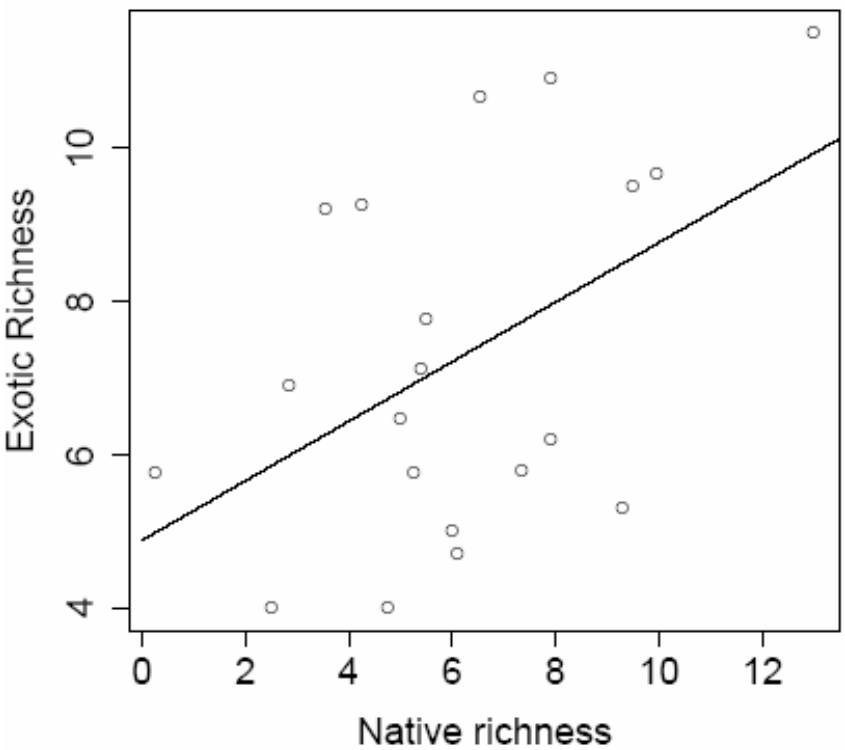
Block scale



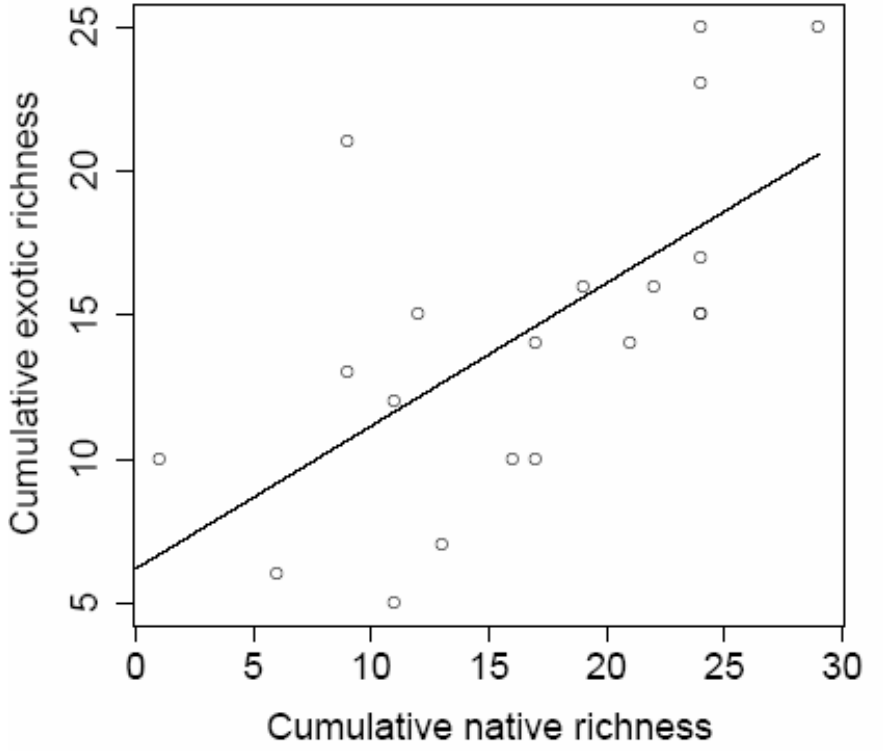
Block -10^3 m^2

α richness: average plot richness within a block

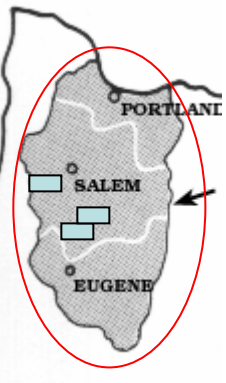
γ richness: total richness within a block



