Estimation of broad-scale species richness: individual-based or spatially-constrained rarefaction?

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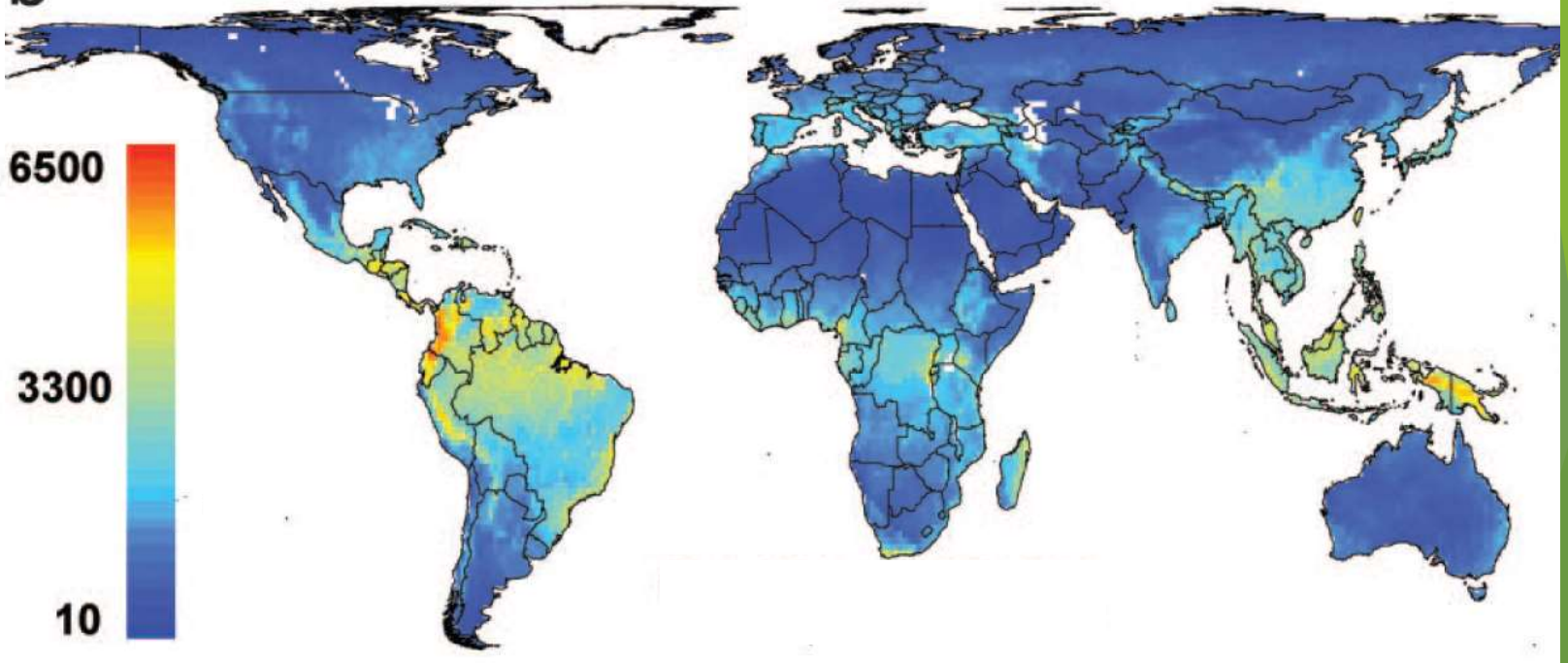
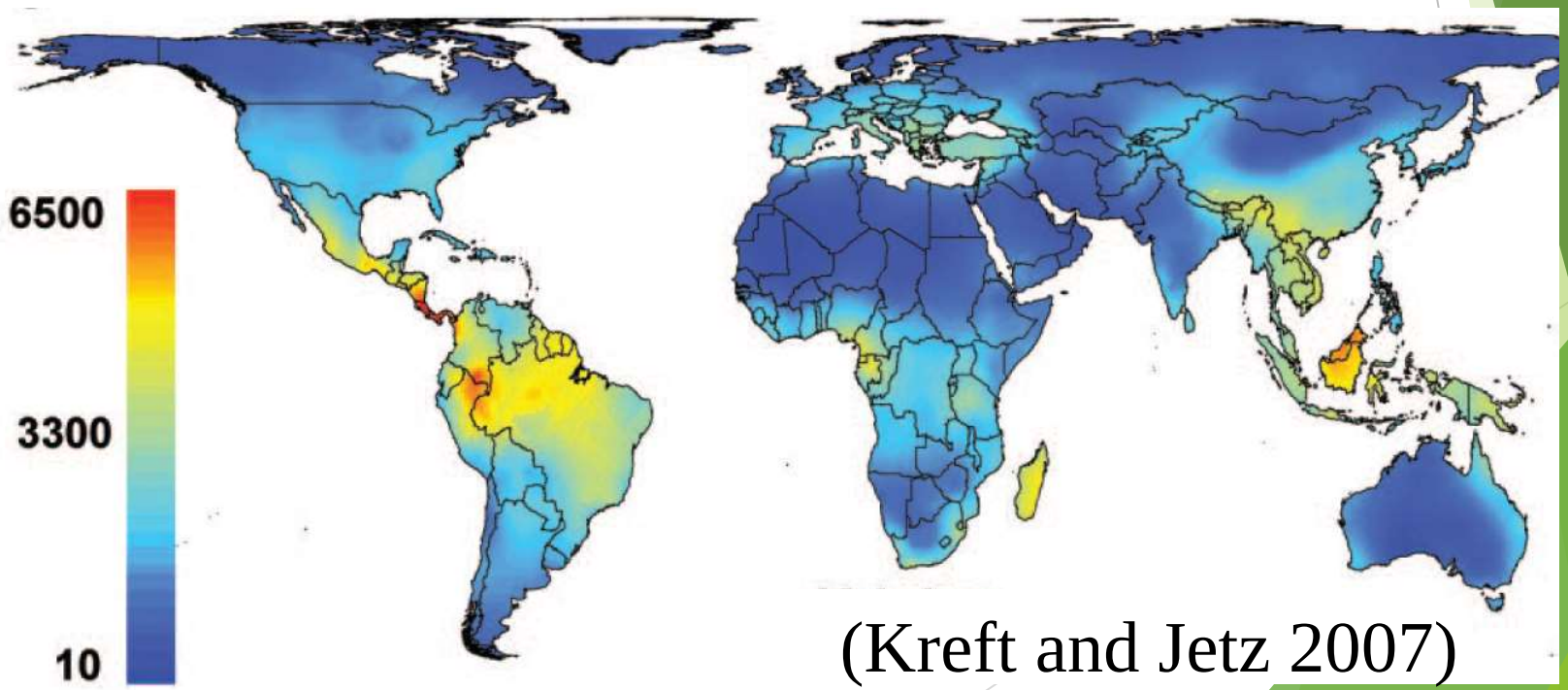
Vascular plant richness

