Why empirical tests of theory mandate more attention to ecological context.

Roly Russell, Spencer Wood, Sam Fuhlendorf, Esteban Muldhavin, & Ian Woiwod.

immediate conclusions

Actual scales of ecological species interactions are very small.

At appropriately small scales, local richness is not governed by regional species pools.

To assess local patterns, we need local data.

what determines local *community* richness?

- Local factors
  - Biotic interactions
  - Abiotic factors
- Regional factors
  - Evolution & Biogeography
  - Abiotic factors
  - History

"The number of species are similar in similar habitats around the world."

MacArthur (1972)

TODAY'S CASE STUDY:

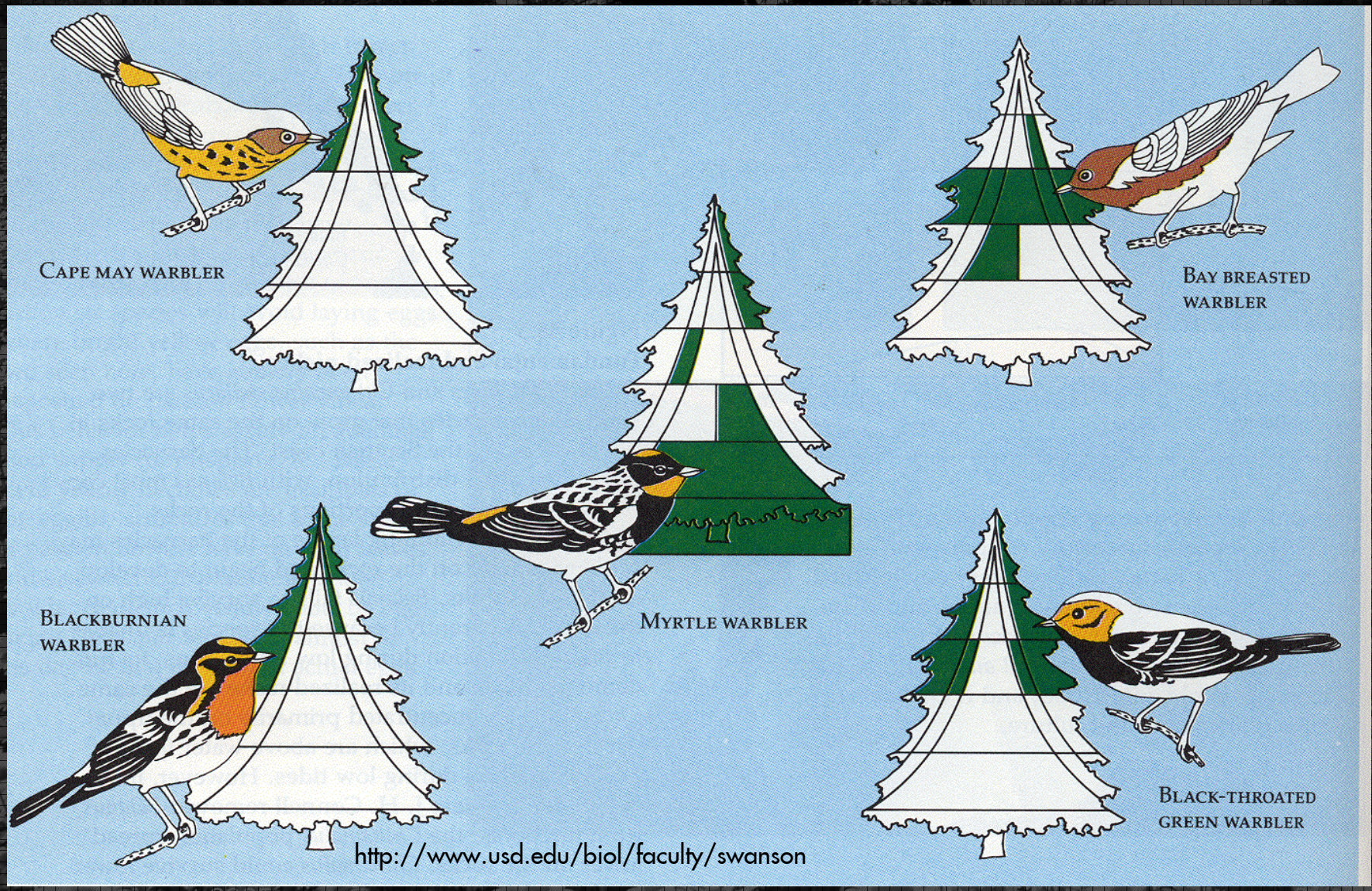
Do local interactions impose a ceiling on local species richness, or do regional species pools determine local richness?

local limits of local richness

local interactions matter

e.g. herbivory, predation, & competition

local limits of local richness



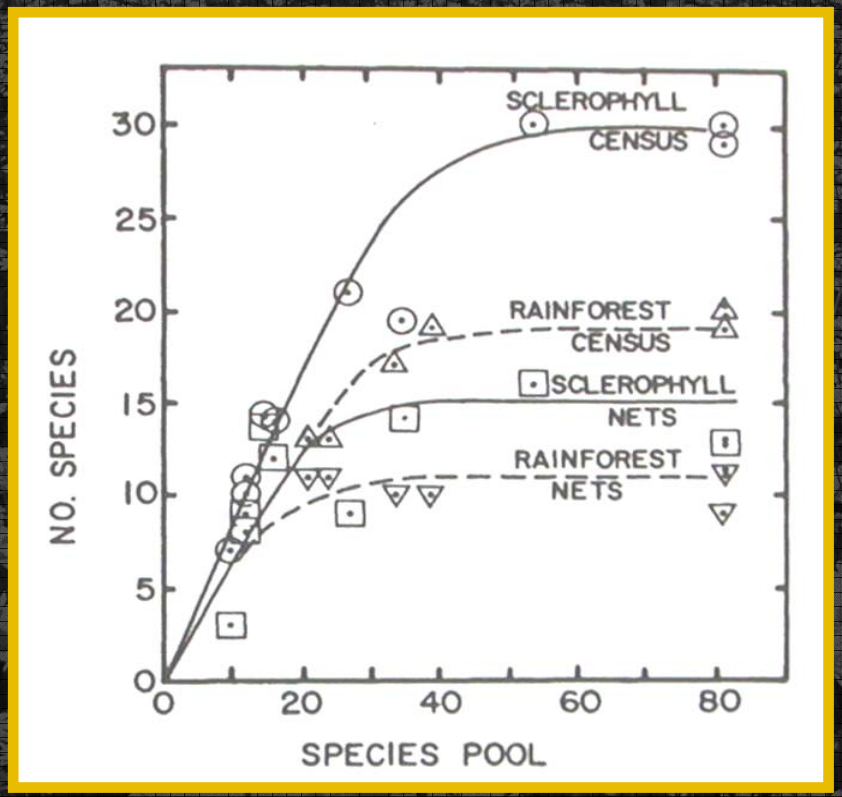
birth of the tool

REVISED QUESTION: how do local & regional influences interact?

one approach:

(mechanism = local ecological interactions)

Terborgh & Faaborg (1980)



outline

[Review]

- Convince you that context is not properly appreciated in many studies.

[Analysis]

- Convince you that this matters greatly for conclusions reached.

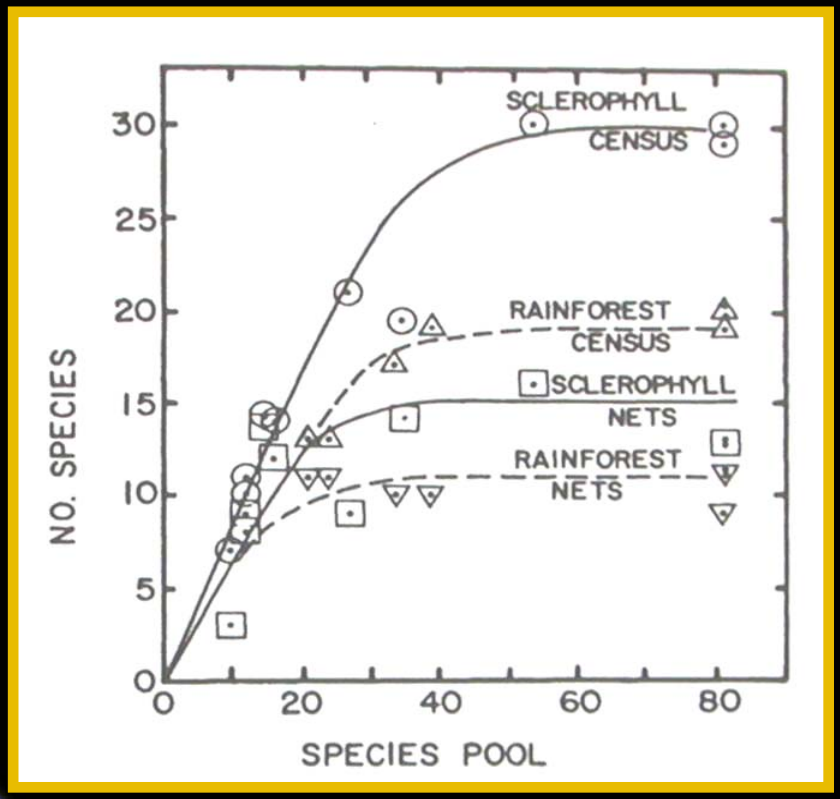
[Forecast]

- Where to next?

REVIEW

the last ¼ century has brought ...

Many studies looking at this pattern, from where Terborg & Faaborg left off.



conclusions are varied.

