Exploring urban biodiversity patterns with iNat data

Misha Leong, California Academy of Sciences
mleong@calacademy.org


Google
Camera : 5,665 m


Courtesy of NASA/DSMP

City Nature Challenge

CITY NATURE CHALLENGE IS ORGANIZED BY

CALIFORNIA ACADEMY OF SCIENCES

NATURAL HISTORY MUSEUM
LOS ANGELES COUNTY

2016

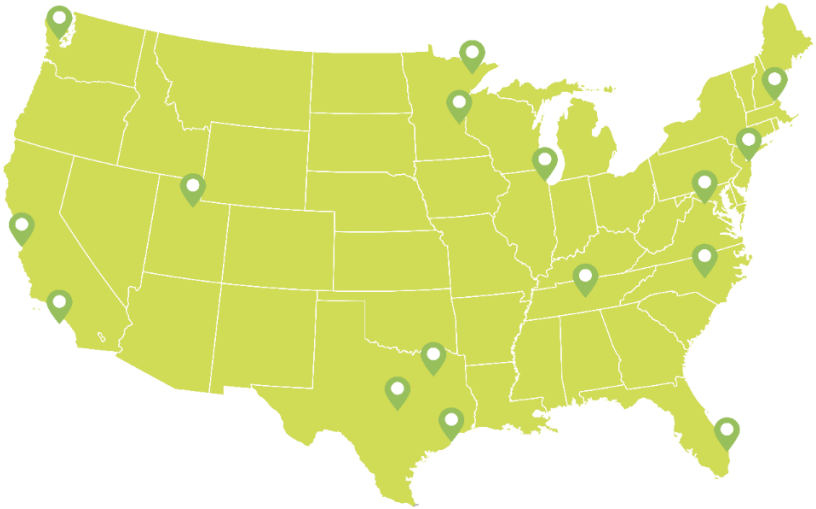
2 cities

1K people

20K obs

2.5K species

2017



16 cities took part

- Austin
- Boston
- Chicago
- Dallas/Fort Worth
- D.C.
- Duluth
- Houston
- Los Angeles
- Miami
- Minneapolis/St. Paul
- Nashville
- New York
- Raleigh
- Salt Lake City
- San Francisco
- Seattle

16 cities **4K people** **125K obs** **8.6K species**

2018

63+ cities

17K people

430K obs

19K species

Urban Homogenization Hypothesis

As urbanization intensifies, does biodiversity become more similar?

Are certain taxa more susceptible?

Which species are "winners" vs "losers" with urbanization?

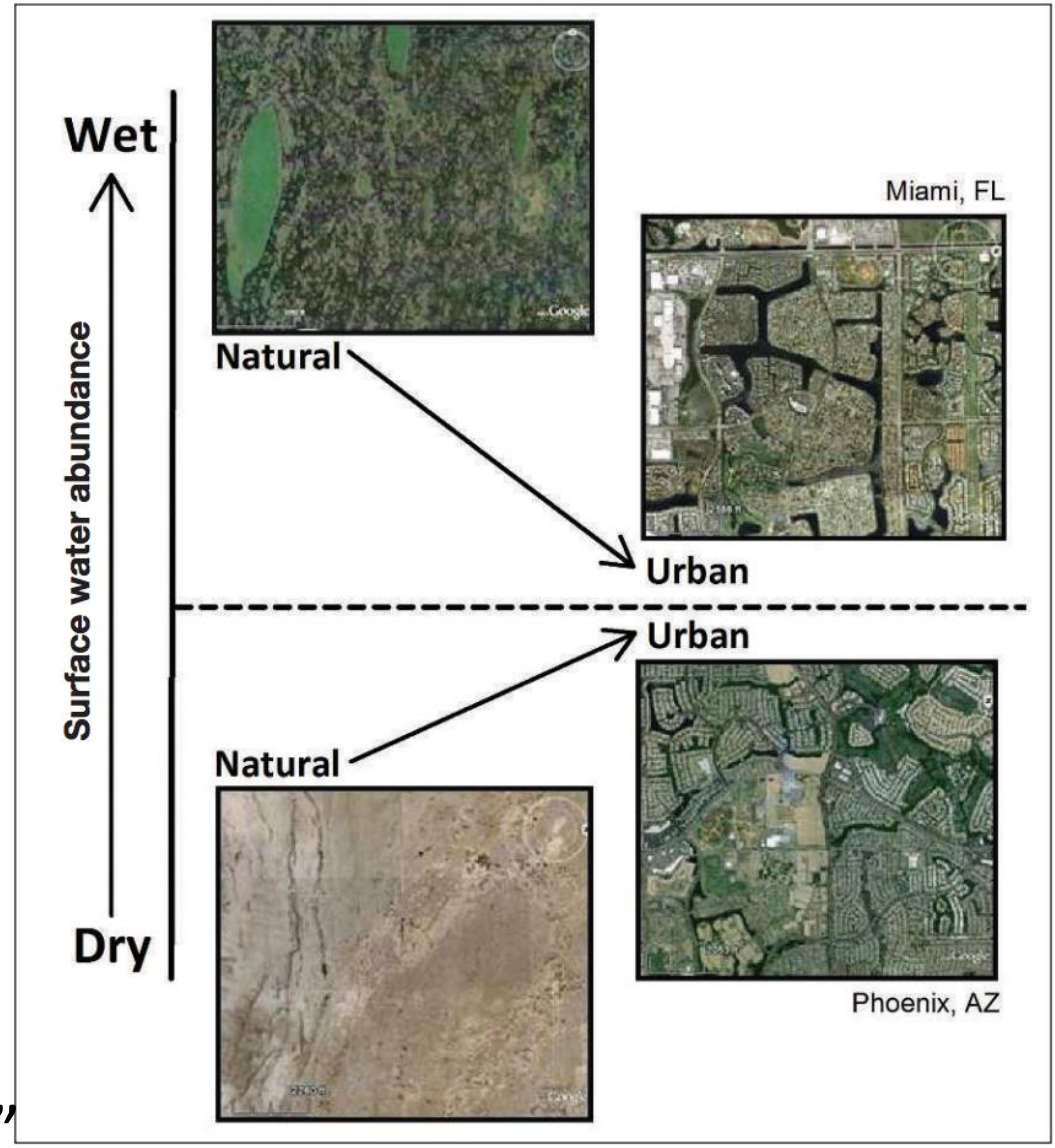
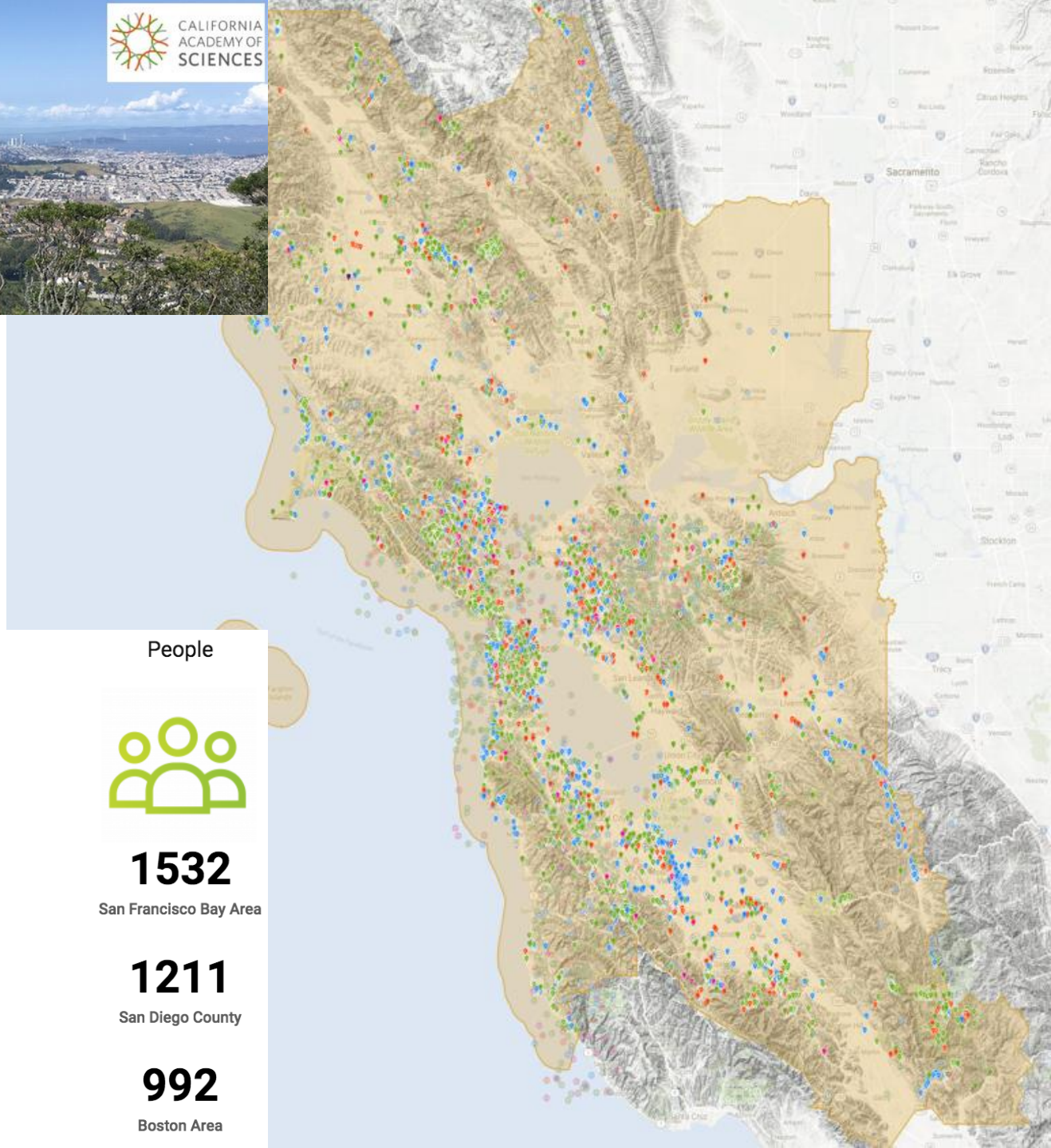