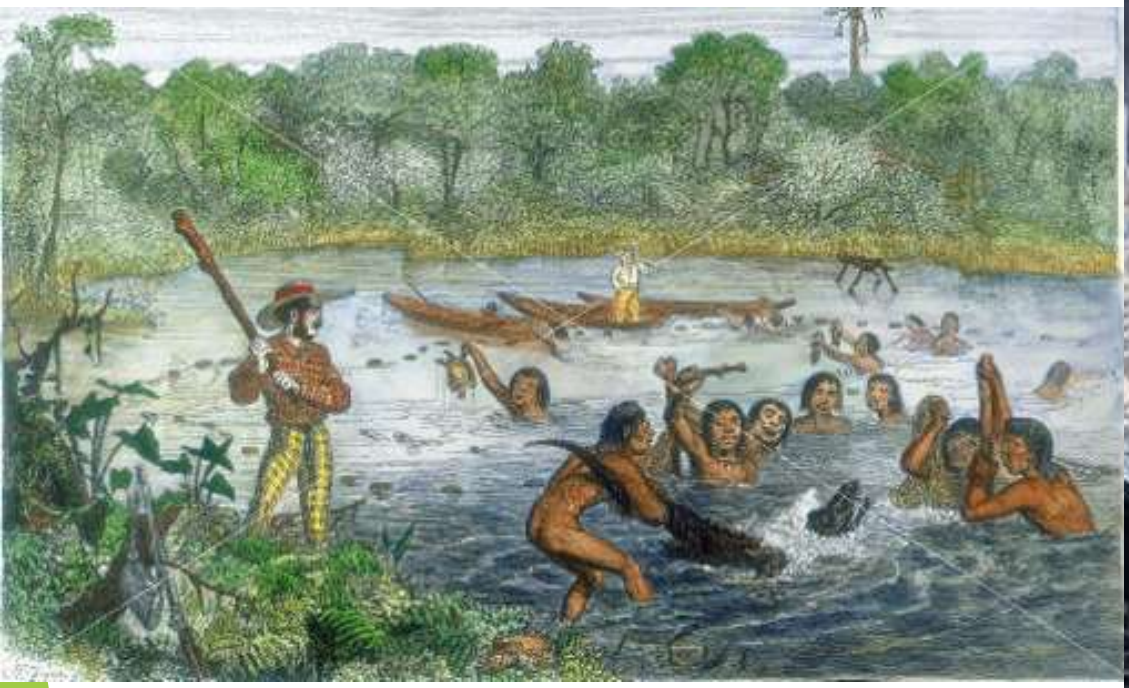




(Kreft and Jetz 2007)