Pearson correlation: 0.48



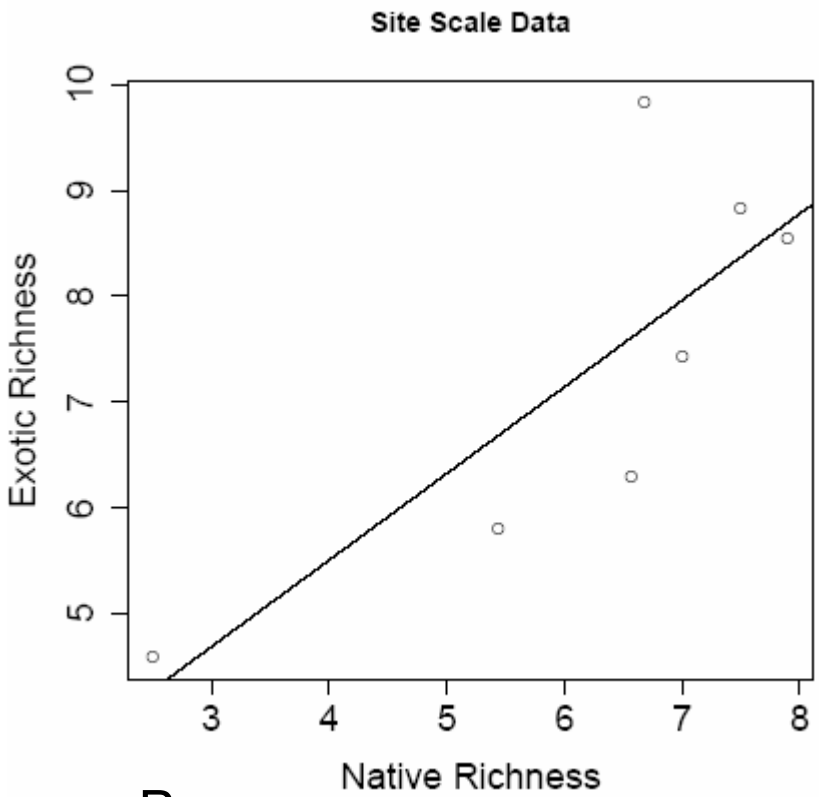
Pearson correlation: 0.64



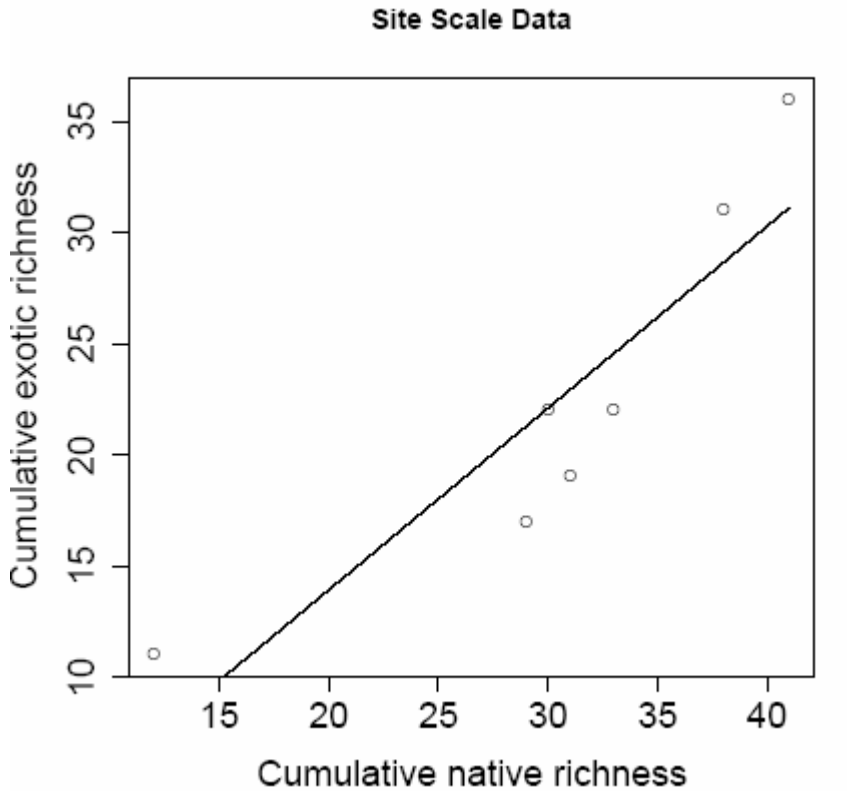
Site scale

α richness: average plot richness within a site