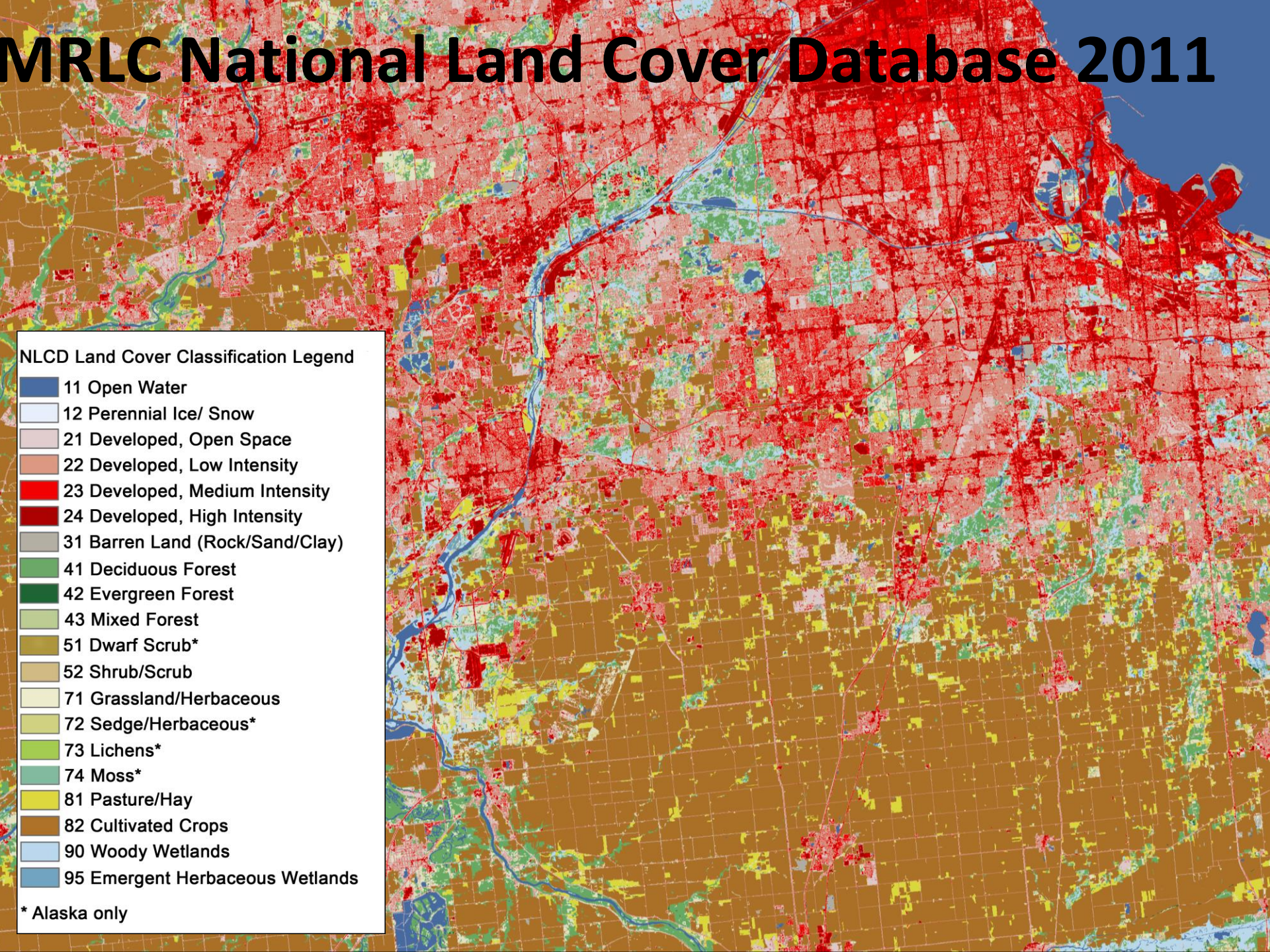
Figure 5. *Urban homogenization should lead to a decrease or alteration in surface waterbodies in humid regions (eg Miami) and an increase in arid regions (eg Phoenix), such that the hydrography of urban ecosystems in these diverse regions are more similar than the hydrography of the native ecosystems that they replaced.*