The Wallacean shortfall:

"paucity of information on the geographic variation of nature" (Lomolino et al. 2010)



Alfred Russell Wallace and Henry Walter Bates hanging out in 1848 by Belém (Pará), Brazilian Amazonia.

Individual-based rarefaction

The simplest rarefaction approach to estimate broad-scale species richness using data from natural history museum and herbarium specimens is known as individual-based rarefaction (Gotelli & Colwell 2001).

Under this approach $E[S_n]$.is estimated from multiple random samples of *n* specimens drawn from the pool of *N* specimens collected in a sampling unit.

Ideally, the pool of *N* specimens collected in a sampling unit would be a random sample from the (potentially very large) set of individuals occurring in the sampling unit.

Spatially-constrained rarefaction

Spatially constrained rarefaction aims to control for the spatial arrangement of sampling activities across a sampling unit (Chiarucci et al. 2009, Bacaro et al. 2012).

In spatially constrained rarefaction the spatial proximity of individuals is considered when drawing subsets of *n* individuals from the pool of all *N* individuals.

In particular, these subsets are obtained by drawing individuals that are near each other in geographic space.

Research hypothesis:

When estimating broad-scale species richness using data from natural history museum and herbarium specimens, spatially-constrained rarefaction is less biased than individual-based rarefaction, because it reduces over estimation of species richness due to spatial aggregation of sampling activities.

Definitions

E[sn.r]

E[Sn.scr]

Sn.a

Study system and general methods

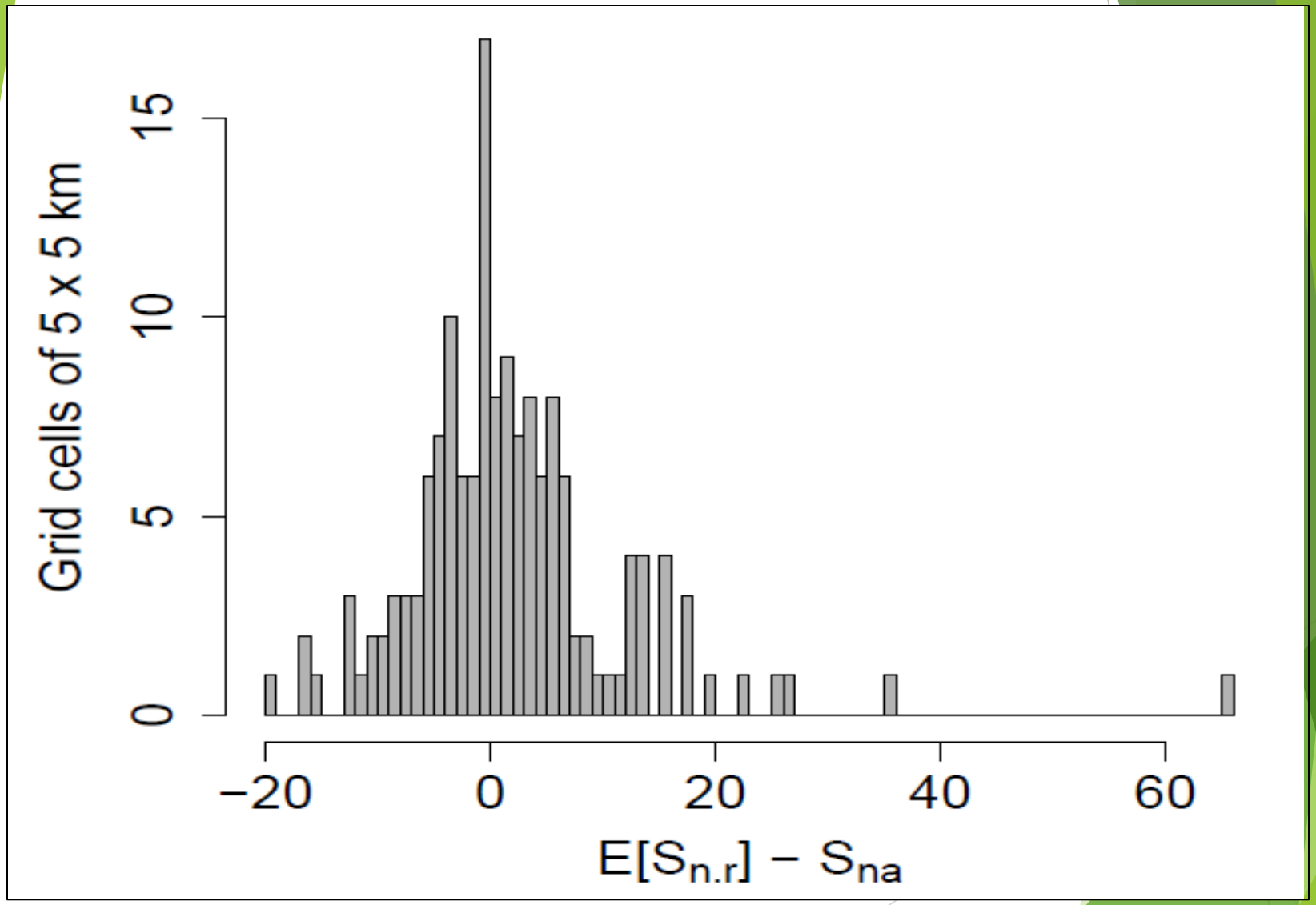
- The Nicaragua flora
  - The flora of Nicaragua is highly diverse, for our study system we used the entire vascular plant flora which includes both woody and herbaceous species.
- Data source and cleaning
  - Tropicos database
  - What was excluded for the data
- The spatial scale and number of grid cells used
  - 5km x 5km grid cells
  - At lease 200 specimen records
- How species richness was estimated
  - Use of accumulation curves
  - Individual rarefaction
  - Spatial constrained rarefaction