γ richness: total richness within a site

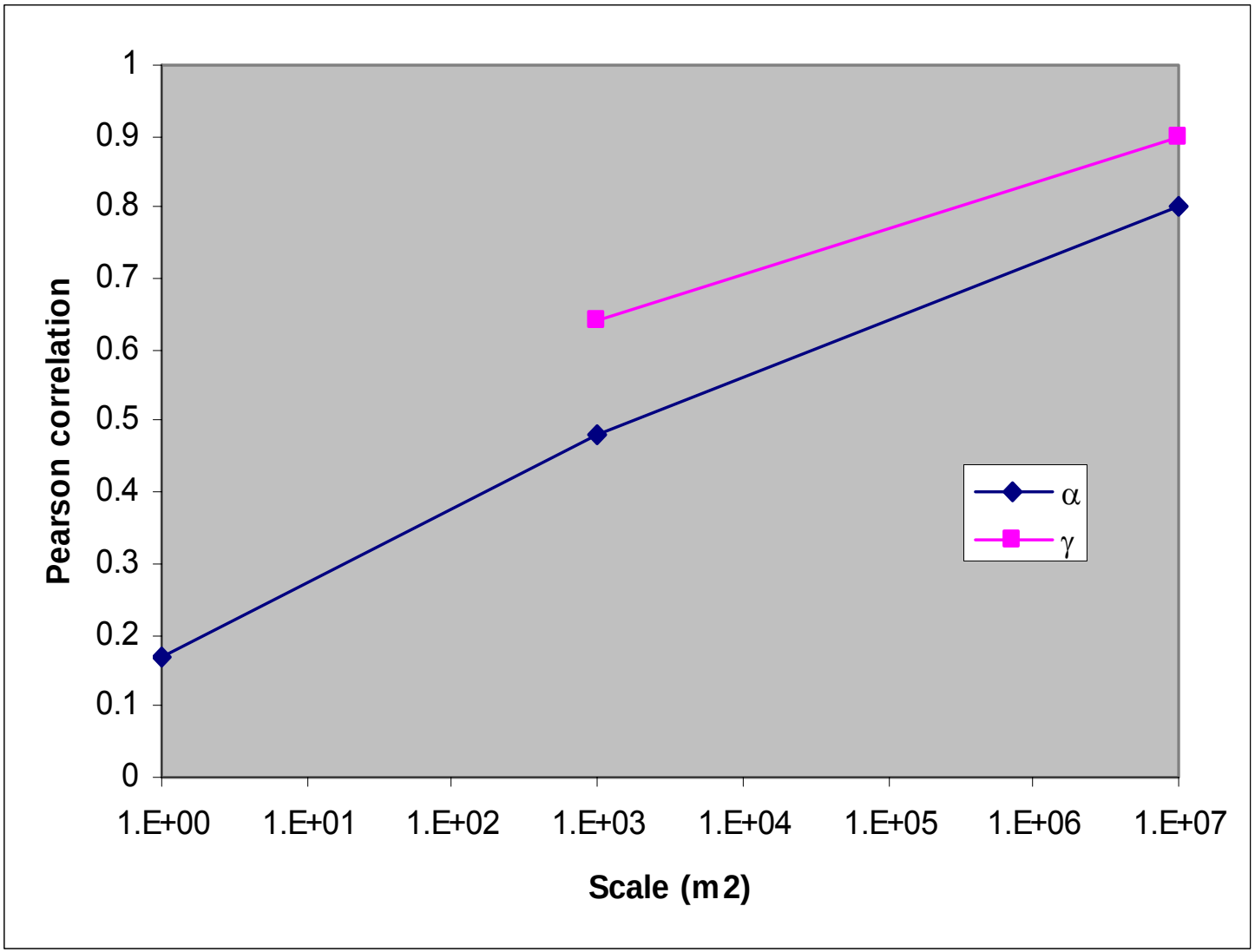


Pearson correlation: 0.8



Pearson correlation: 0.9

Native-exotic richness correlations increase with scale