Groffman et al, *Front Ecol Envrion*, 2014



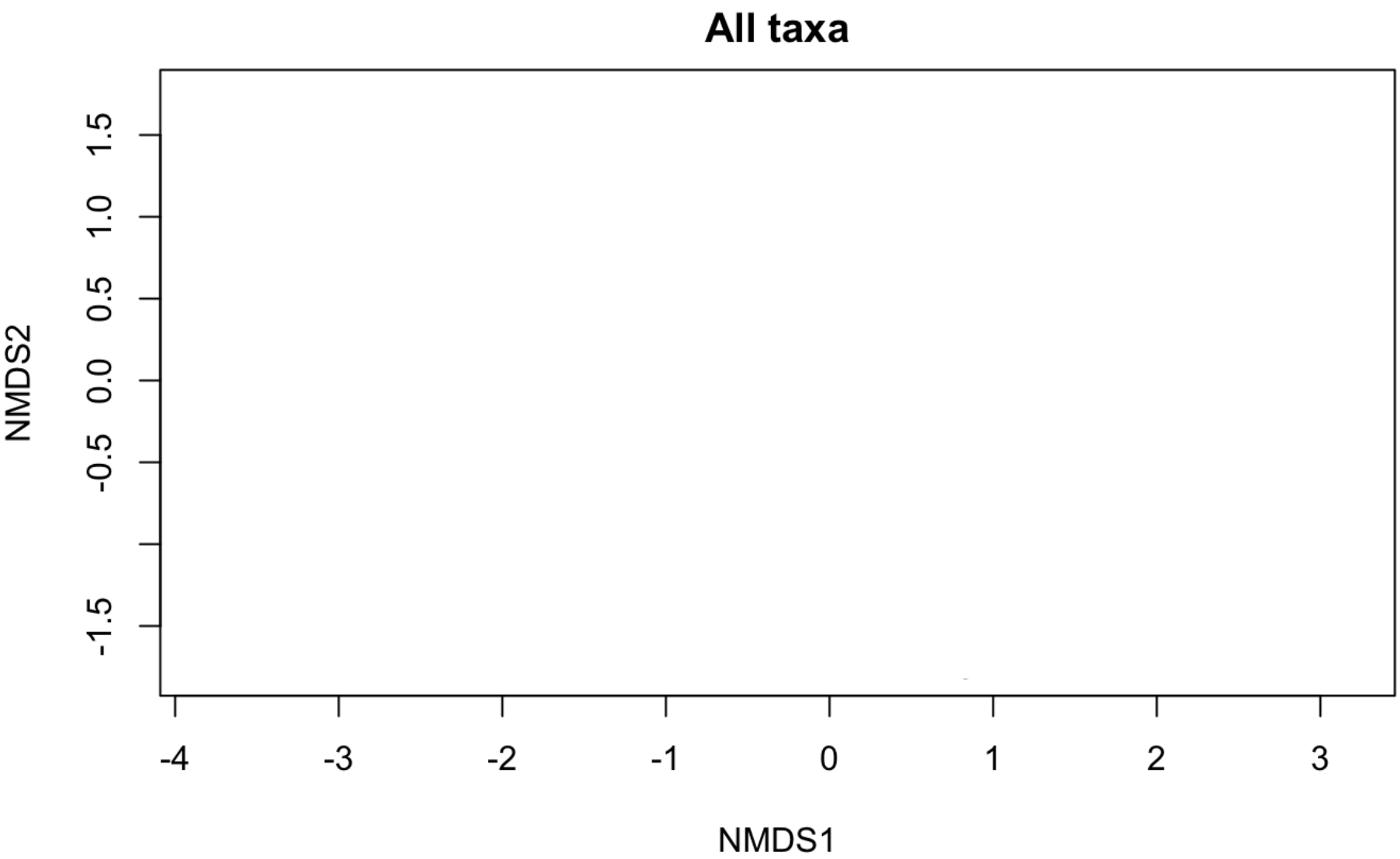
Observations	Species	People
41737 San Francisco Bay Area	**3211** San Francisco Bay Area	**1532** San Francisco Bay Area
34218 Dallas/Fort Worth	**3088** Houston	**1211** San Diego County
33448 San Diego County	**2946** San Diego County	**992** Boston Area

