Quantifying Specialization with Abundance Data

Techniques in measuring insect-preference

Scott Nordstrom
Oregon State EISI
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Specialization's Importance

- Asymmetric relations
- Resilience
- Coevolution of specialists
- Applications to conservation
  - Where to focus preservation efforts?
- Application to evolution
  - Where is speciation occurring?

Current method for quantifying

- Bluthgen et. al. (2006) and *d′*
- Kullback-Leibler divergence
- Null hypothesis: generalists visit flowers based on how active
- Uses:
  - *p′ij* = Proportion of pollinator i's visits to flower j
  - *qj* = Proportion of flower j's interactions to all interactions
- On a scale of 0 – 1
  - 0: no divergence, generalist
  - 1: complege divergence, specialist

$$d_i = \sum_j p'_{ij} \ln \frac{p'_{ij}}{q_j}$$

New parameter

- New parameter (χ)
- Kullback-Leibler divergence
- Null hypothesis: generalist visits flowers by how abundant they are
- Uses:
  - *p'ij* = Proportion of pollinator j's visits to flower j
  - *fj* = Proportion of meadow composed of flower j
- Theoretical perfect specialist = all visits go to rarest of all flowers

$$\chi_i = \sum_j p'_{ij} \ln \frac{p'_{ij}}{f_j}$$

What to choose from?

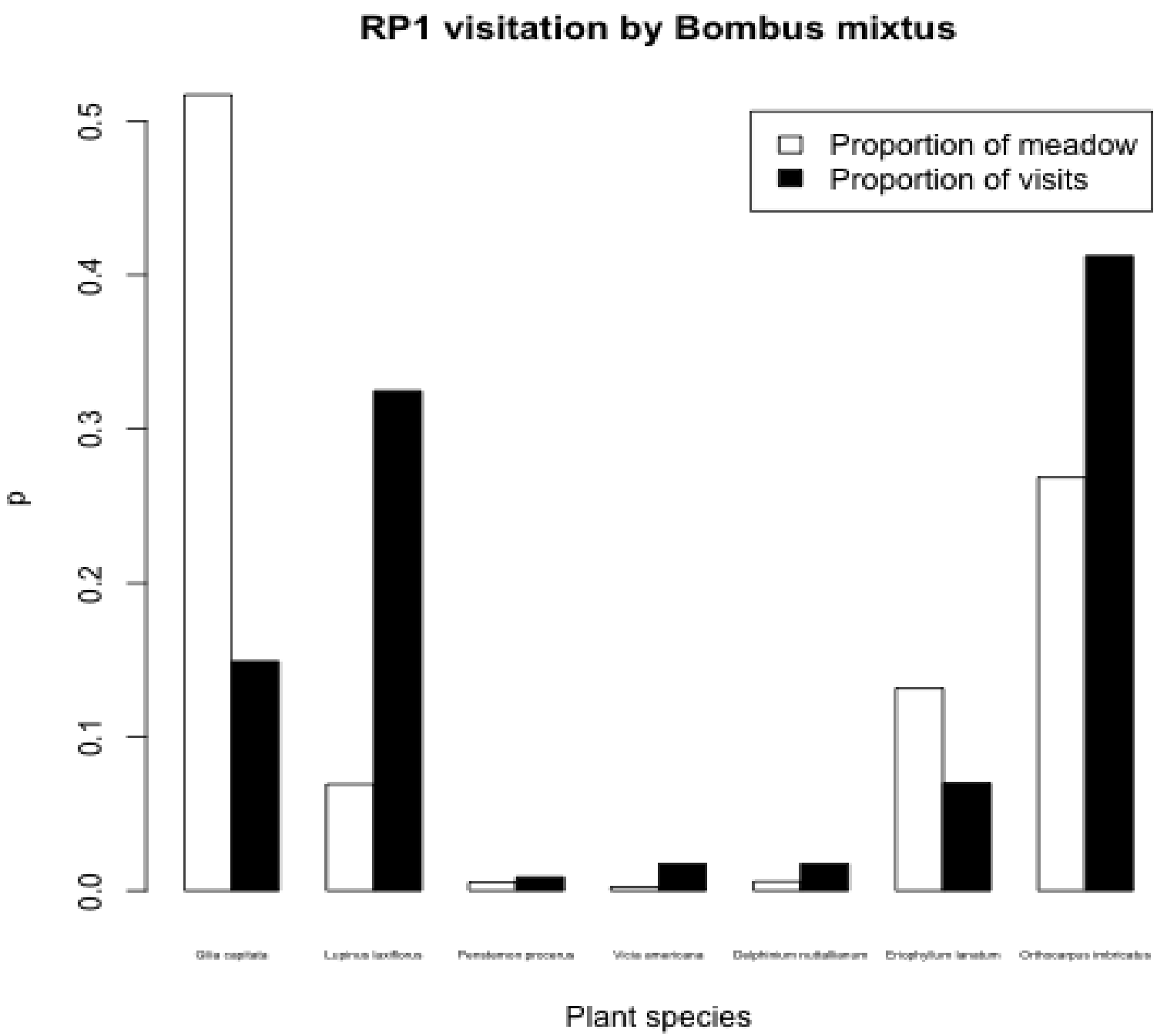
- Forbidden links
- Consider *only* observed partners?