Saturation does occur:

crustaceans (Abele ’84) fish (Westoby ’85) birds (Terborgh & Faaborg ’80) helminths (Kennedy & Grop ‘94) leaf miners (Opler ’74) birds (Lawes, Eeley & Piper ’00)

Saturation does *not* occur:

fig wasp parasitoids (Hawkins & Compton ’92) birds (Ricklefs ’87; Weins ’89) oak gall wasps (Cornell) corals (Cornell & Karlson ’96) bracken herbivores (Lawton et al. ’93) fish (Hugeny & Paugy ’95; Oberdorff et al. ’98)

why no general conclusion?

Potentially incongruous

- habitat, (o.k.)
- taxa, or (o.k.)
- scale. (not so o.k.)

what kinds of contexts are studied?

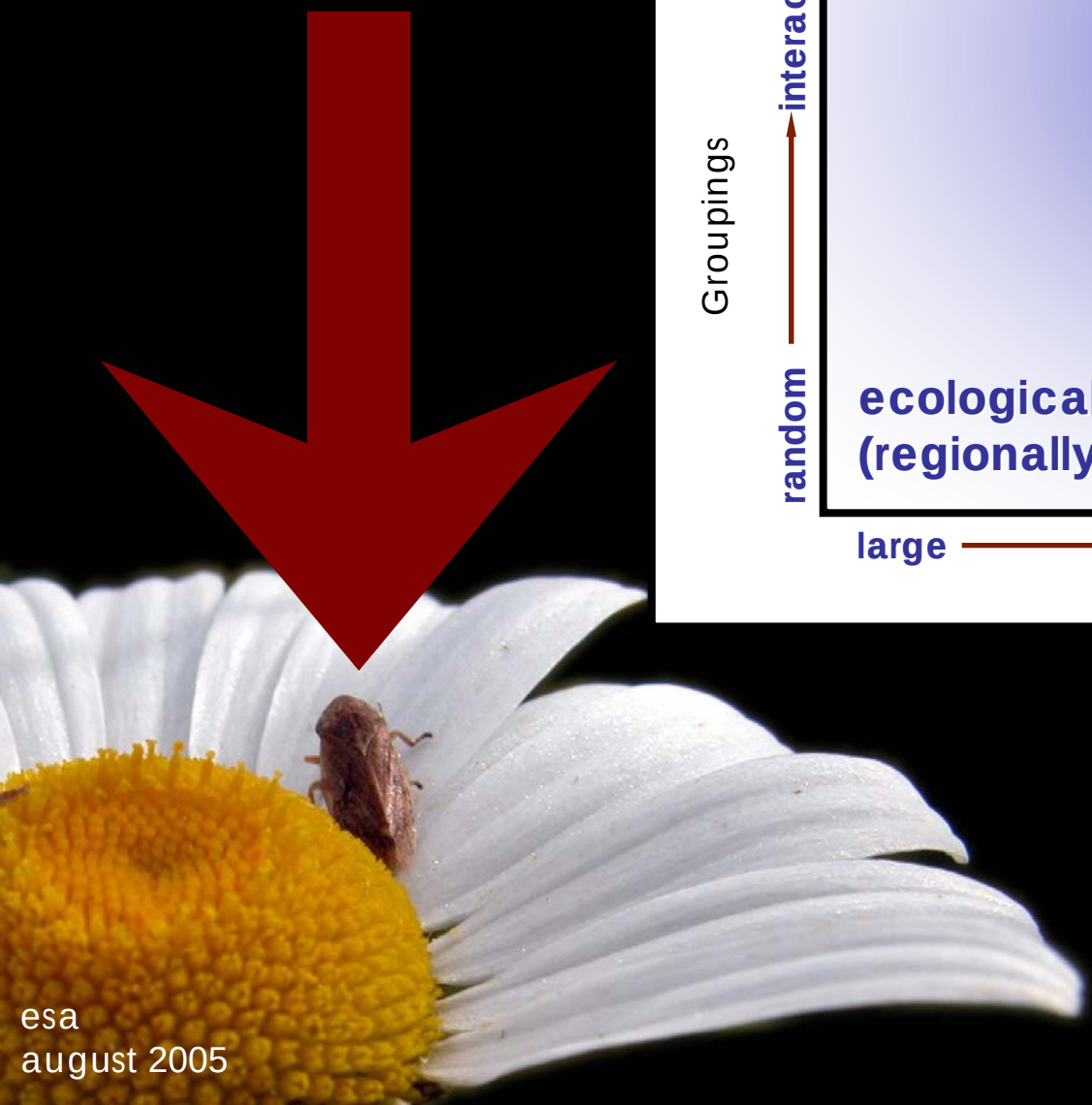
Some extreme examples:

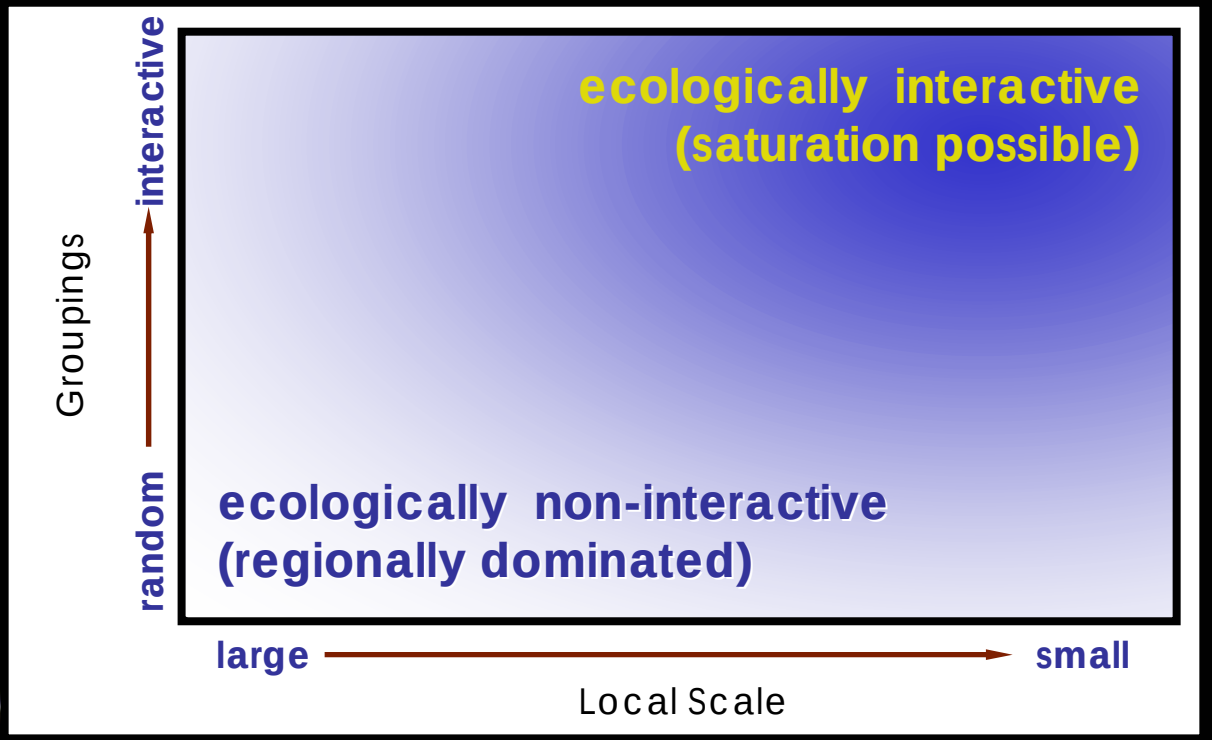
Flora & fauna of a fish gut.

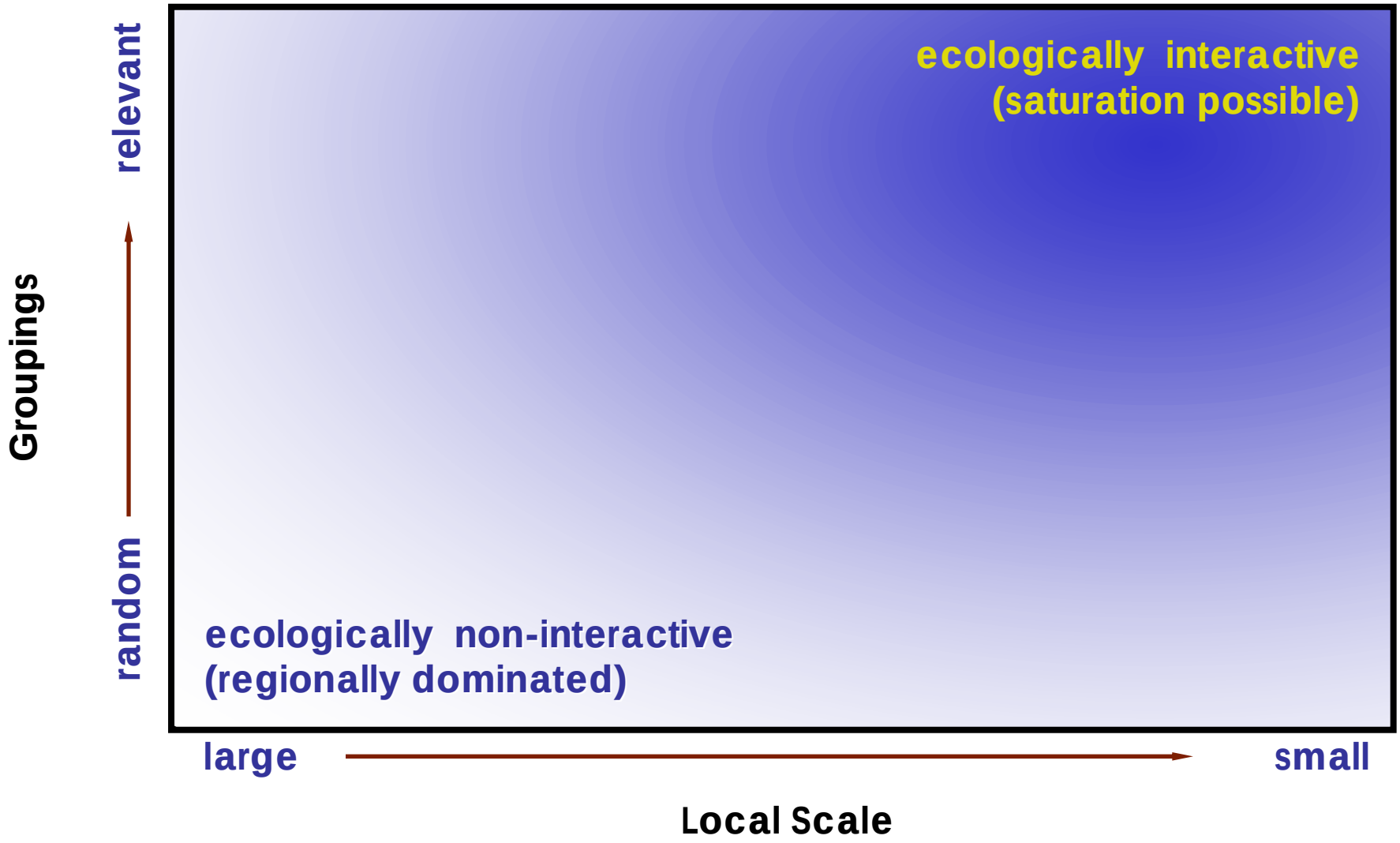
Plants in a ‘quadrat’.