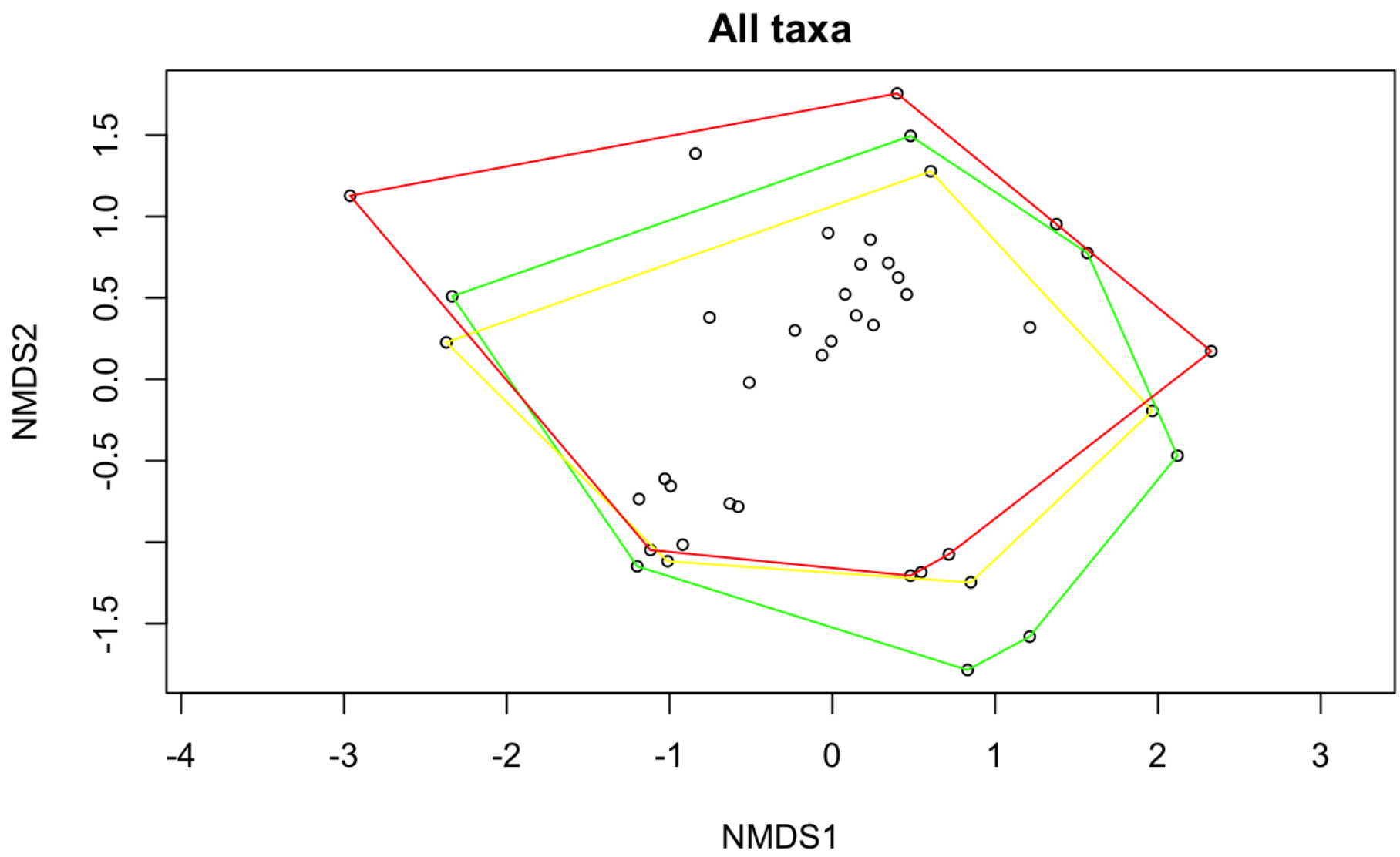
MRLC National Land Cover Database 2011



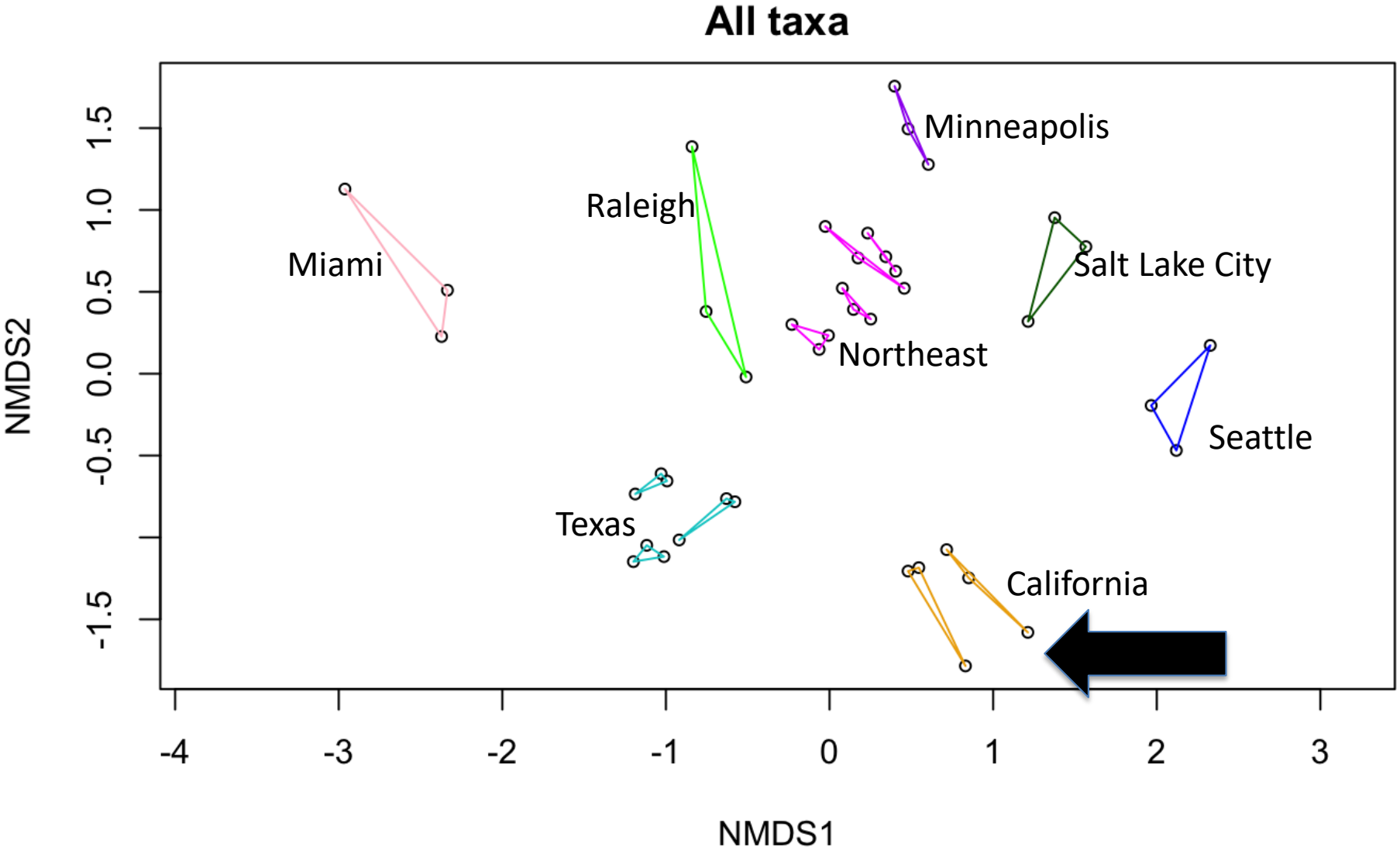
As urbanization intensifies, does biodiversity become more similar?