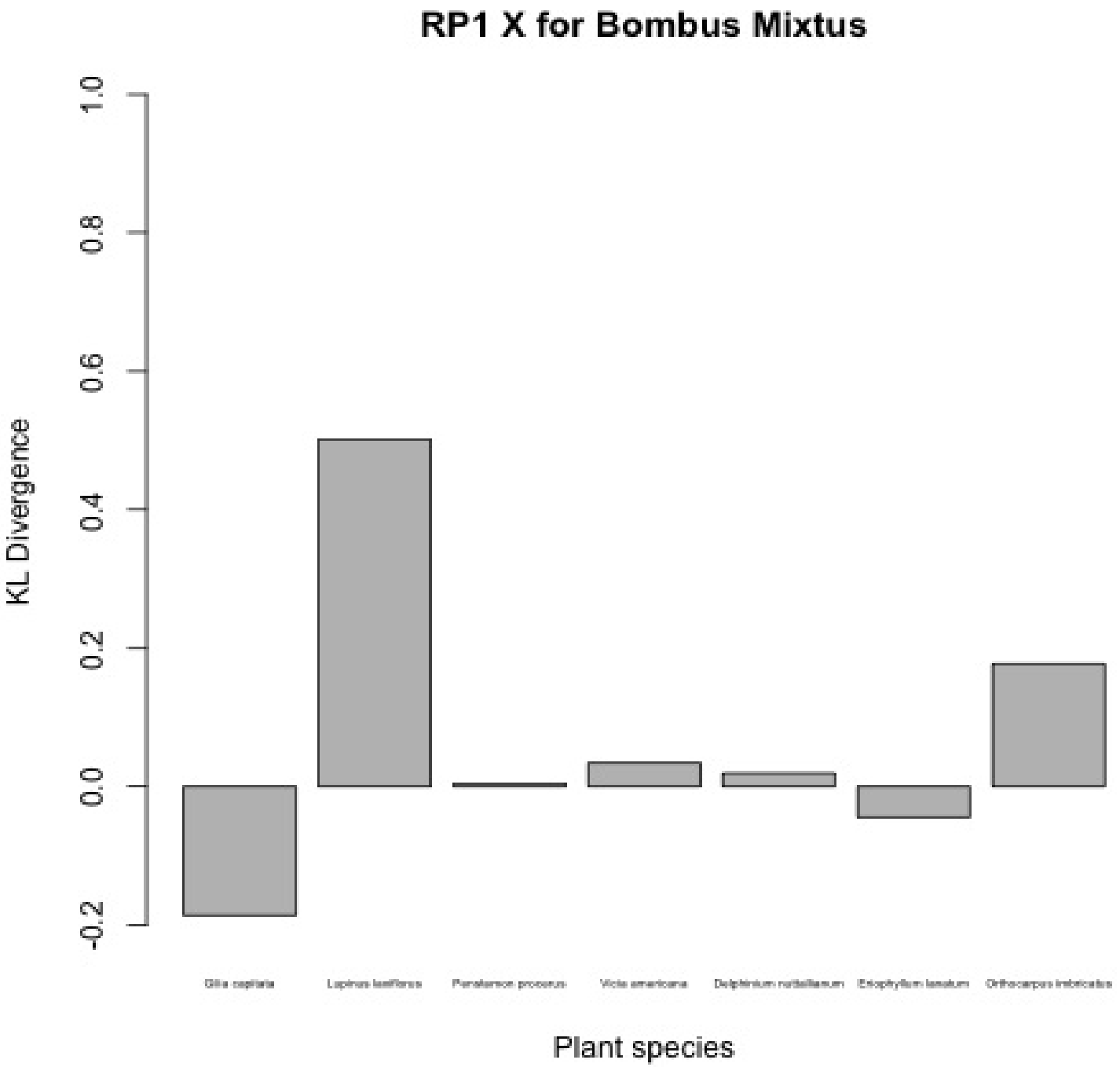
Accounting for forbidden links

- New parameter (*X*)
- Limit flowers “available” to ones we have interactions for (Fi)
- Uses
  - p'ij = Proportion of pollinator i's visits to flower j
  - f'ij = Proportion of meadow consisting of only allowable flower j
- Theoretical perfect specialist = all visits go to rarest flower in Fi

$$X_i = \sum_{j \in F_i} p'_{ij} \ln \frac{p'_{ij}}{f'_{ij}}$$

$$where\ F_i = \left\{ j \mid p'_{ij} > 0 \right\}$$


RP1 visitation by Bombus mixtus
Proportion of meadow
Proportion of visits
p
0.0
0.1
0.2
0.3
0.4
0.5
Gilia capitata
Lupinus laxiflorus
Penstemon procerus
Vicia americana
Delphinium nuttallianum
Eriophyllum lanatum
Orthocarpus imbricatus
Plant species


RP1 X for Bombus Mixtus
KL Divergence
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Gilia capitata
Lupinus latifolius
Penstemon procerus
Viola americana
Delphinium nuttallianum
Eriophyllum lanatum
Orthocarpus imbricatus
Plant species