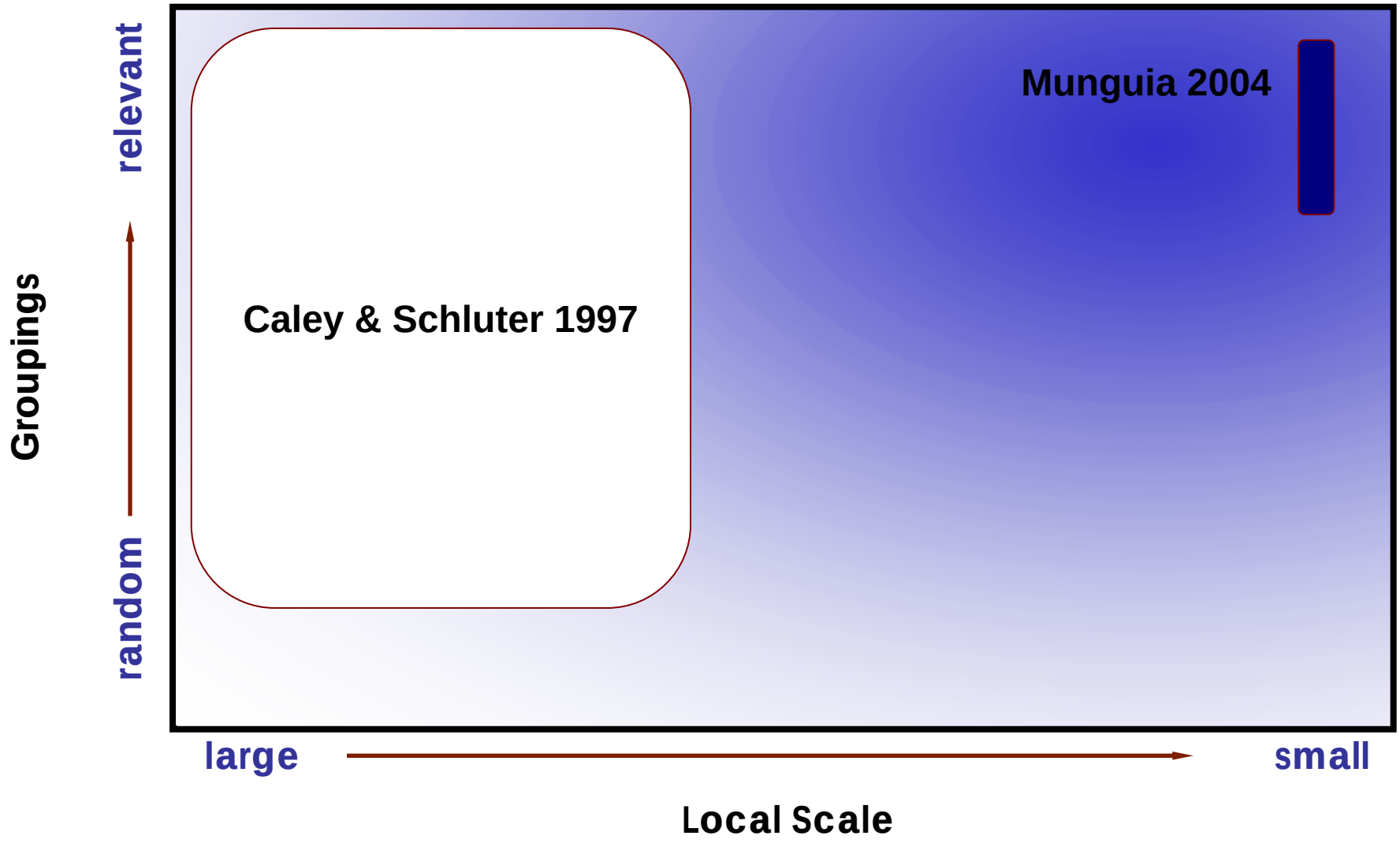
All birds in an area ½ the size of Switzerland.

a theoretical model

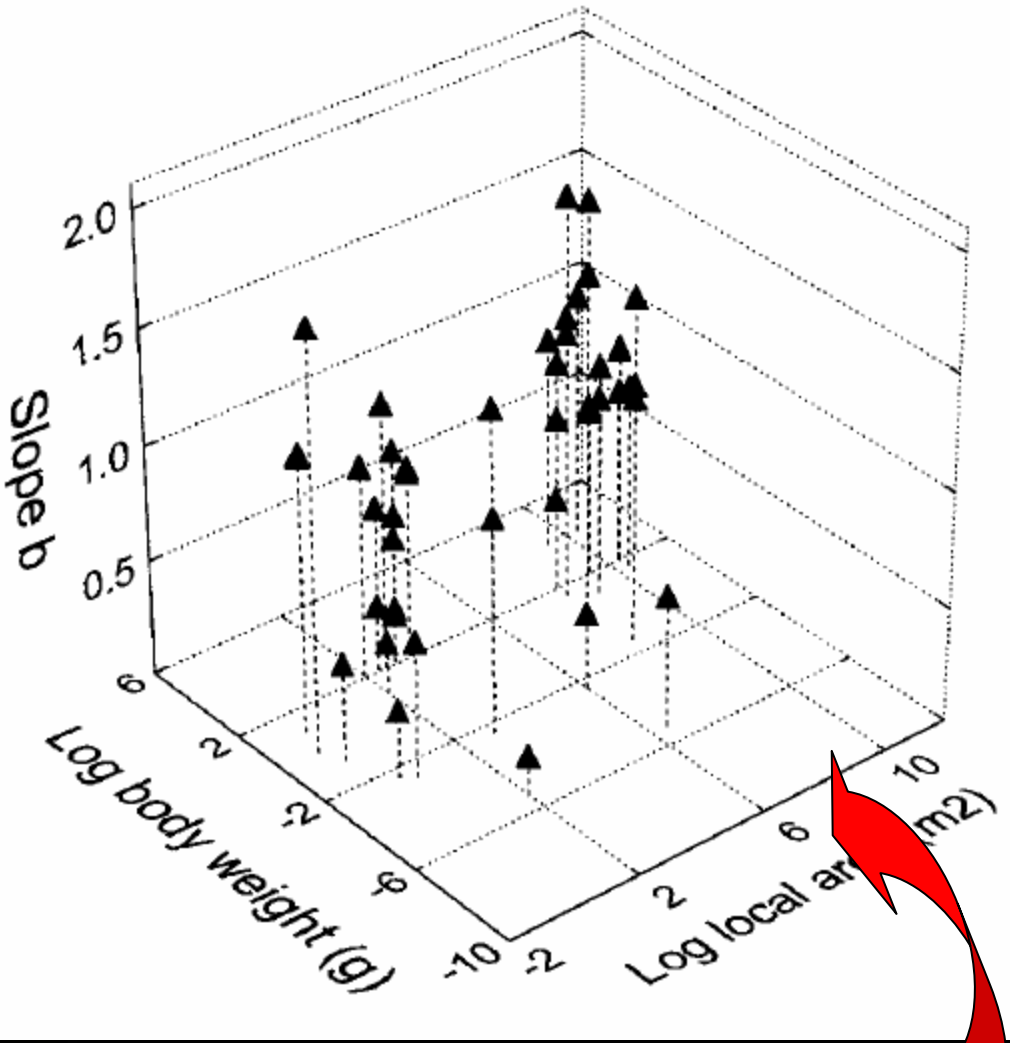





ecologically interactive
(saturation possible)
ecologically non-interactive
(regionally dominated)
Groupings
relevant
random
large
small
Local Scale


Groupings
relevant
random
Munguia 2004
Caley & Schluter 1997
large
small
Local Scale

Hillebrand & Blenckner 2002



1,000,000 m^2!!

conclusions of review

Conclusion:

Huge range in defined ‘local’ scales.

(Wide range of contexts in general)

Implication:

Could be responsible for the unsatisfying range of observed conclusions.

ANALYSIS

understanding if scale matters.