- NMDS
  - ex. Is the community composition of highly urbanized Chicago more similar to natural Chicago or highly urbanized Houston?)
- PERMANOVA
  - adonis(formula = all_matrix ~ all_env$landcover_group, data = all_env, permutations = 999, strata = all_env$hometown)


All taxa
NMDS2
1.5
1.0
0.5
0.0
-0.5
-1.5
-4
-3
-2
-1
0
1
2
3
NMDS1


All taxa
NMDS2
1.5
1.0
0.5
0.0
-0.5
-1.5
-4
-3
-2
-1
0
1
2
3
NMDS1

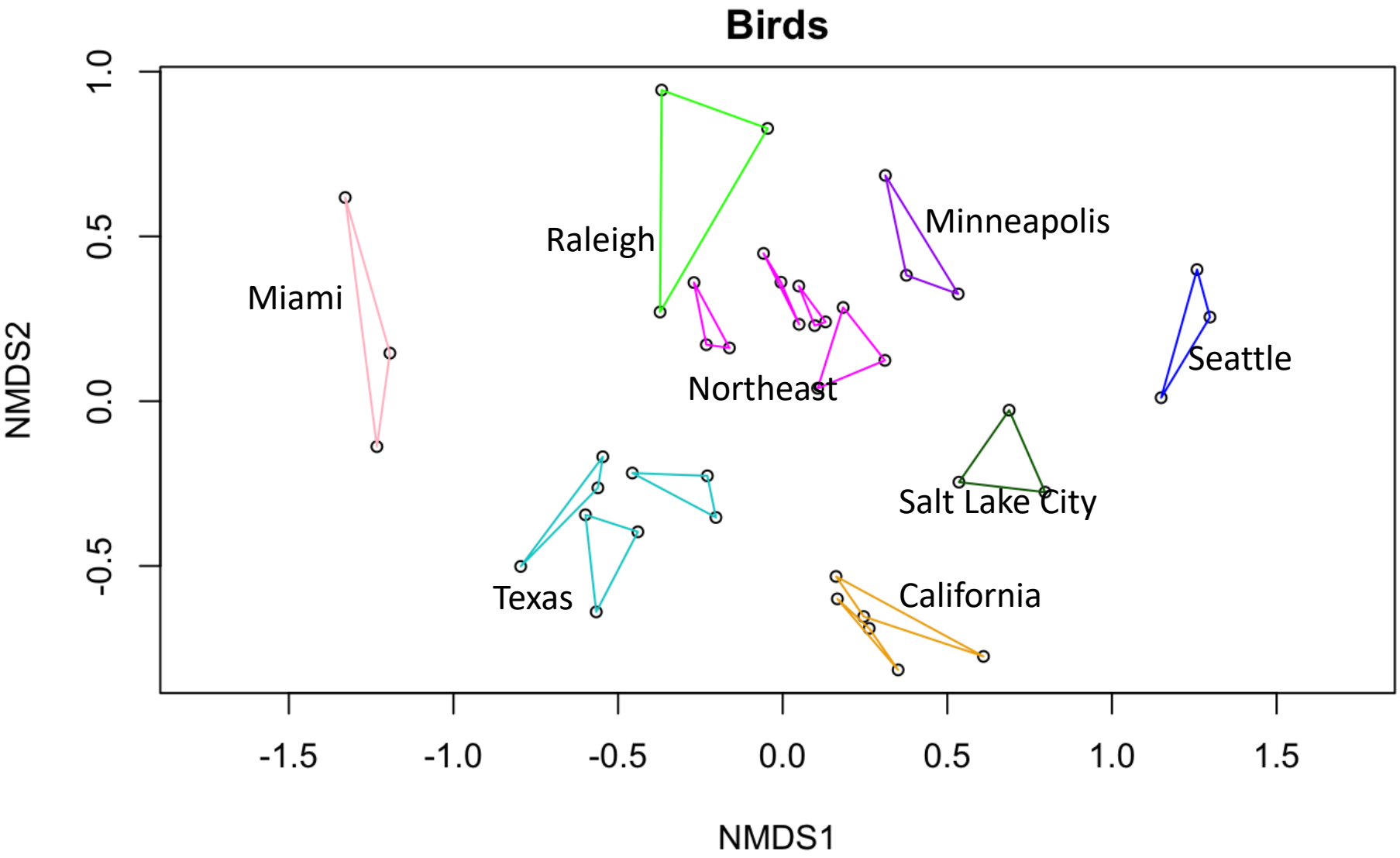
Stress = 0.156; Procrustes: rmse 5.03e-05; max residual 0.0002



PERMANOVA$_{NLCD(city)}$
$p < 0.001$; $R^2 = 0.05$

PERMANOVA$_{city(NLCD)}$
$p < 0.001$; $R^2 = 0.70$

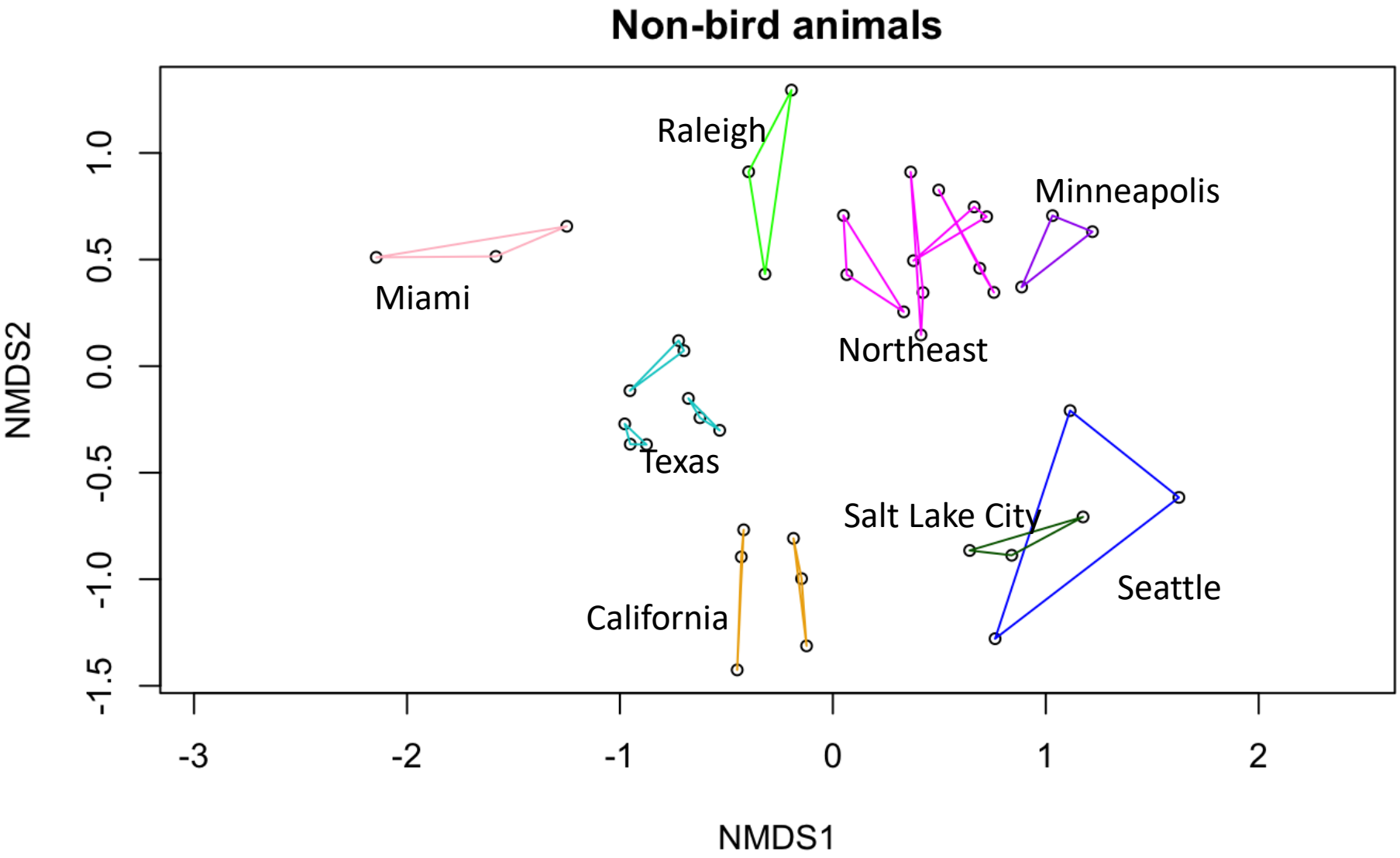
Stress = 0.20; Procrustes: rmse 0.01566; max residual 0.0703