Methods for Analyzing

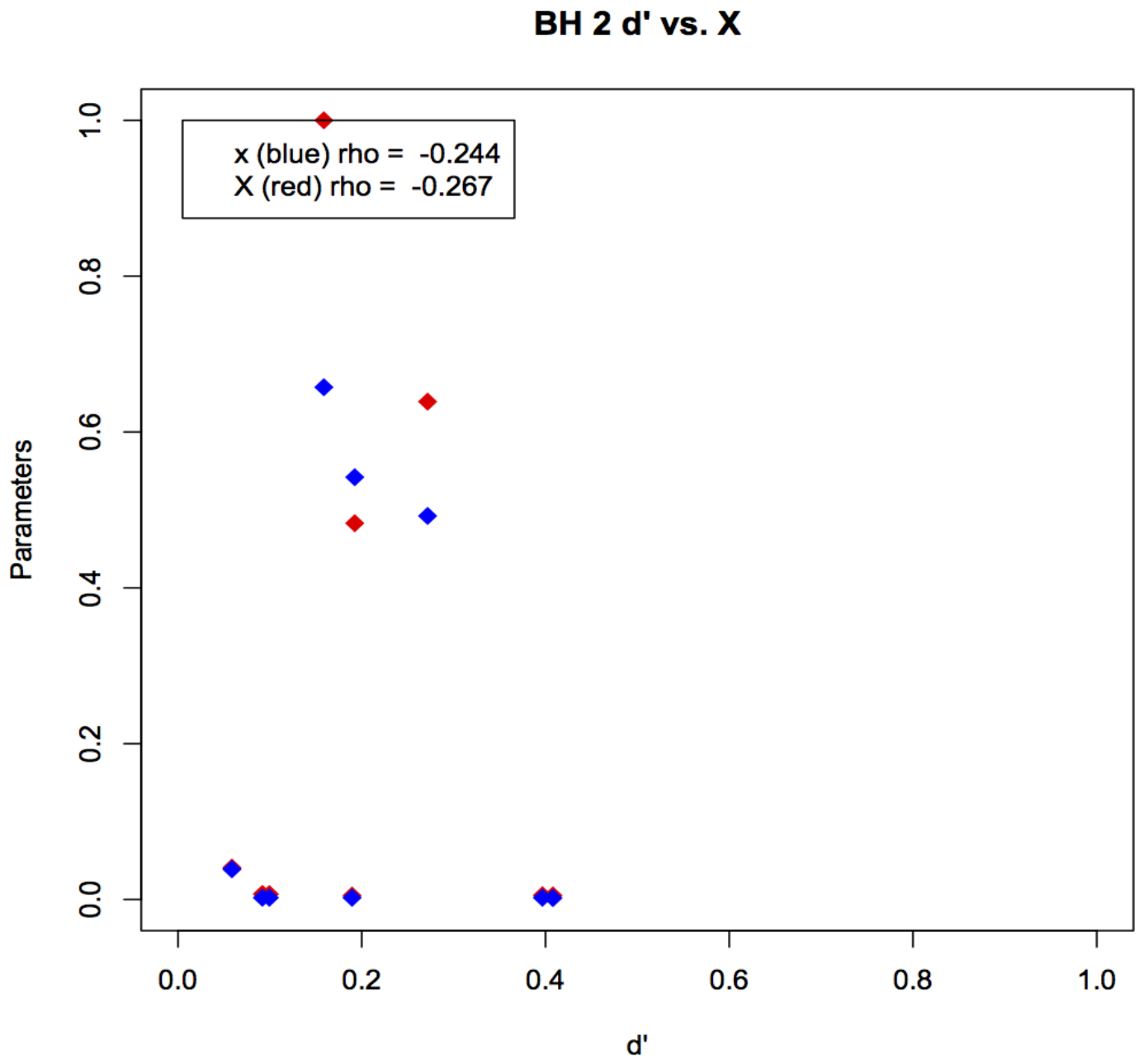
- 4 meadows observed (BD, CPM, RP1, LM)
  - Varying size from .62 ha to 3.24 ha
  - Varying in insect and plant composition
- 2 rounds observed per meadow
  - Three weeks apart
- Plotting d' vs. X, d' vs. χ
  - Known specialists, known generalists
  - Where do these values differ?