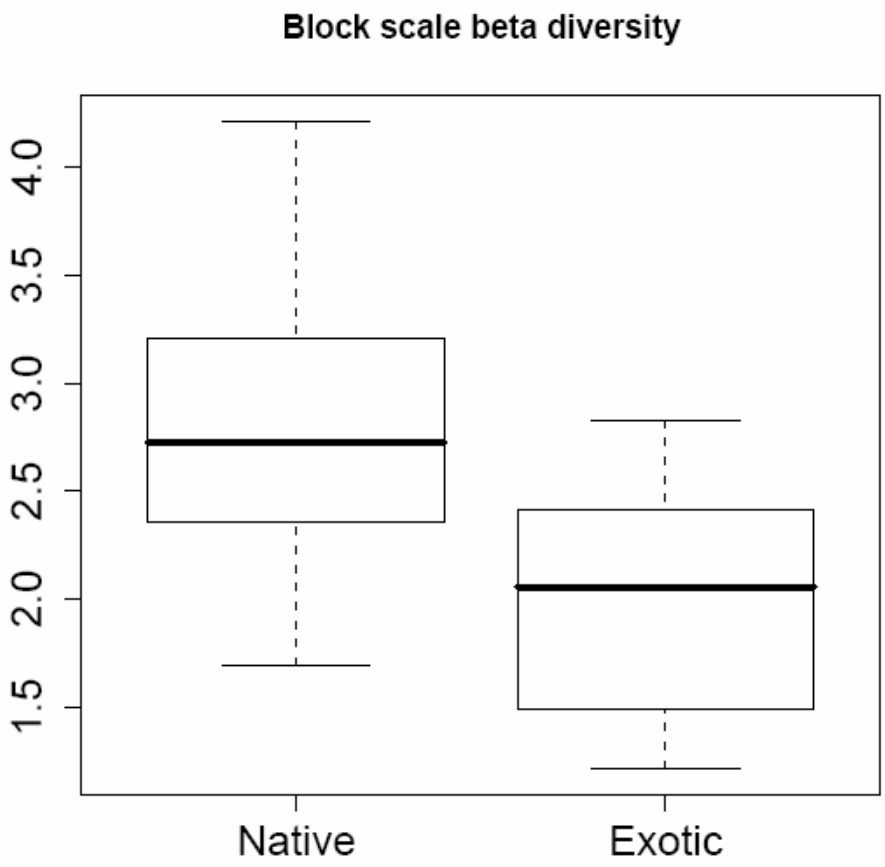


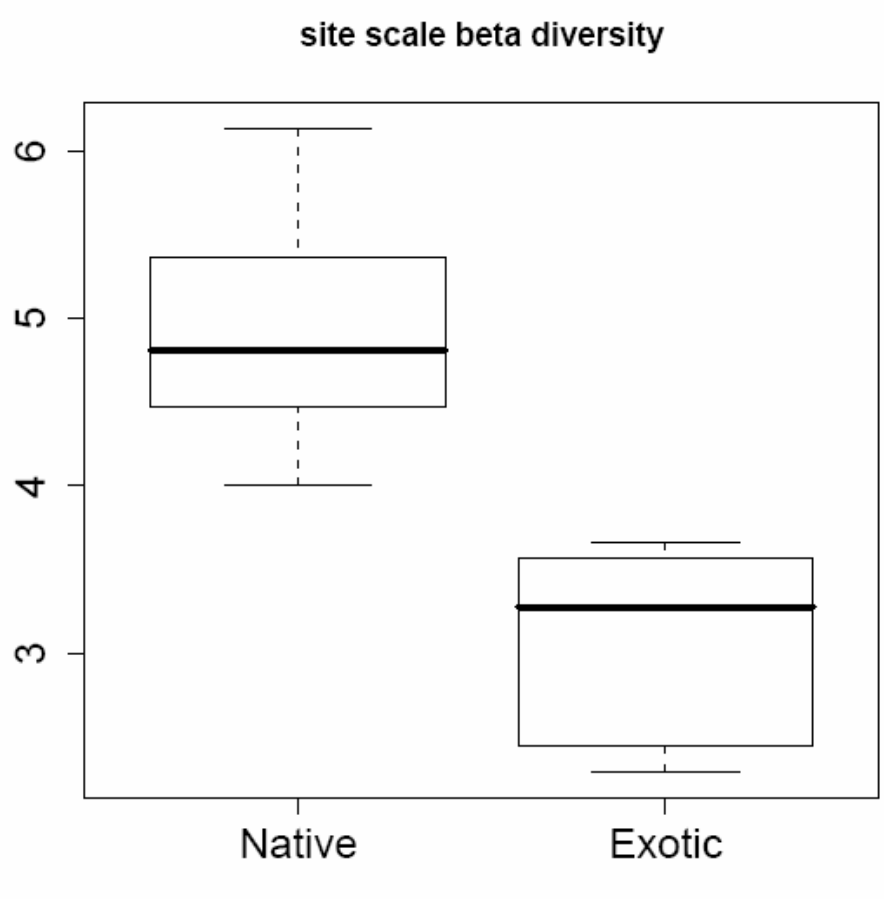
Spread

Does the same exotic community occur everywhere?

- Do native and exotic plant communities differ in beta diversity?