$PERMANOVA_{NLCD(city)}$
$p < 0.001$; $R^2 = 0.08$

$PERMANOVA_{city(NLCD)}$
$p < 0.001$; $R^2 = 0.64$

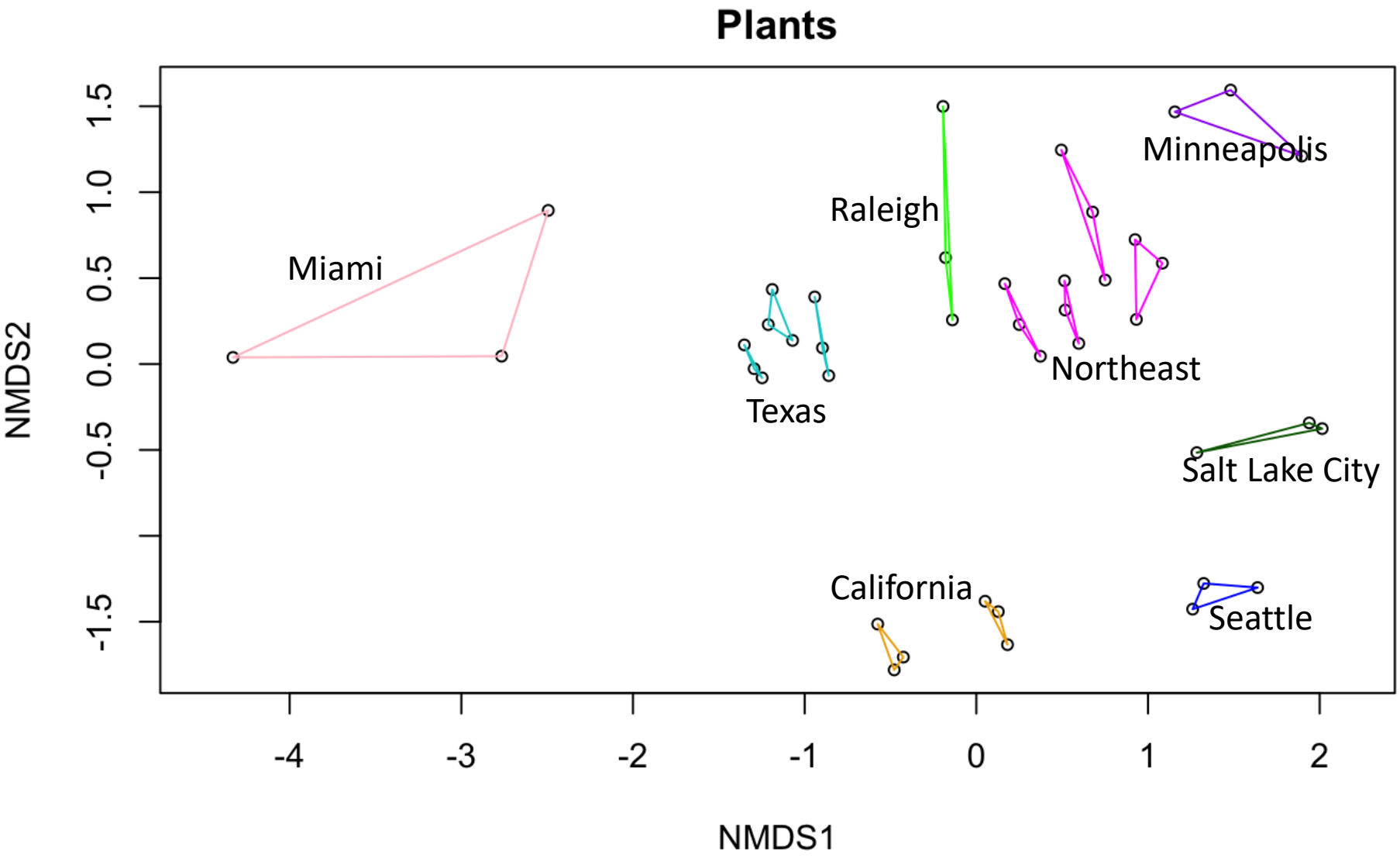
Stress = 0.1977; Procrustes: rmse 0.00836; max residual 0.0378