Prediction 1

on average, across grid cells, E[Snr] - Sna > 0

The first prediction states that, on average across grid cells, $E[S_{n.r}]$ is larger than $S_{n.a}$. This prediction derives from the fact that accurate rarefaction curves are statistical expectations of accumulation curves (Gotelli & Colwell 2001).

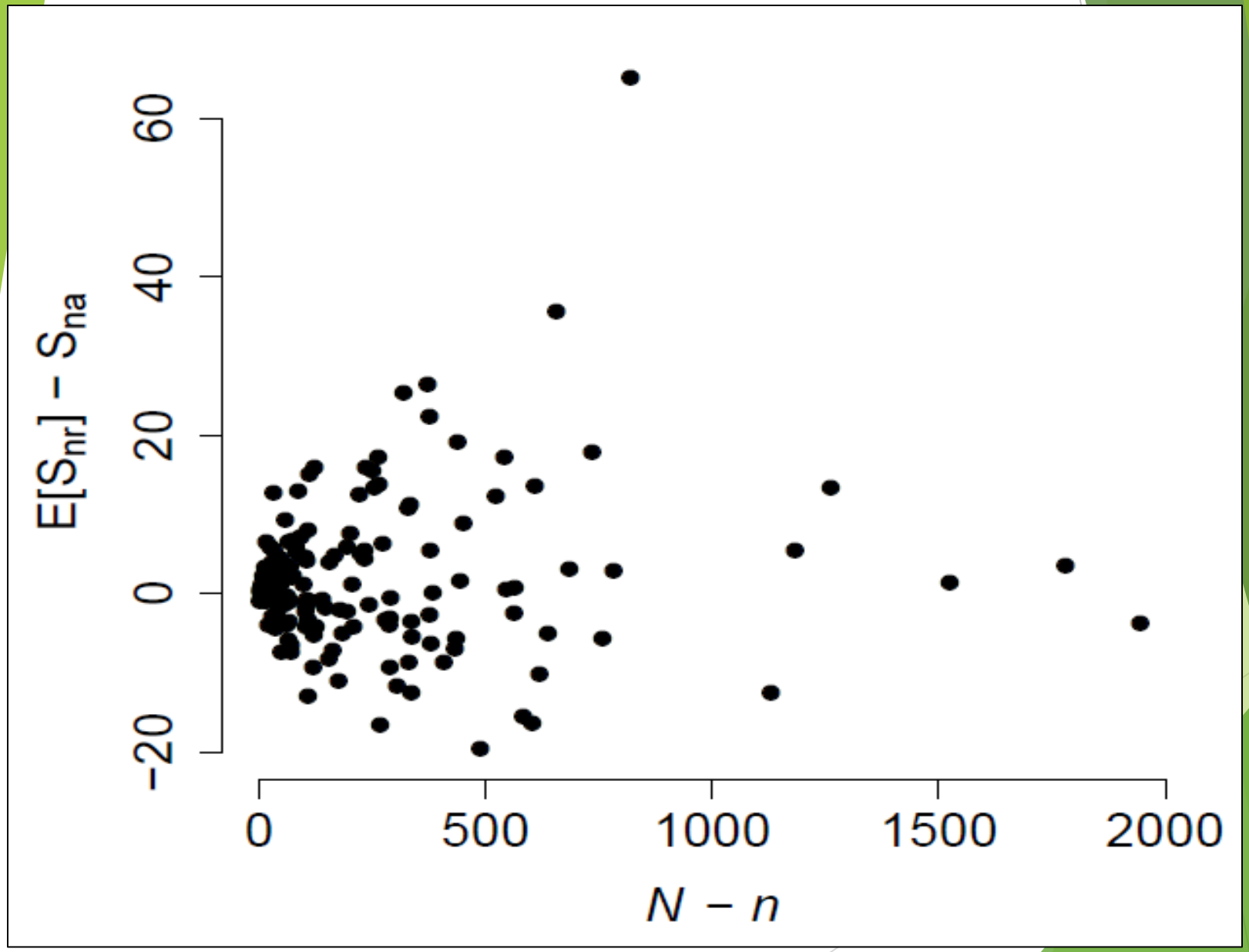
Results of testing prediction 1



Prediction 2

The relationship between $[S_{n.r}]$ – $S_{n.a}$ and N – n is positive

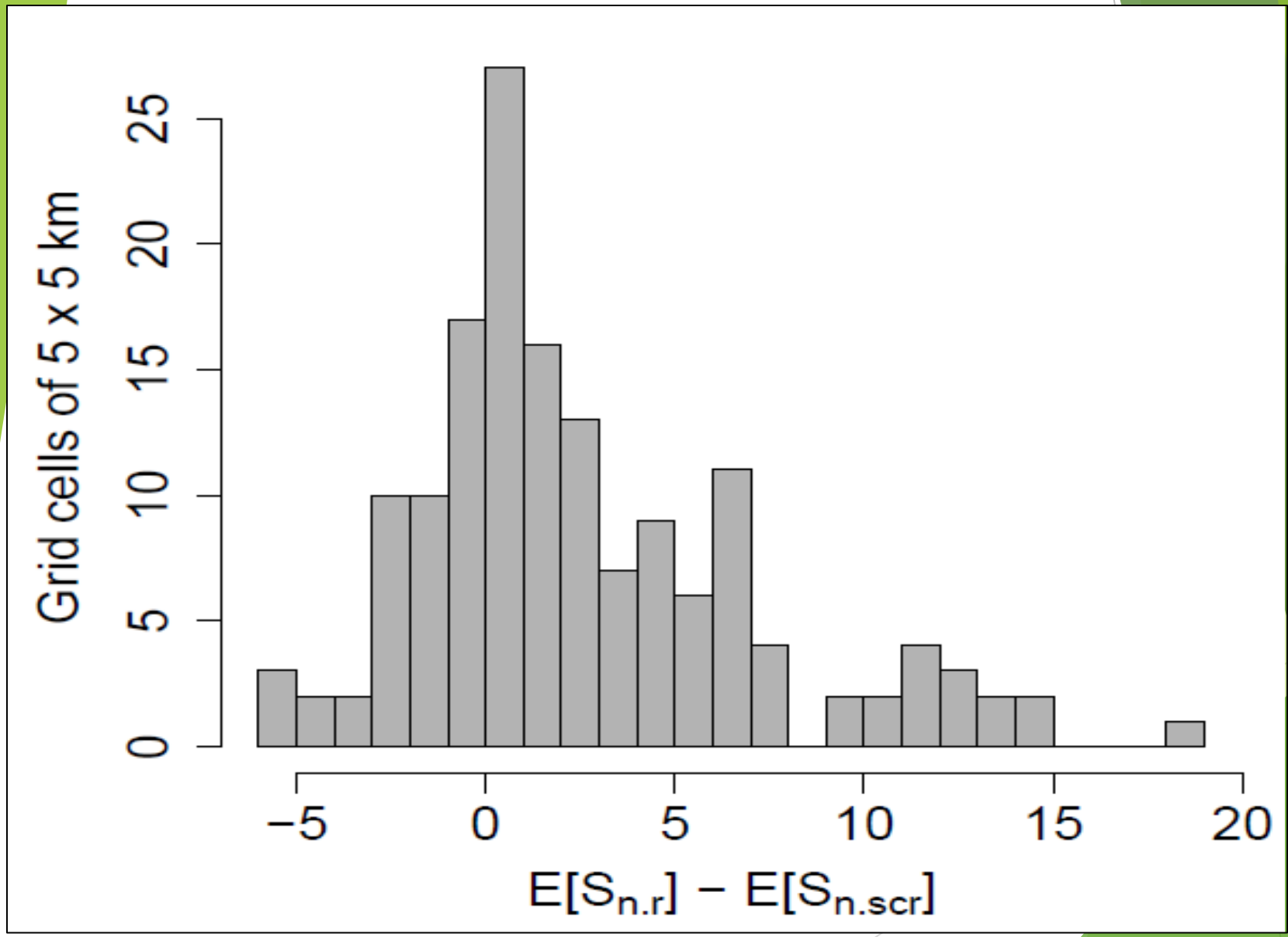
Results of testing prediction 2



Prediction 3

$E[S_{n.r}] - E[S_{n.scr}] > 0$