Native & exotic beta diversity



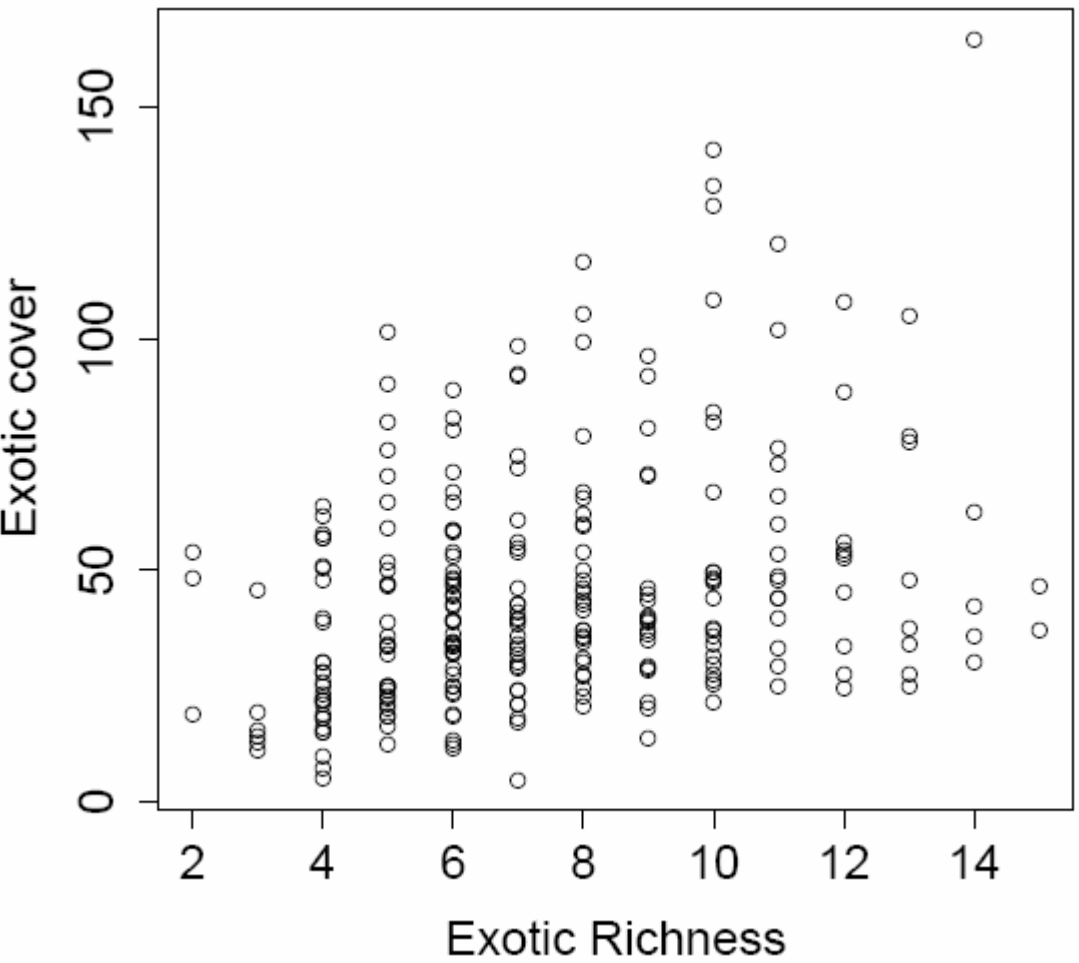


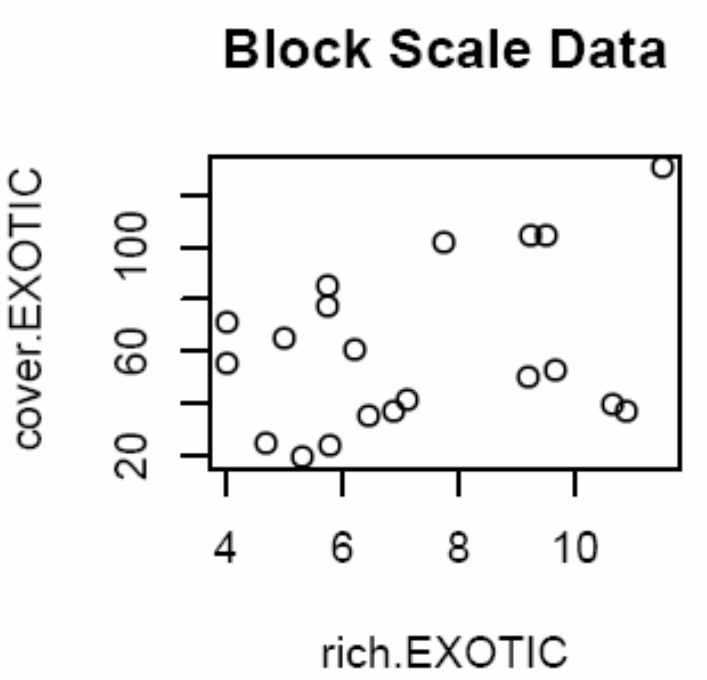
Spread

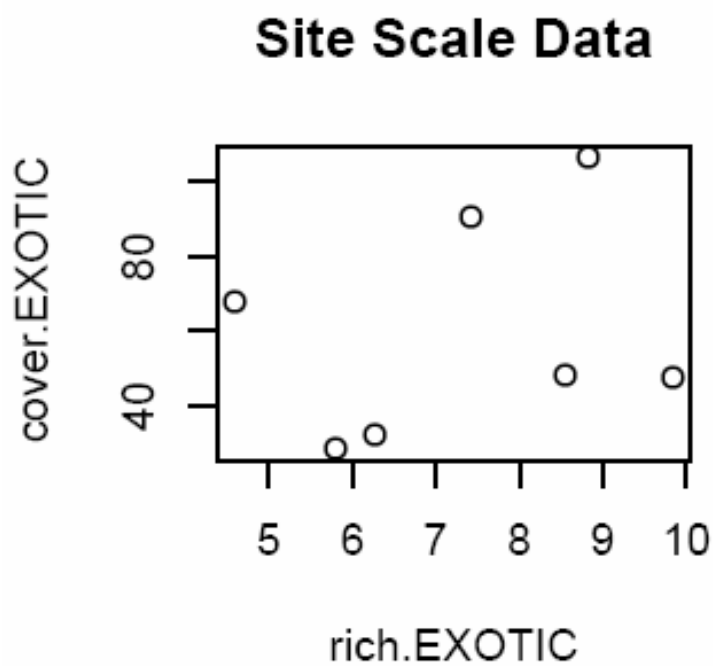
- Native & exotic richness positively correlated
  - Strength of correlation increases at larger spatial scales
  - Pattern holds true for both alpha and gamma diversity