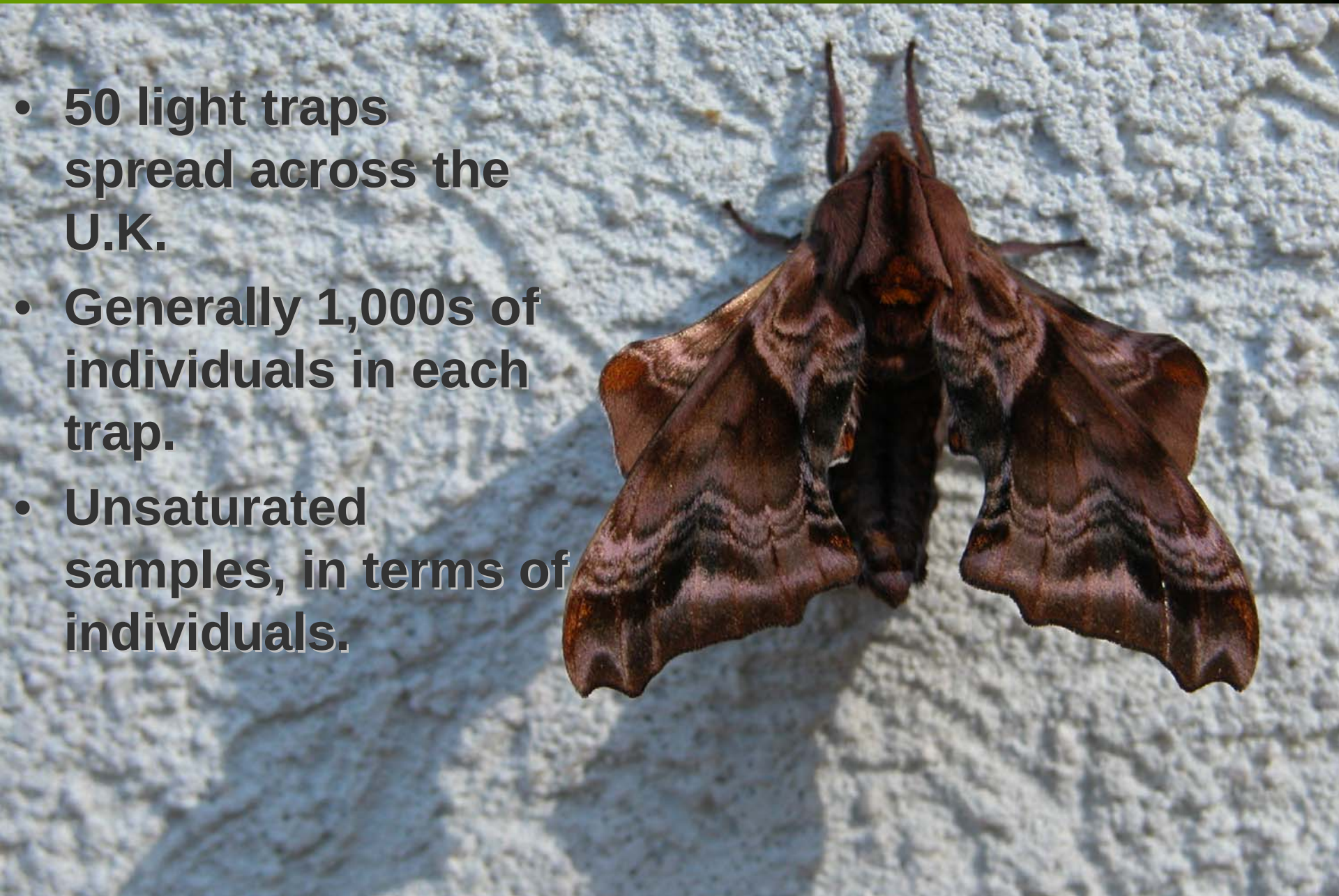
Test for a ceiling in local species richness, irrespective of the regional species pool.

Use data from:

- Moth communities,
- Desert plant communities, and
- Rocky intertidal communities.

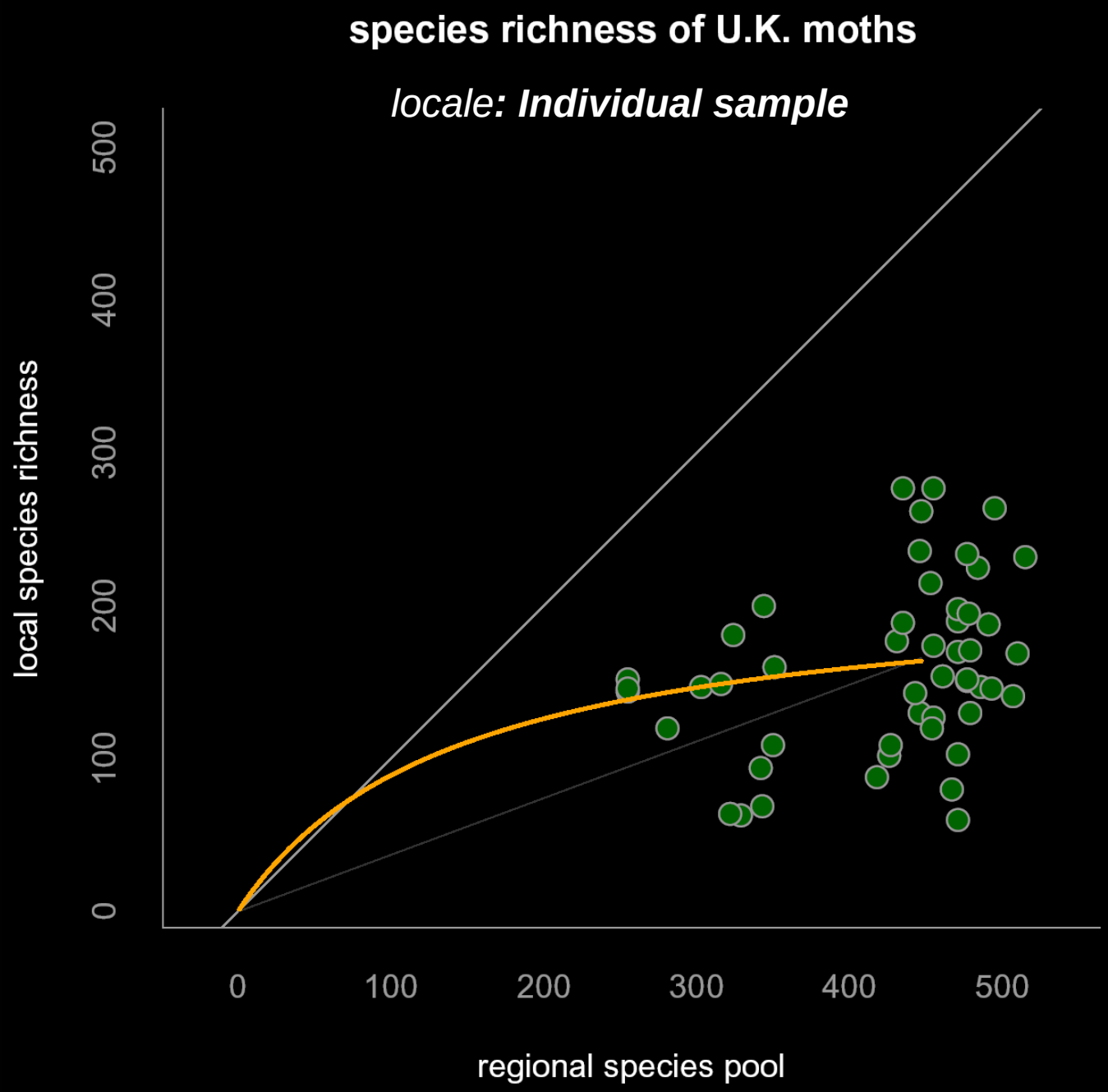
Observe the dependence of conclusions to changes in local scales.