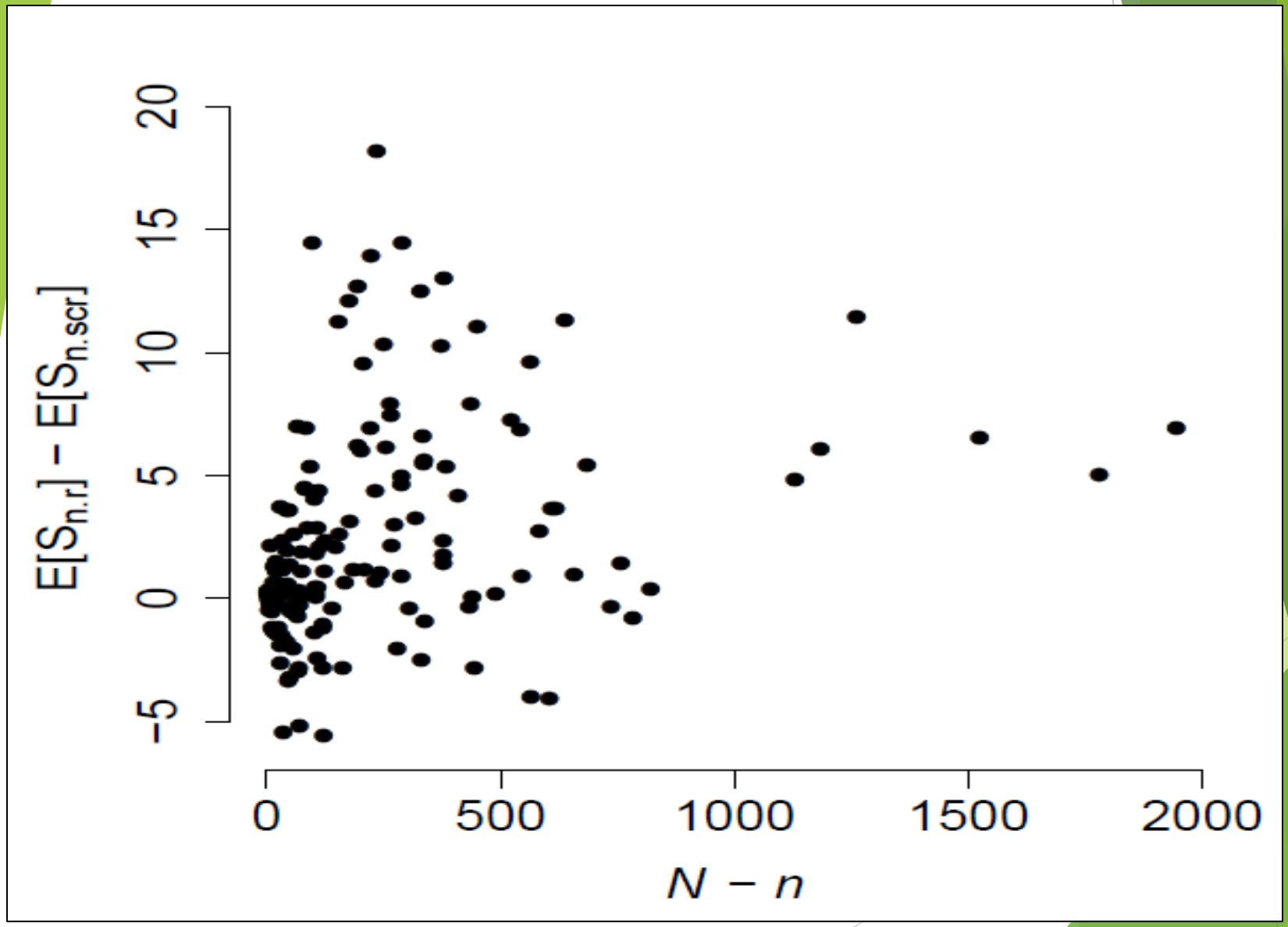
Results of testing prediction 3



Prediction 4

The relationship between $E[S_{n.r}]$ - $E[S_{n.scr}]$ and *N* – *n* is positive

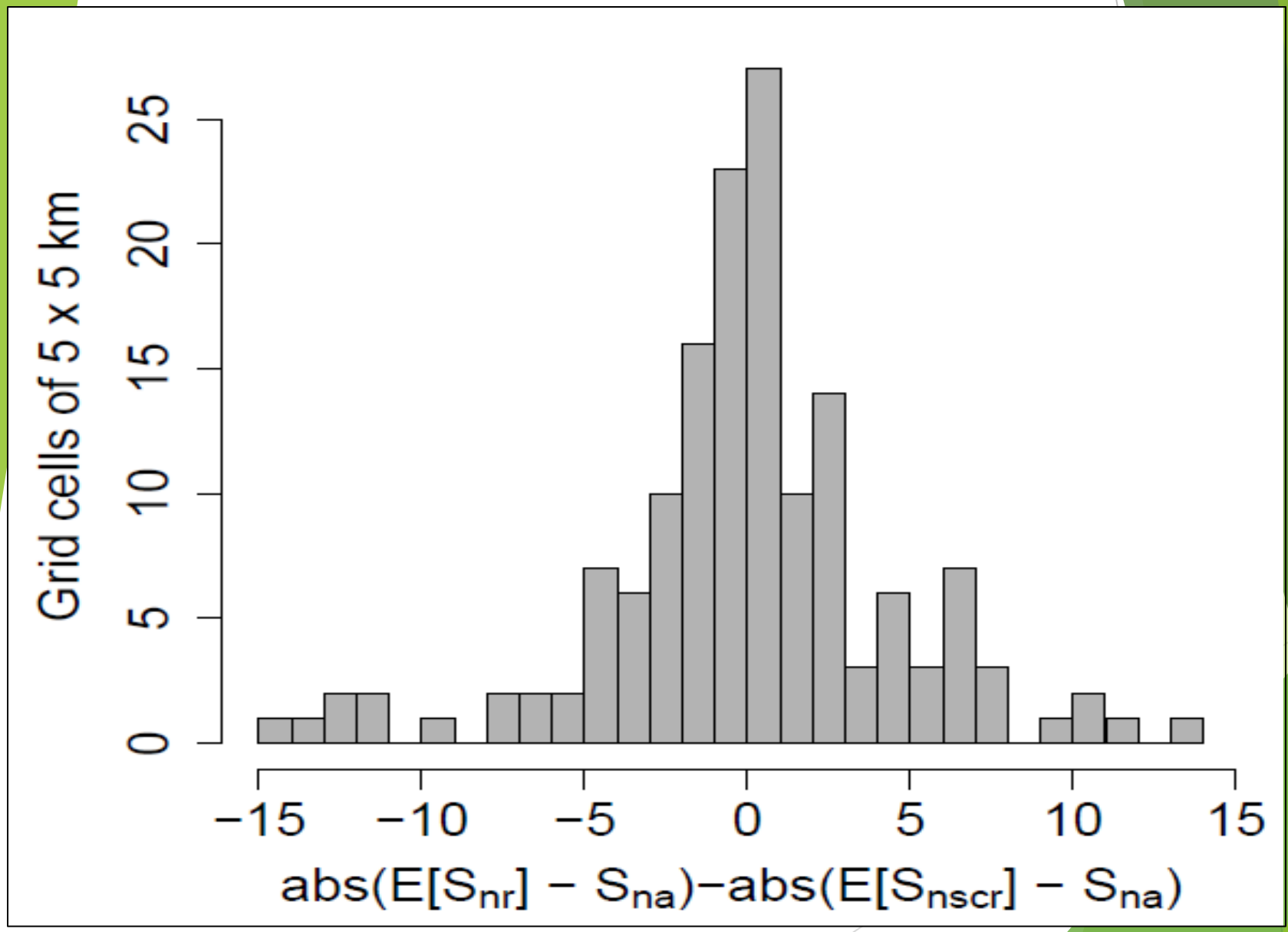
Results of testing prediction 4



Prediction 5