$PERMANOVA_{NLCD(city)}$
$p < 0.001$; $R^2 = 0.05$

$PERMANOVA_{city(NLCD)}$
$p < 0.001$; $R^2 = 0.66$

Stress = 0.133; Procrustes: rmse 0.0031; max residual 0.0135



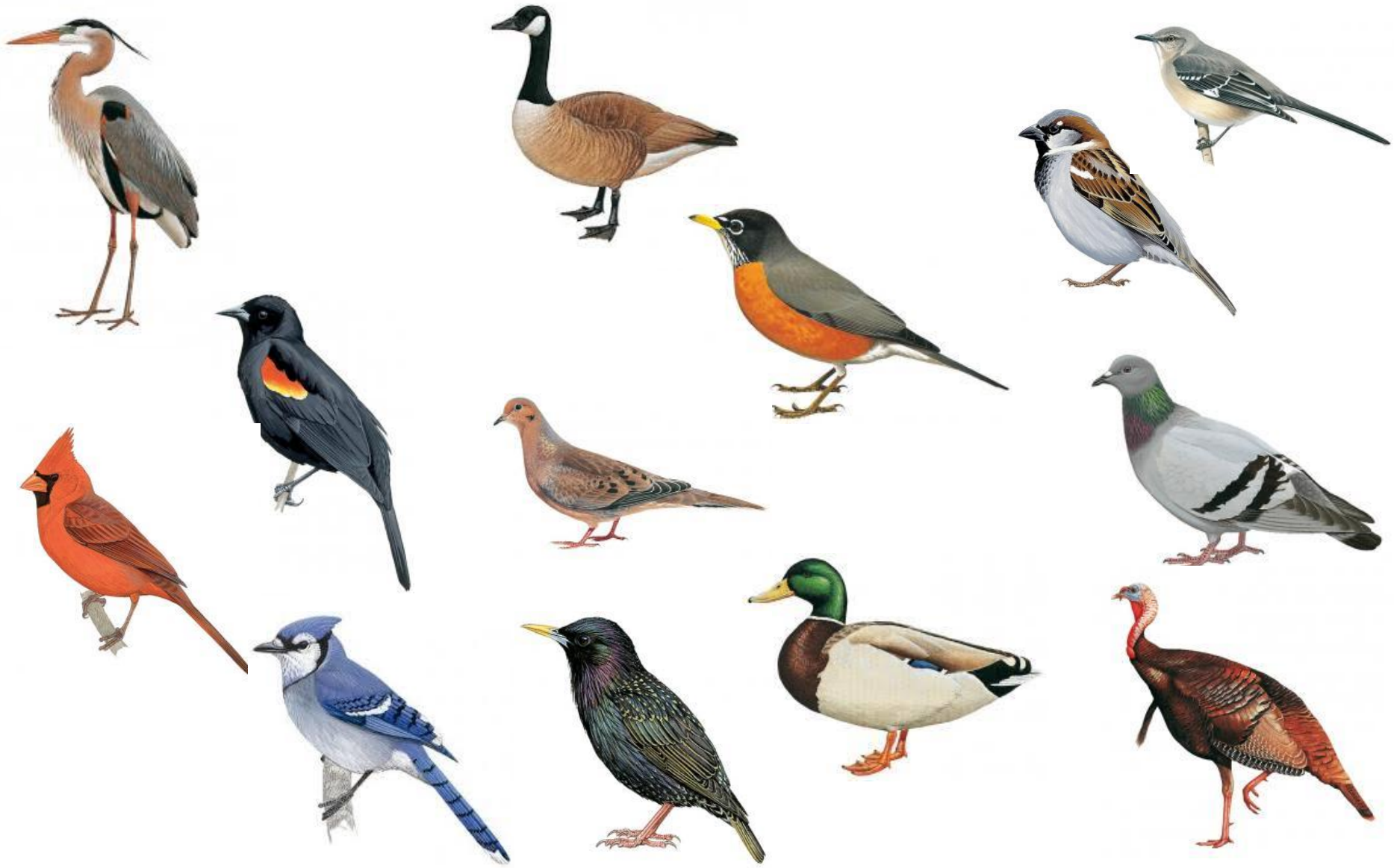
PERMANOVA$_{NLCD(city)}$
$p < 0.001$; $R^2 = 0.04$

PERMANOVA$_{city(NLCD)}$
$p < 0.001$; $R^2 = 0.71$

Most common species

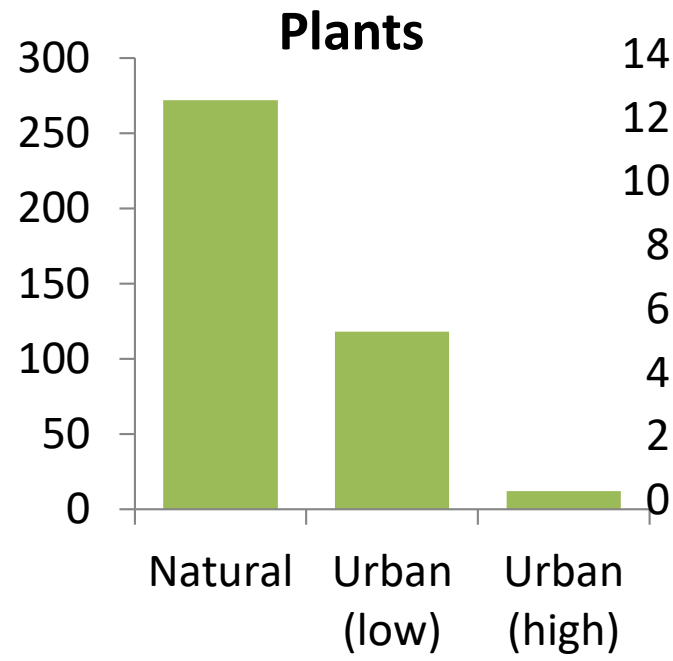
- Divided species by taxa
- Ranked them in order of most to least frequently observed by land use type, nested by city