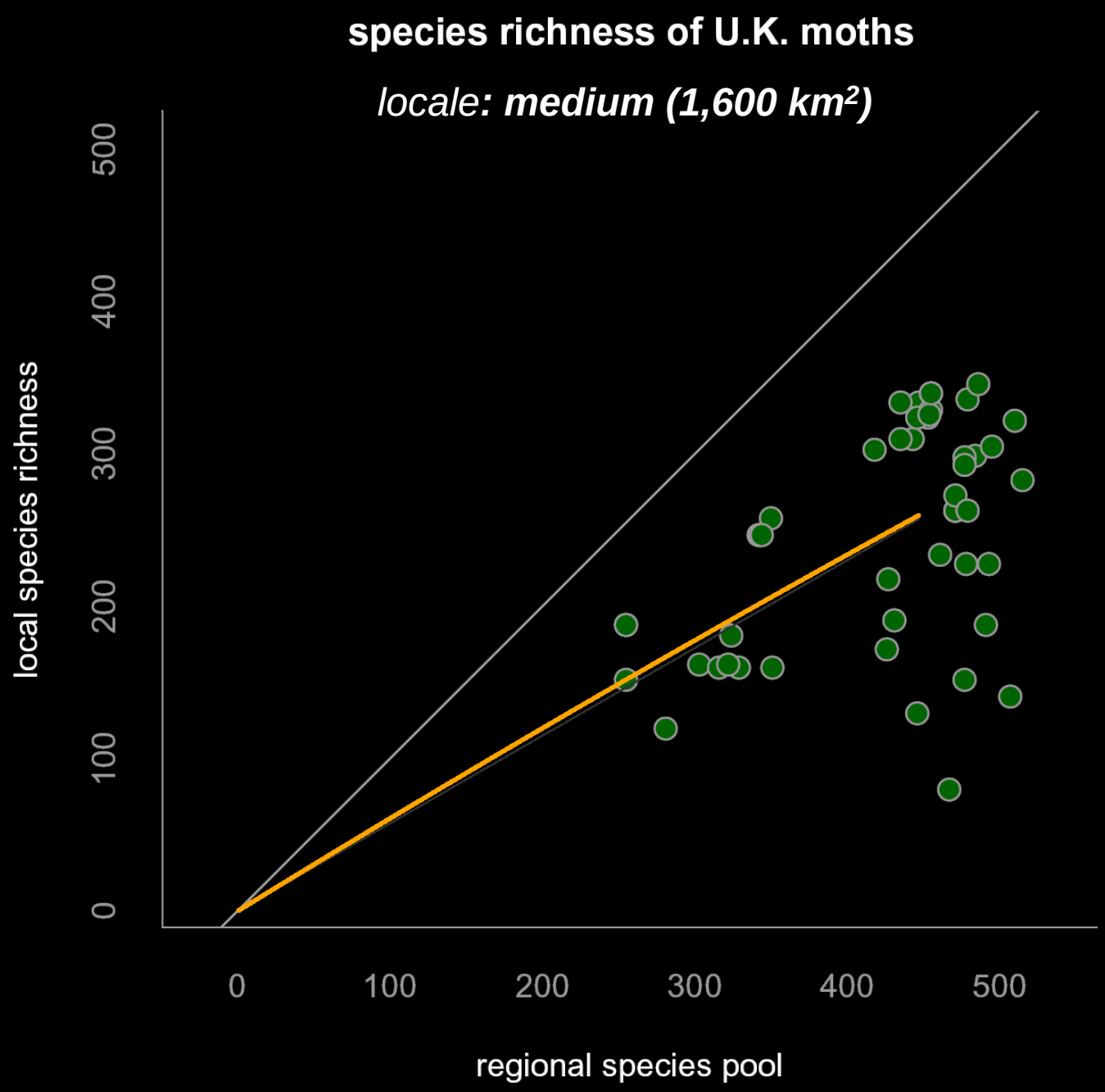
moth data

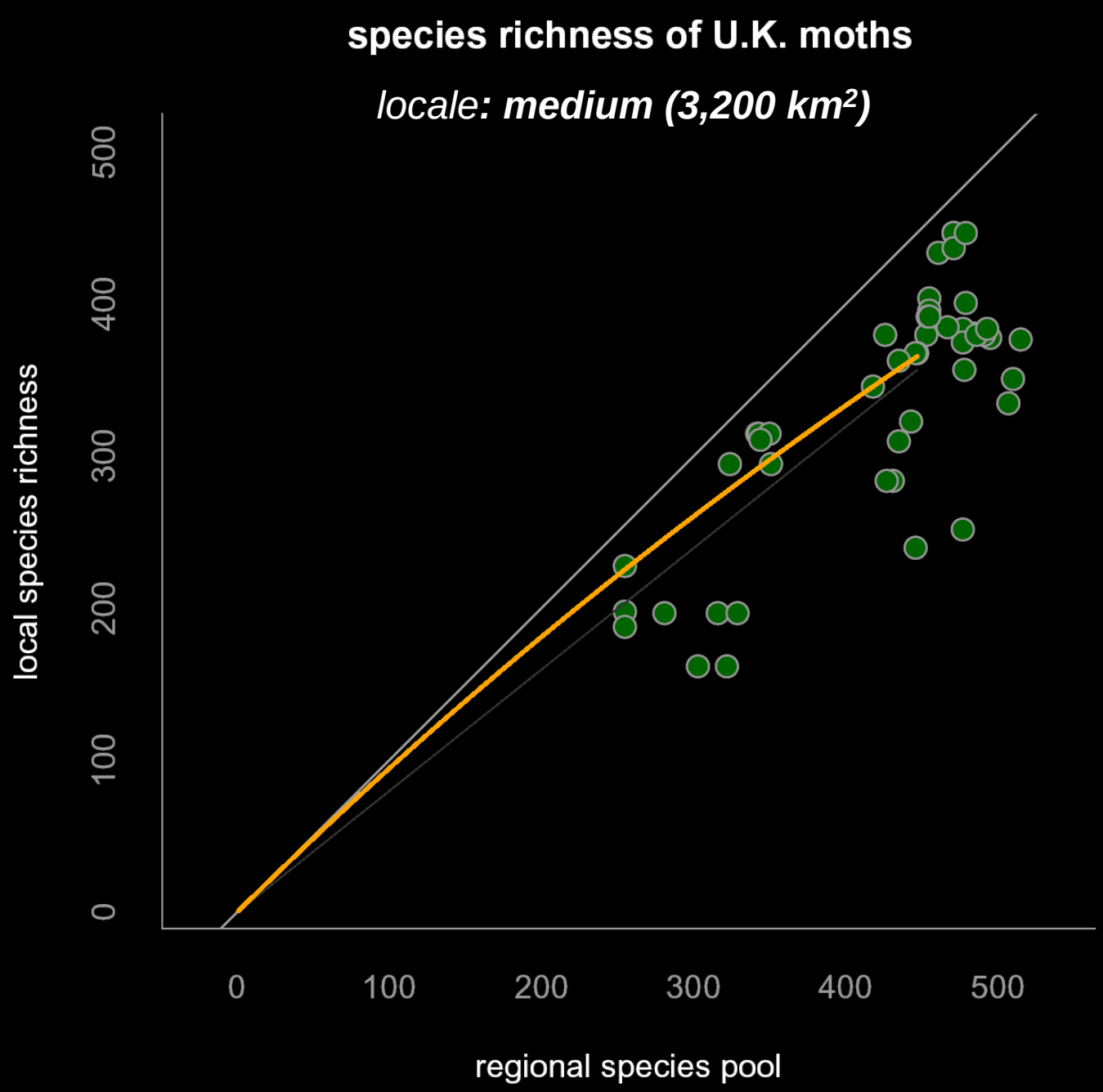


- 50 light traps spread across the U.K.
- Generally 1,000s of individuals in each trap.
- Unsaturated samples, in terms of individuals.

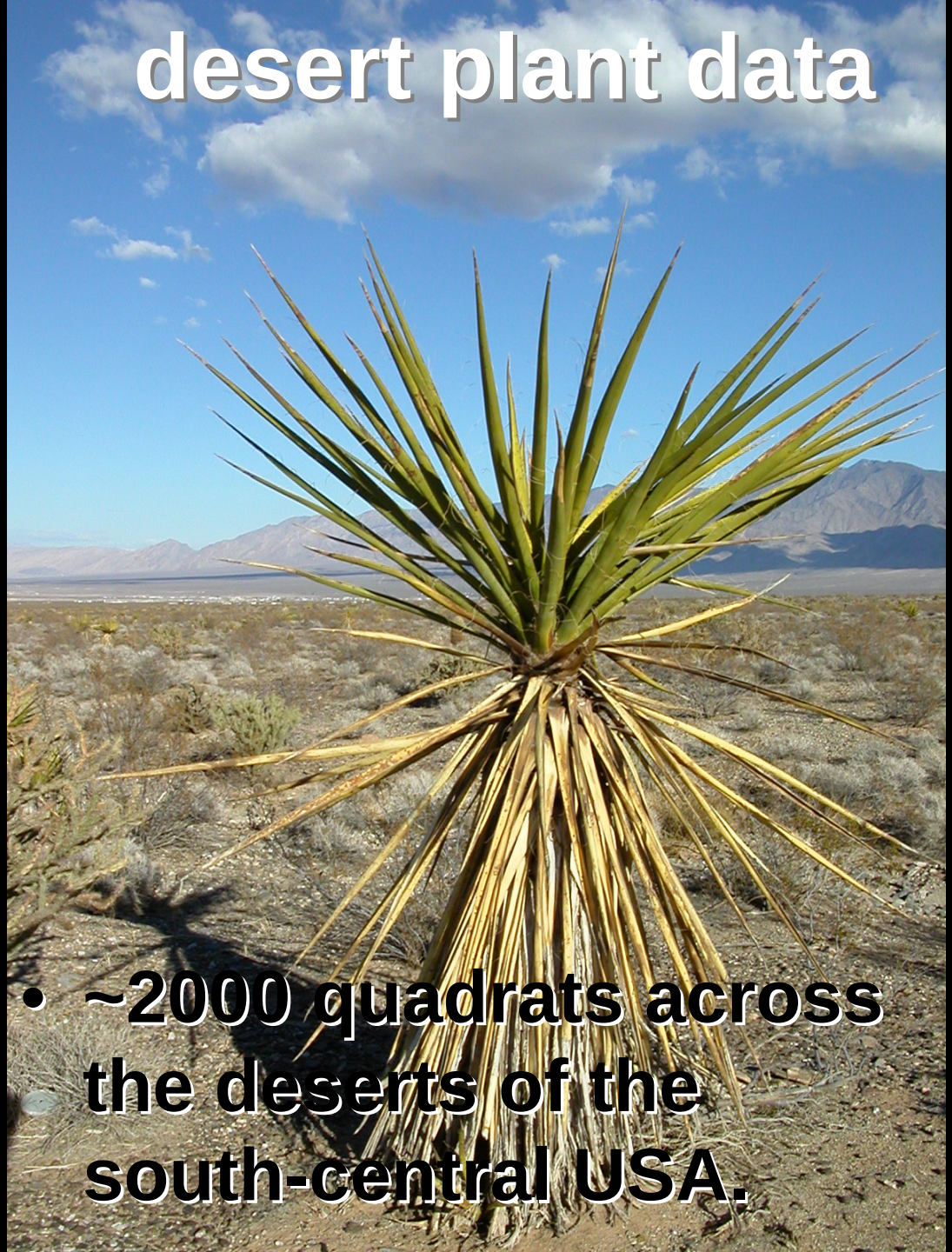

Photo: Ian Woiwod


species richness of U.K. moths
locale: Individual sample
local species richness
0
100
200
300
400
500
regional species pool