$$| E[S_{n.scr}] - S_{n.a} | - | E[S_{n.scr}] - S_{n.a} | > 0$$

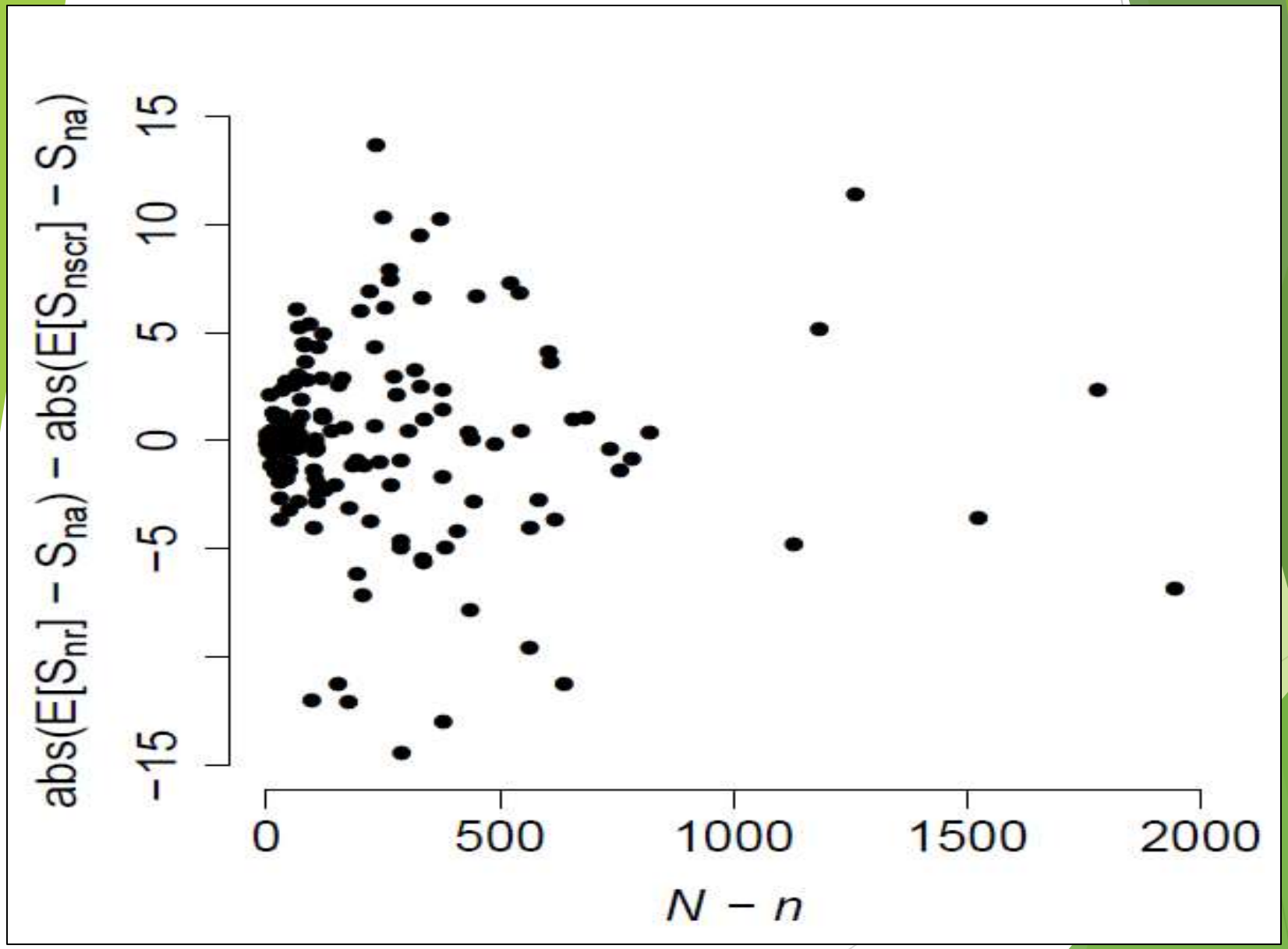
Results of testing prediction 5



Prediction 6

The| $E[S_{n.scr}]$ - $S_{n.a}$ | - | $E[S_{n.scr}]$ - $S_{n.a}$ | and *N* - *n* is e relationship between positive.

Results of testing prediction 6



Conclusions

The hypothesis was not empirically supported. Broad-scale species richness estimates based on spatially-constrained rarefaction do not seem to be less biased that those based on individual-based rarefaction

Acknowledgements

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