- Distinct local native floras vs homogonized exotic community
  - Exotic species more “trampy” than natives

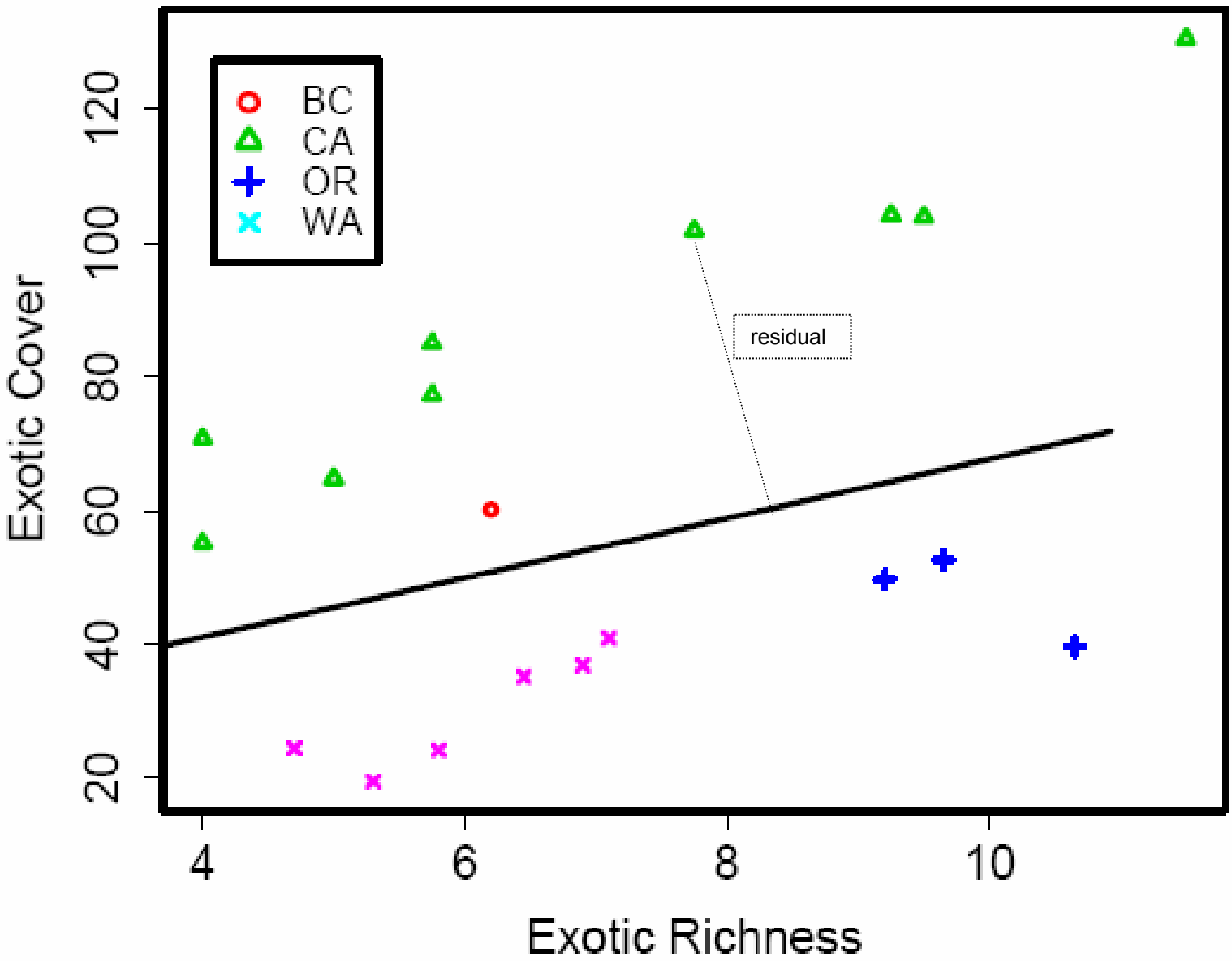
Impact

- Is exotic richness a good indicator of exotic impact?
  - How well does richness correlate with a measure of abundance?