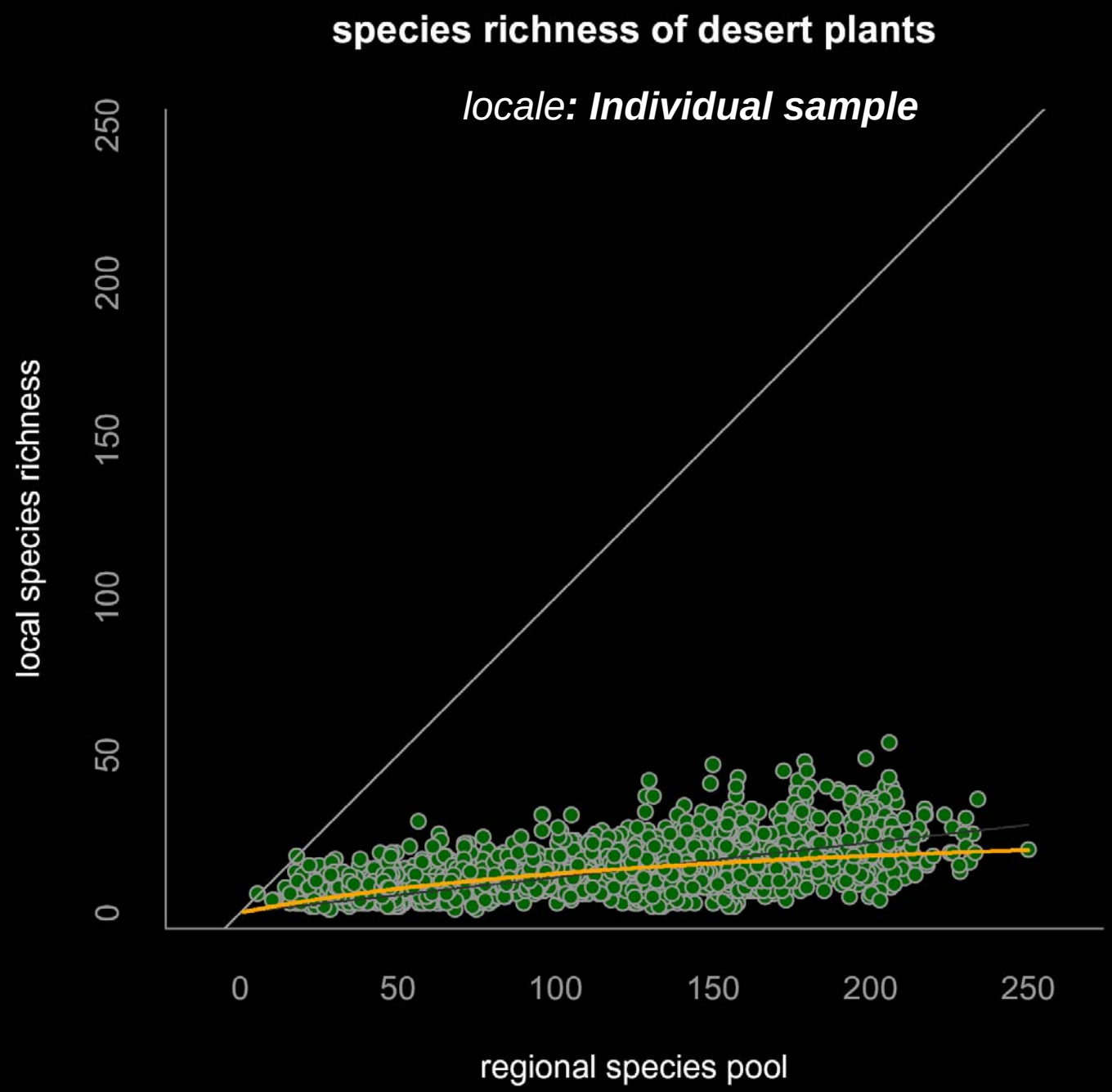

species richness of U.K. moths
locale: medium (1,600 km²)
local species richness
0
100
200
300
400
500
regional species pool

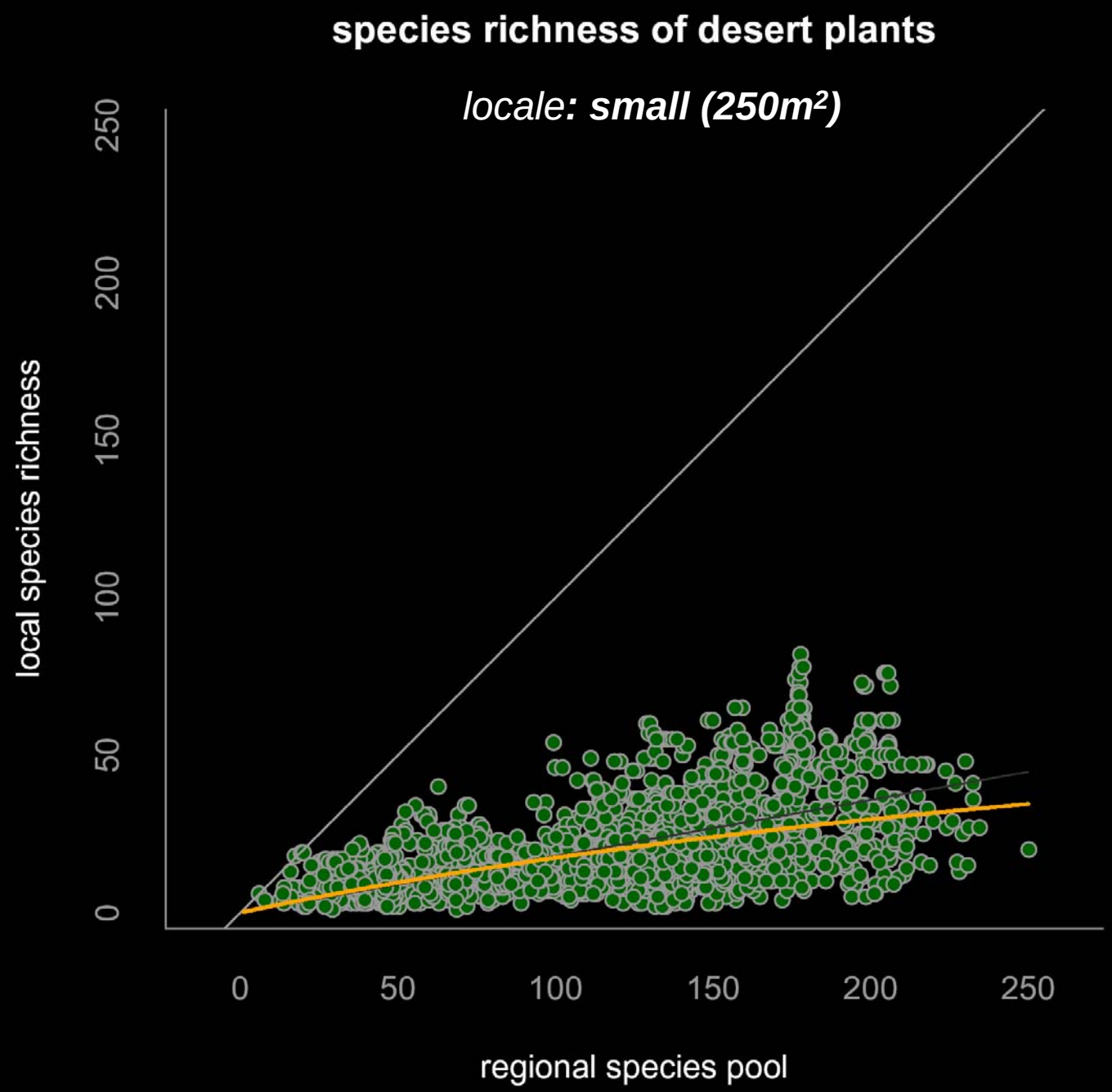

species richness of U.K. moths
locale: medium (3,200 km²)
local species richness
0
100
200
300
400
500
regional species pool