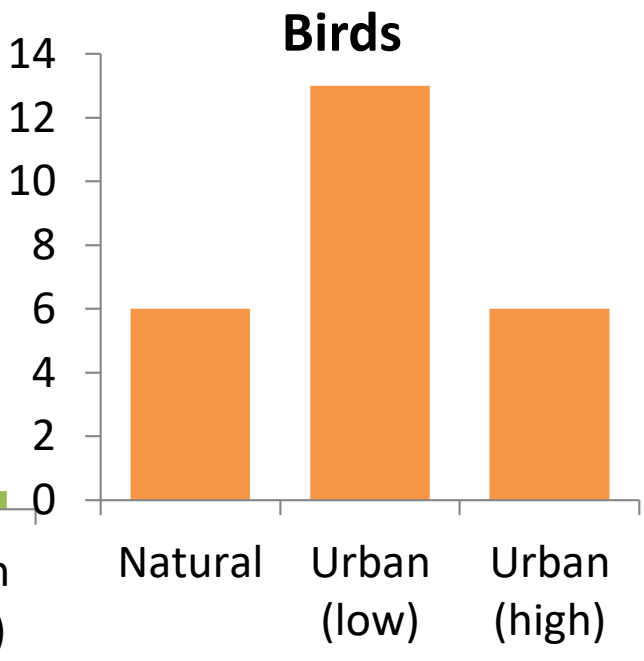
Natural ⟵ Everywhere ⟶ Urban

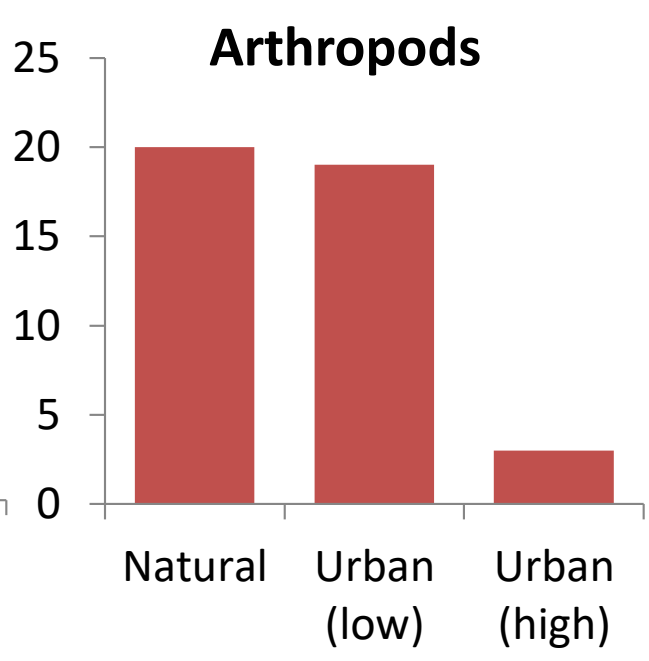


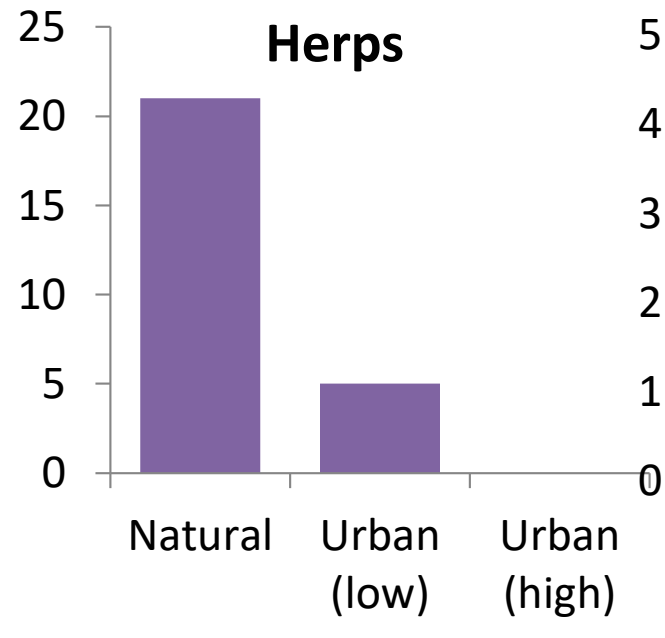
Over-representation

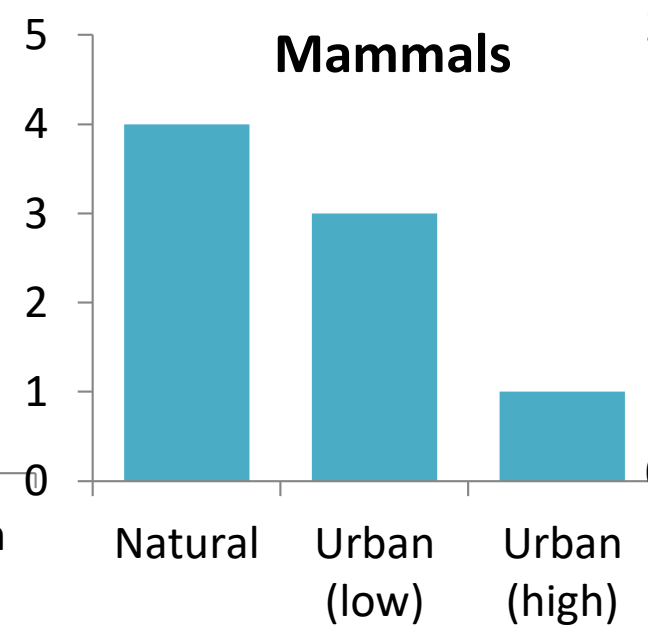
1. Filtered out species found at least 10 times.
2. Divided # of times found in each land use type by total # of times found.
3. If this proportion was greater than 0.33 + 1 sd, considered it “over-represented)”

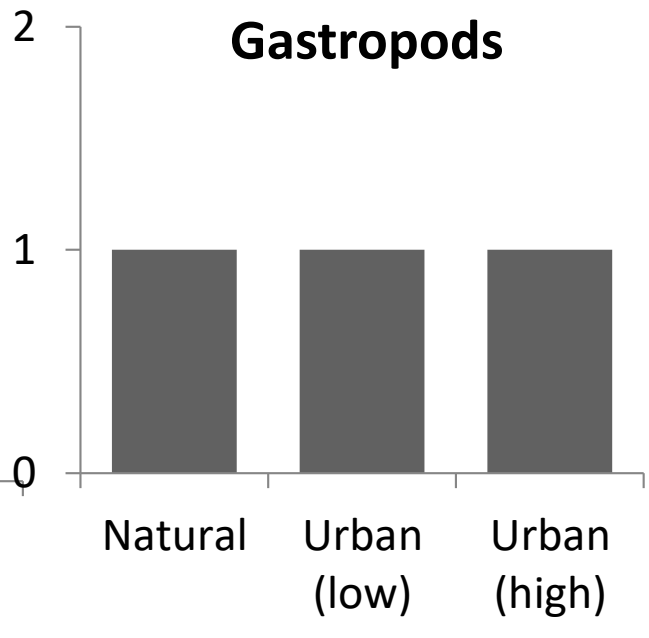

Plants
300
250
200
150
100
50
0
Natural
Urban (low)
Urban (high)


Birds
14
12
10
8
6
4
2
0
Natural
Urban (low)
Urban (high)


Arthropods
25
20
15
10
5
0
Natural
Urban (low)
Urban (high)


Herps
25
20
15
10
5
0
Natural
Urban (low)
Urban (high)


Mammals
5
4
3
2
1
0
Natural
Urban (low)
Urban (high)


Gastropods
2
1
0
Natural
Urban (low)
Urban (high)

Over-representation in high urban

- Birds
  - Columba livia (pigeon)
  - Zenaida asiatica (mourning dove)
  - Passer domesticus (house sparrow)
  - Spinus psaltria (goldfinch)
  - Pica hudsonia (magpie)
- Arthropods
  - Schistocerca nitens (grasshopper)
  - Polistes dominula (European paper wasp)
  - Aphis nerii (oleander aphid)
- Mammals
  - Otospermophilus beecheyi (California ground squirrel)
- Gastropods
  - Cepaea nemoralis (grove snail)

Future work

- Expansion
  - Specialization indices and trait data
  - International comparisons
- Methodology
  - 2016 vs 2017 vs 2018
  - Research grade versus verifiable observations
  - CNC vs general iNat vs GBIF

THANKS!

Misha Leong, California Academy of Sciences
mleong@calacademy.org