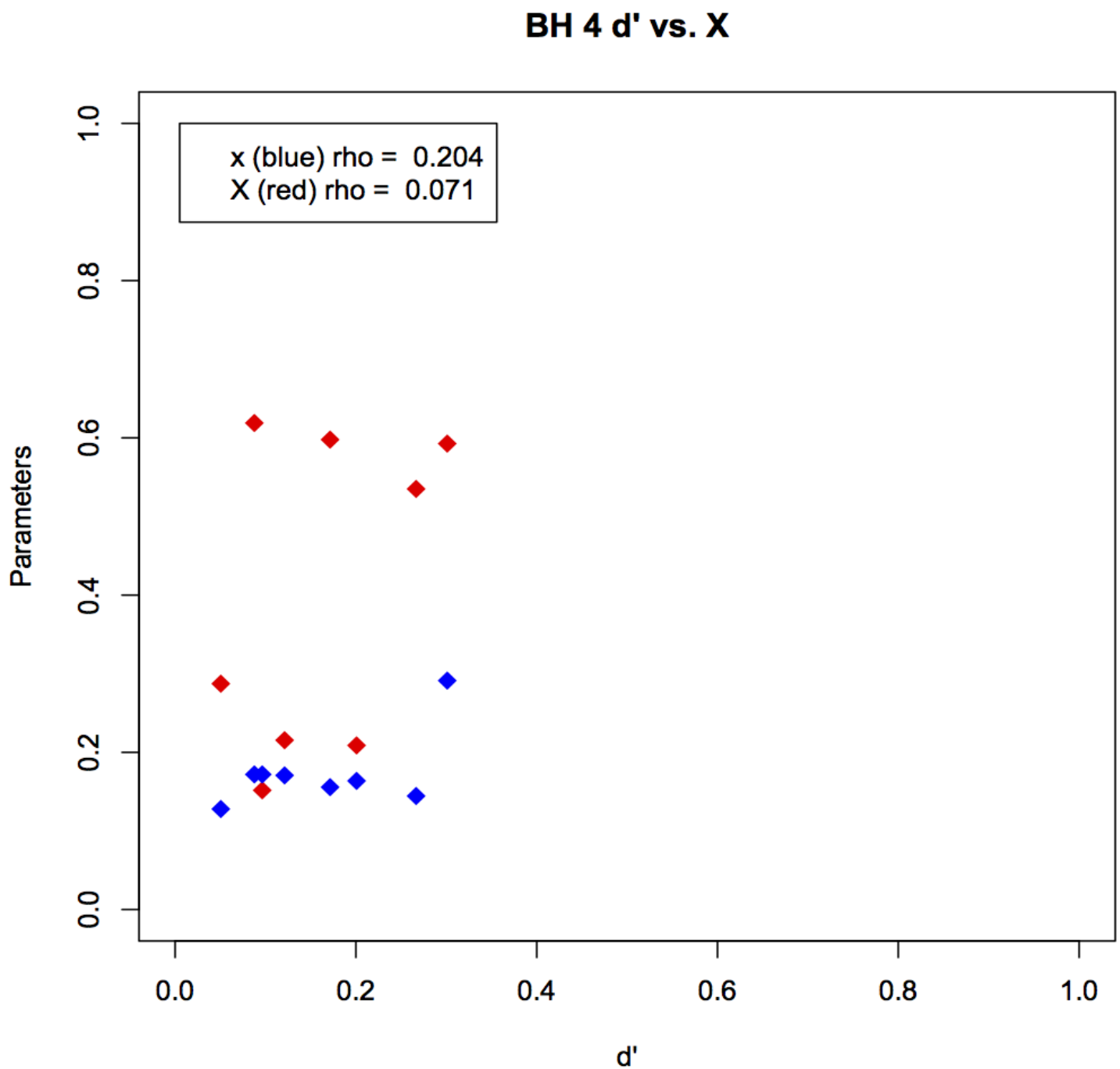
Hypotheses

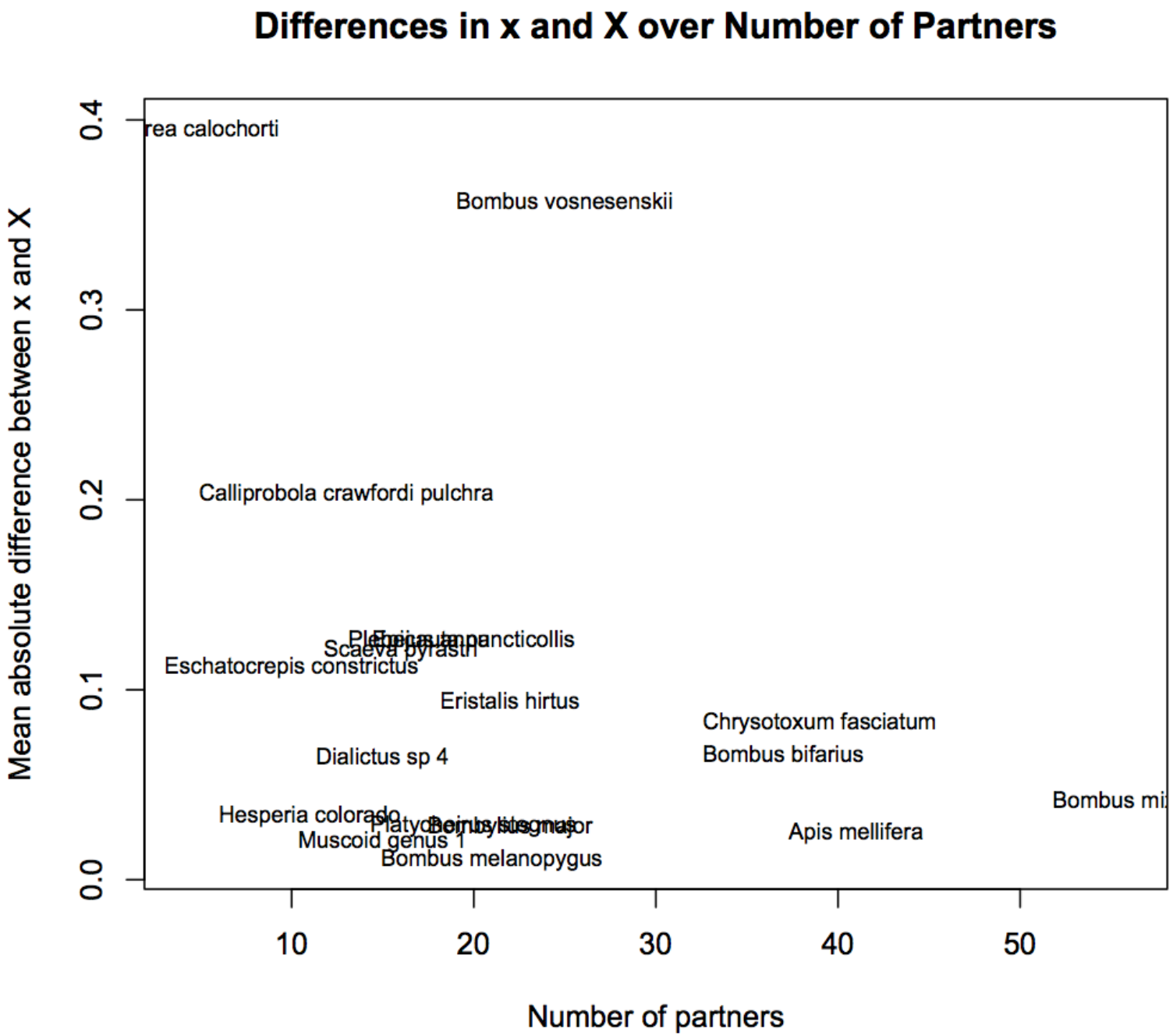
- Not including forbidden links in flower proportions will lead to differences in X and χ
- X will accurately identify generalists and specialists more often than d' or χ

Analysis

- Data set for 2011 – too many inconsistencies
- No correlation between any of the three parameters
  - Suggests flowers are not pollinated in proportion to their abundance
- *d′* fails to catch specialists when they pollinate generalist flowers
- None of three parameters directly account for species degree
  - Can be problematic for meadows dominated by one flower
- Orders only 75 % correlated between χ and X
- Differences in magnitude between χ and X increases with more forbidden links


BH 2 d' vs. X
x (blue) rho = -0.244
X (red) rho = -0.267
Parameters
d'
0.0
0.2
0.4
0.6
0.8
1.0


BH 4 d' vs. X
x (blue) rho = 0.204
X (red) rho = 0.071
Parameters
d'
0.0
0.2
0.4
0.6
0.8
1.0


Differences in x and X over Number of Partners
Mean absolute difference between x and X
Number of partners
0.0
0.1
0.2
0.3
0.4
10
20
30
40
50
rea calochorti
Bombus vosnesenskii
Calliprobola crawfordi pulchra
Scaeva pyrastri
Eschatocrepis constrictus
Eristalis hirtus
Chrysotoxum fasciatum
Bombus bifarius
Dialictus sp 4
Hesperia colorado
Muscoid genus 1
Bombus melanopygus
Apis mellifera

Conclusions

- Data set too problematic to make effectively calculate χ and X
- d' and χ are not accurate for identifying specialist species
- The more forbidden links a species has, the more divergence χ and X will have
  - X is a superior parameter for identifying specialists
- Differences in parameter values may be due to normalization