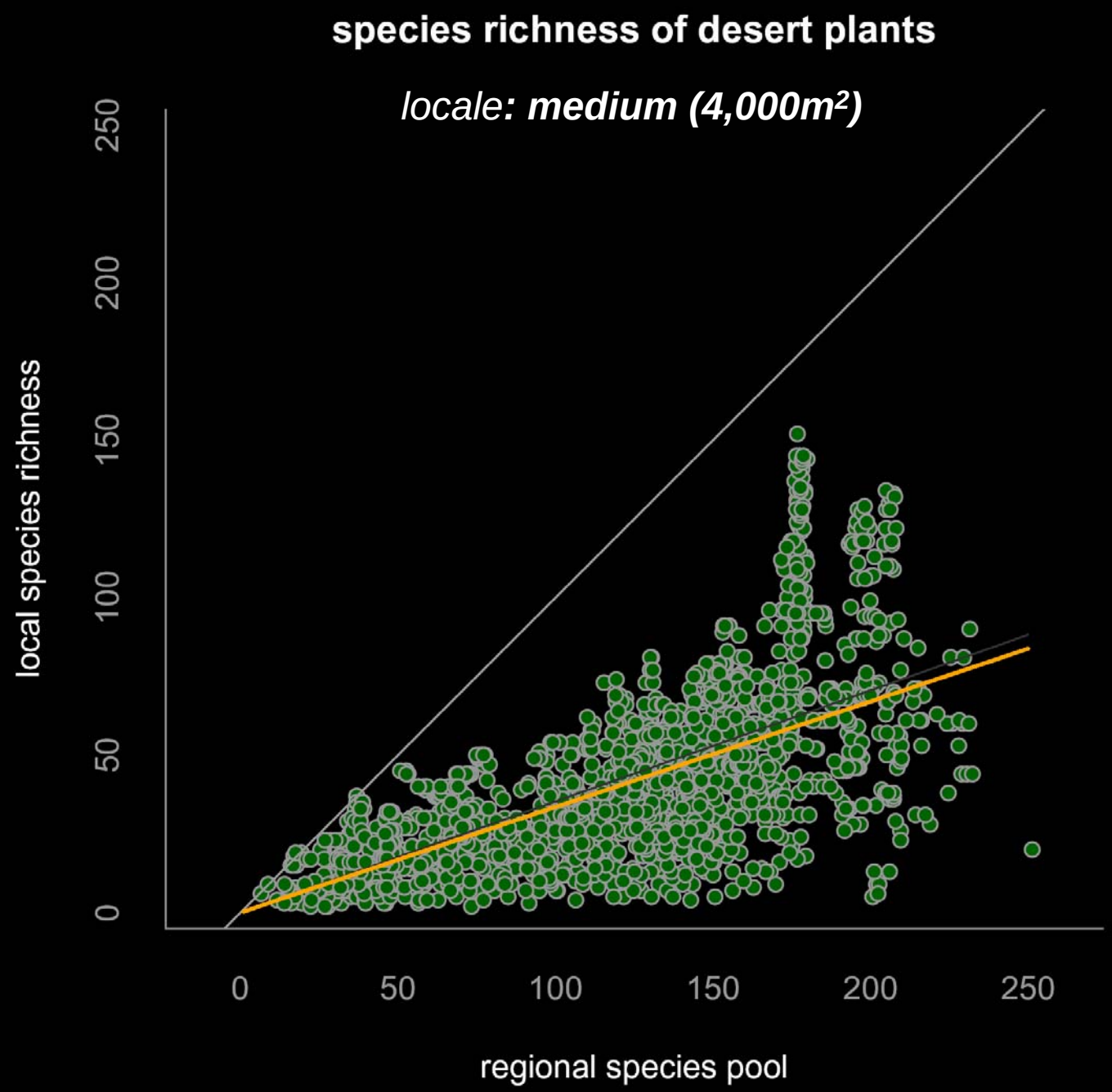
desert plant data

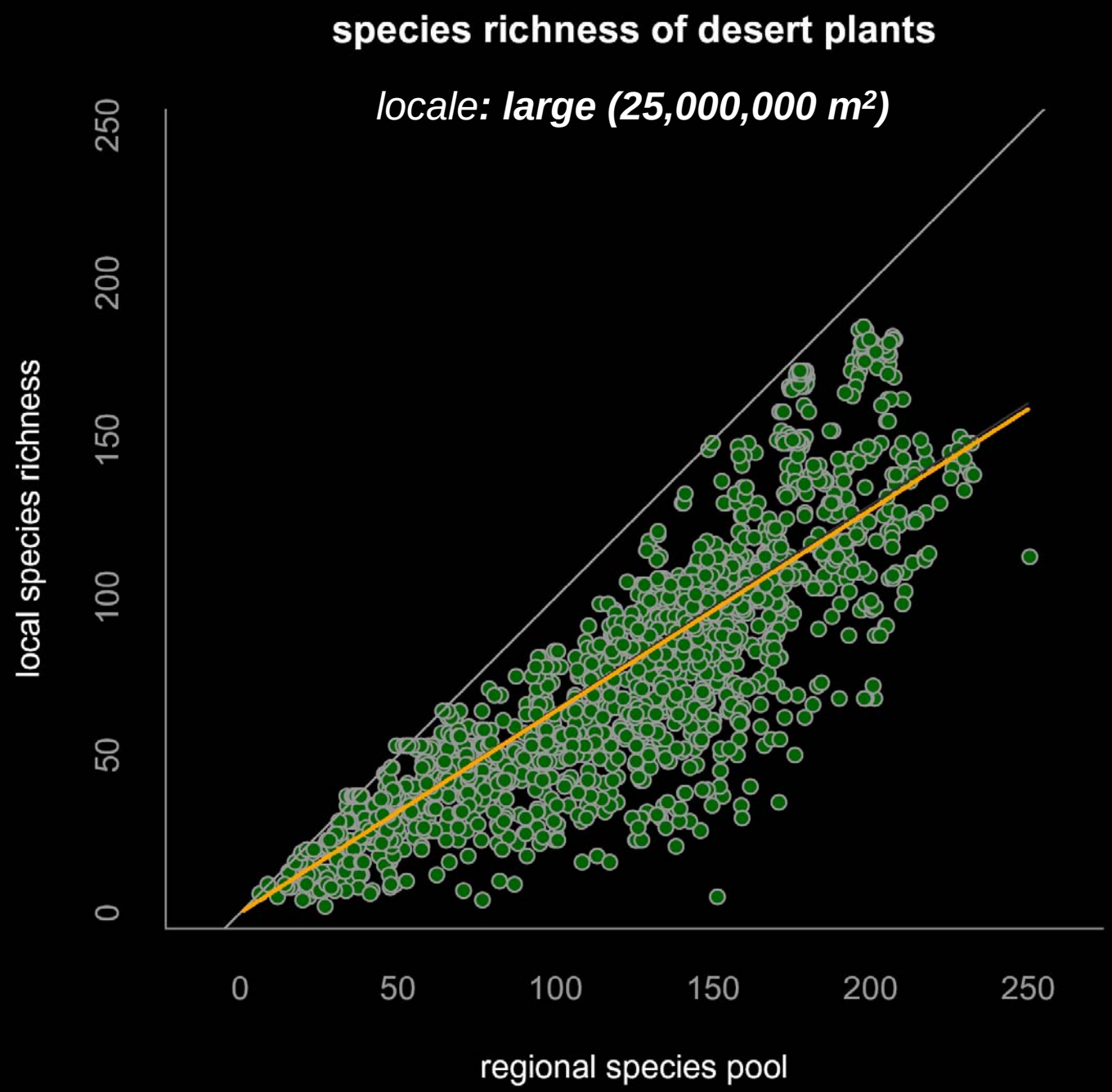


- ~2000 quadrats across the deserts of the south-central USA.


species richness of desert plants
locale: Individual sample
local species richness
0
50
100
150
200
250
0
50
100
150
200
250
regional species pool


species richness of desert plants
locale: small (250m²)
local species richness
0
50
100
150
200
250
regional species pool


species richness of desert plants
locale: medium (4,000m²)
local species richness
0
50
100
150
200
250
regional species pool

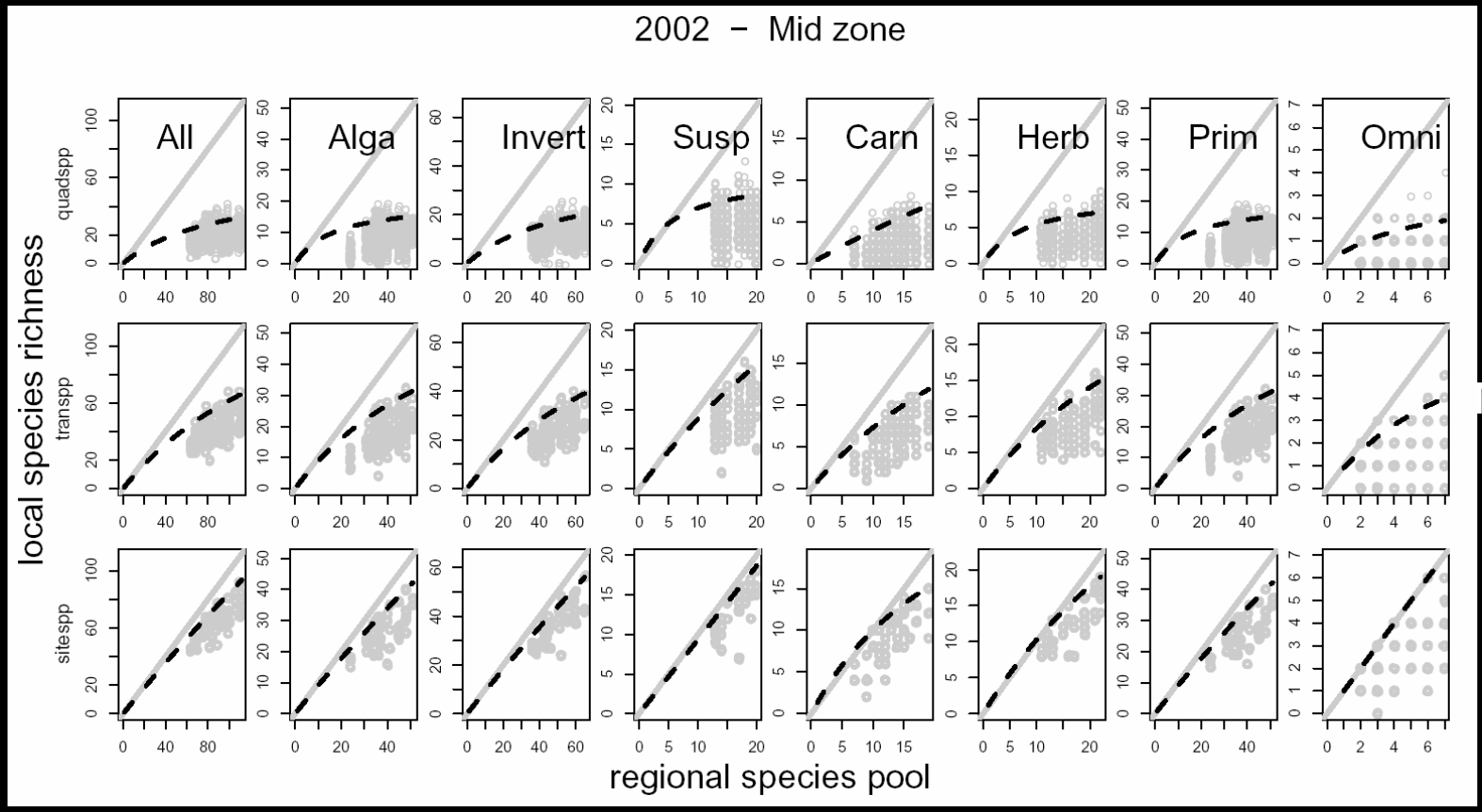

species richness of desert plants
locale: large (25,000,000 m²)
local species richness
0
50
100
150
200
250
0
50
100
150
200
250
regional species pool

rocky intertidal data

Quadrats down the west coast of the U.S.A.