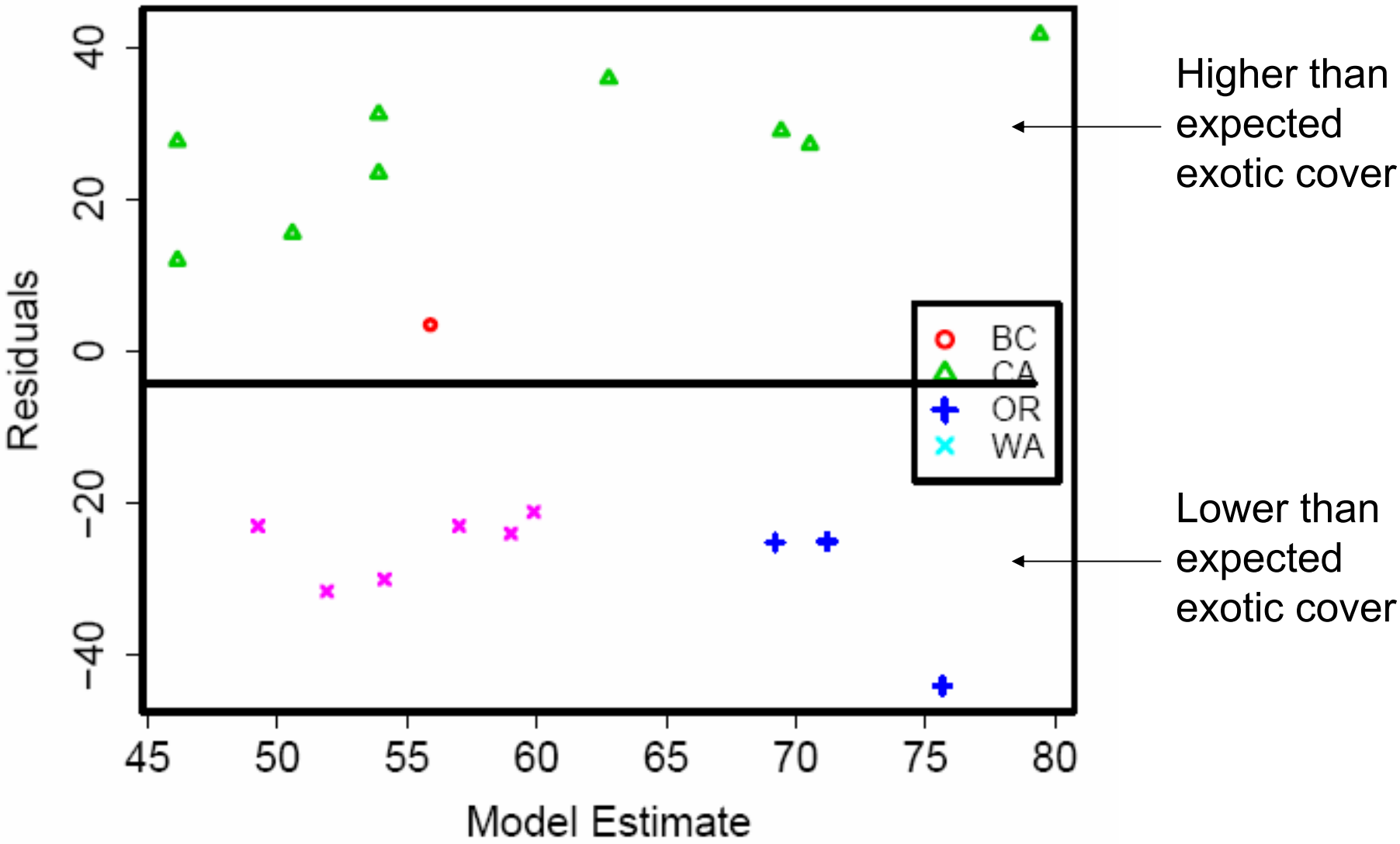

Exotic cover
0
50
100
150
2
4
6
8
10
12
14
Exotic Richness

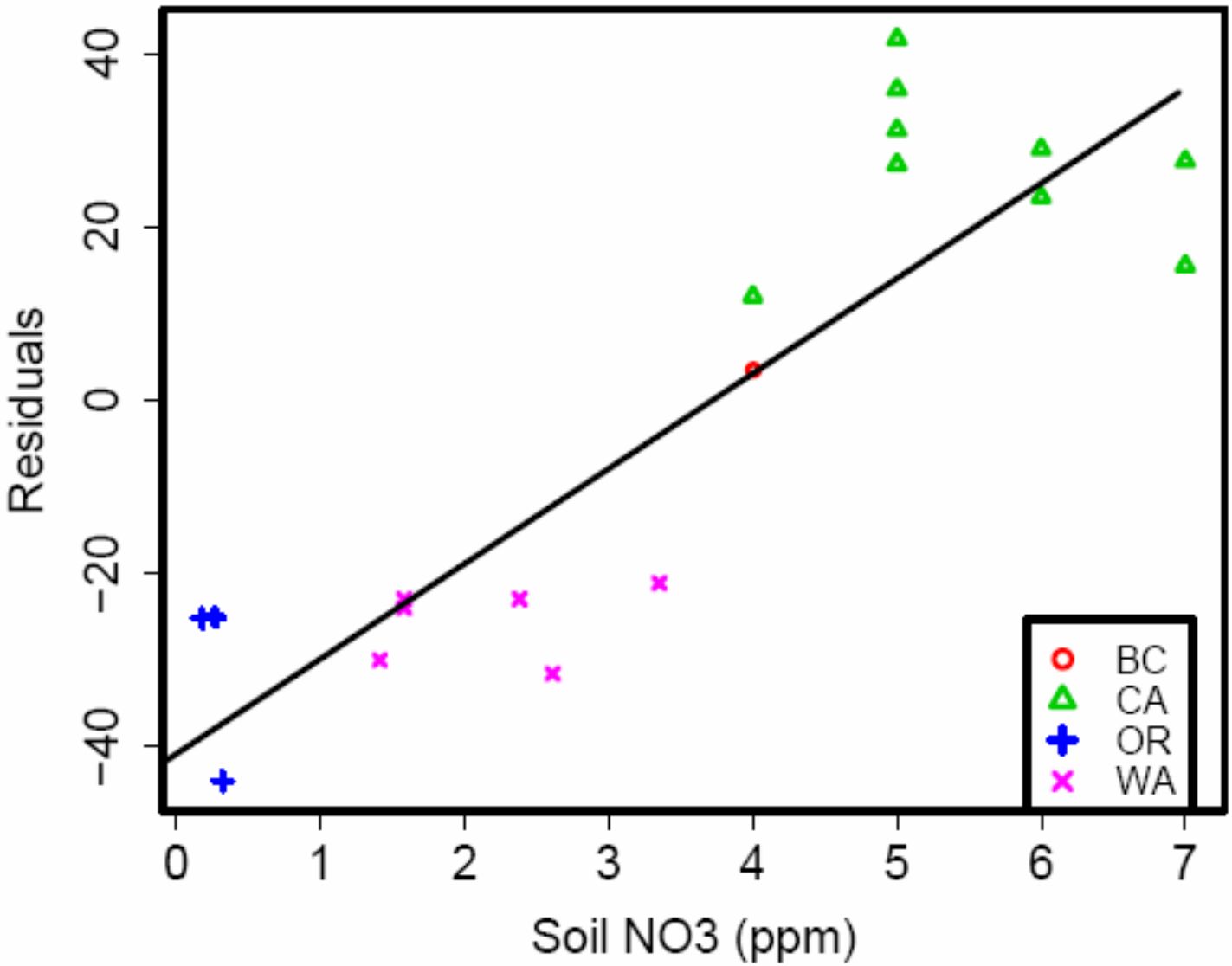

Block Scale Data
cover.EXOTIC
20
60
100
4
6
8
10
rich.EXOTIC


Site Scale Data
cover.EXOTIC
40
80
5
6
7
8
9
10
rich.EXOTIC


BC
CA
OR
WA
residual
Exotic Cover
20
40
60
80
100
120
4
6
8
10
Exotic Richness

R^2 : 0.19
p = 0.059


Residuals
40
20
0
−20
−40
45
50
55
60
65
70
75
80
Model Estimate
BC
CA
OR
WA
Higher than expected exotic cover
Lower than expected exotic cover



R^2 : 0.75

P <.0001

Exotic cover explained by exotic richness and soil nitrate

Combined model (no3 + exotic richness)

R2 : 0.94

P <.0001

Is exotic richness a good indicator of exotic impact?

Maybe not…

Cover and richness respond oppositely to soil fertility

Richness is not a good surrogate for impact at very high or very low levels of NO_3

Conclusions

- Hotspots of native diversity are hotspots of exotic diversity
- However, native and exotic species respond differently to spatial heterogeneity
- Exotic richness may not be a good indicator of exotic impact

Implications for management

The bad news: The sites with the highest native diversity may be the most vulnerable to invasion by many exotic species

The good news: However, those sites with the highest *number* of exotic species may not be the sites with the highest *impact* from exotic species

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Collaborators & field crew