Nested design; Quadrats (10) in Transects (3) in Sites (3) in Areas (18).

results (one zone, one year)

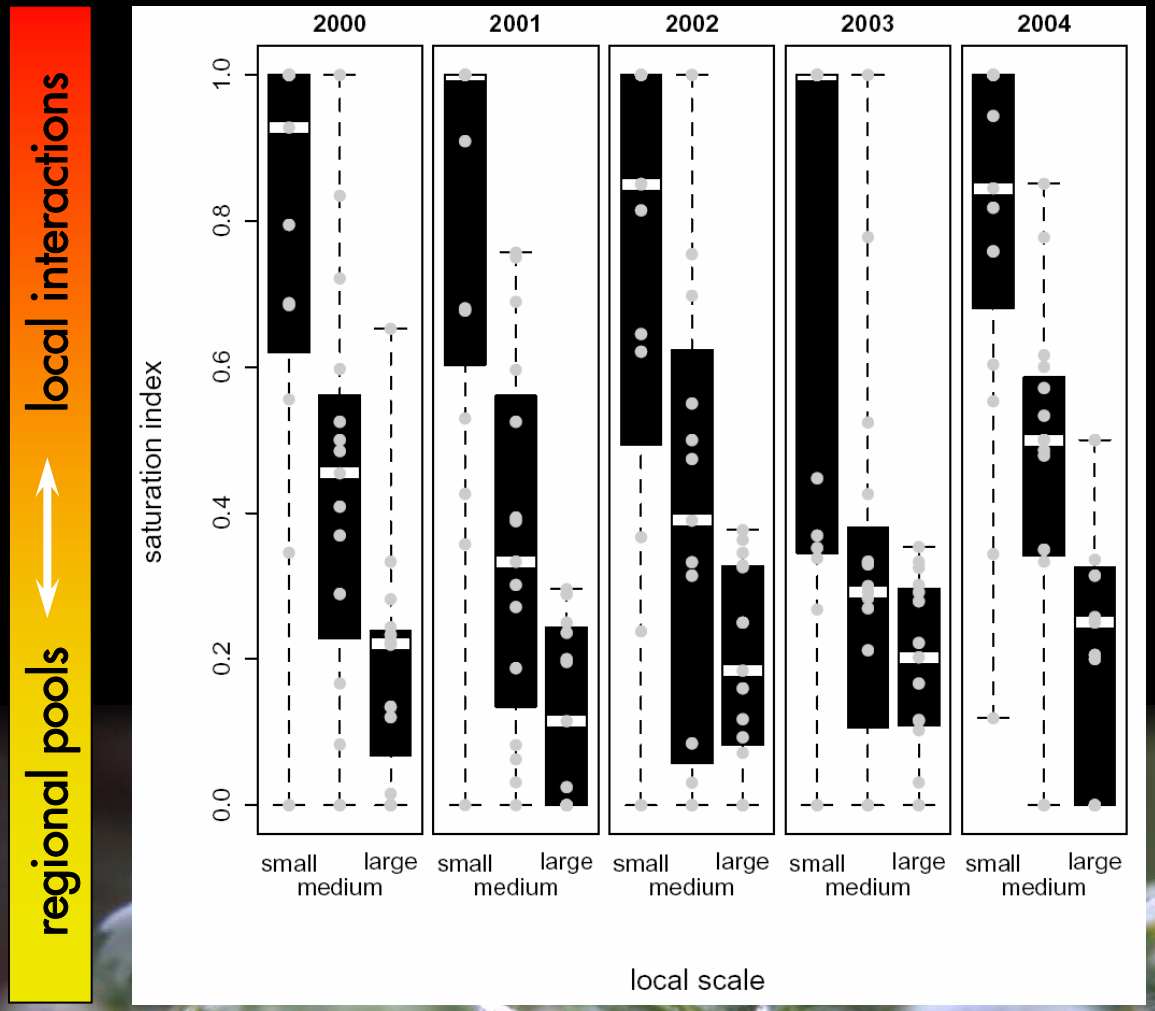


Small Scale

Medium

Large

intertidal results



analysis conclusion

Spatial scale of "local" will enormously influence expected—and observed—results.

[reminder: Spatial scale of proposed mechanism must match observations]

A richness ceiling, if evident, will only be apparent at "small" local scales (relative to most previous studies).

FORECAST

new tools needed

Part 1:

- Tool cannot distinguish local limitations of species richness versus regional species pool limitation—only tests whether regional species pools drive local richness.

new tools needed

Part 2:

- Truly multi-factor analyses are needed, but extremely difficult data to collect.
- Need simultaneous assessment of:
  - a) interaction strength,
  - b) abiotic factors, and
  - c) regional species pools.

conclusions

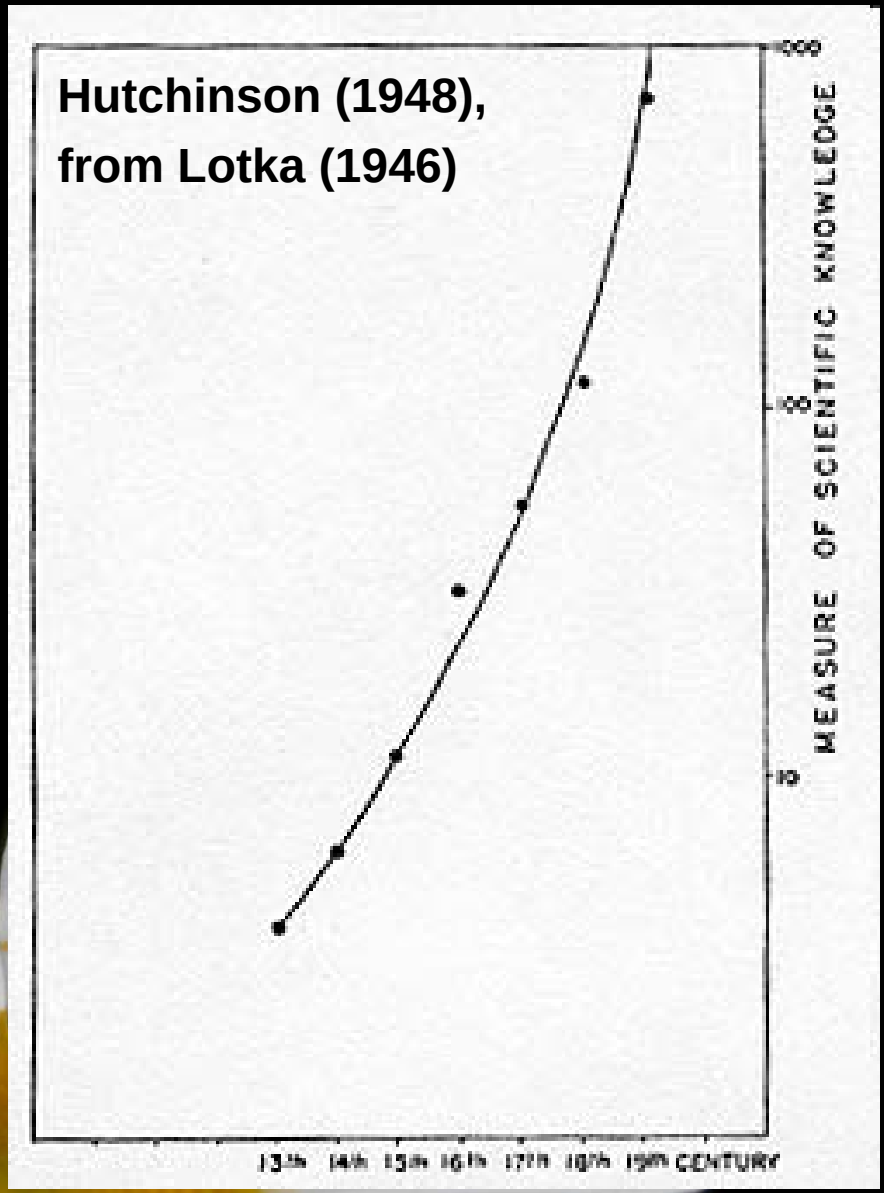
Ecological context has overwhelming influence on predicted patterns—particularly definition of local spatial scales. We don't pay enough attention to this.

At the scale of local interactions, regional species pools to not well predict local richness—but this doesn't mean local interactions do (as oft implied).

New tools are needed for determining key drivers of local species richness.

finally ...

More information does not equal more knowledge. We need more intelligent synthesis as well.



gratitude to ...

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People

Field data collectors, planners, et cetera.

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