seed dispersal of great basin plants

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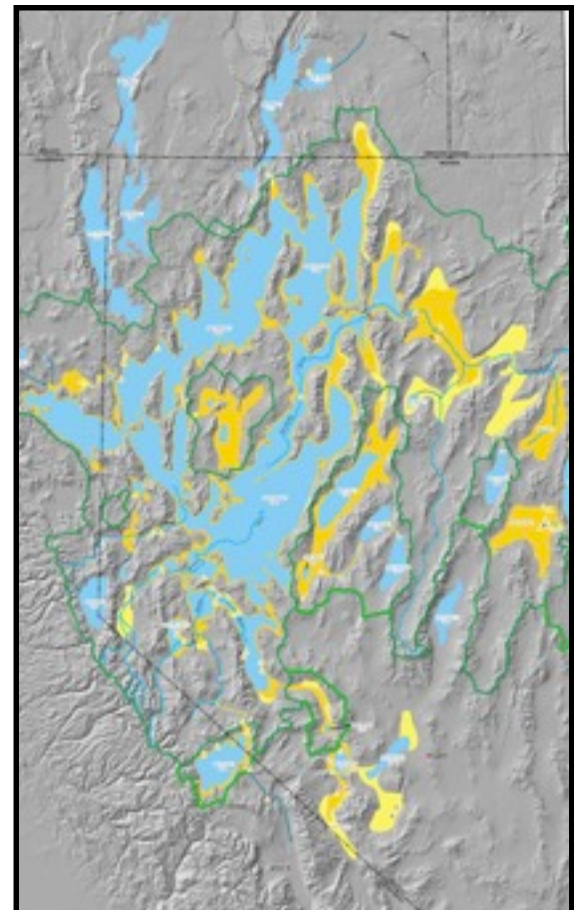
northern california botanists 2013 symposium
15 january 2013

outline

beginnings

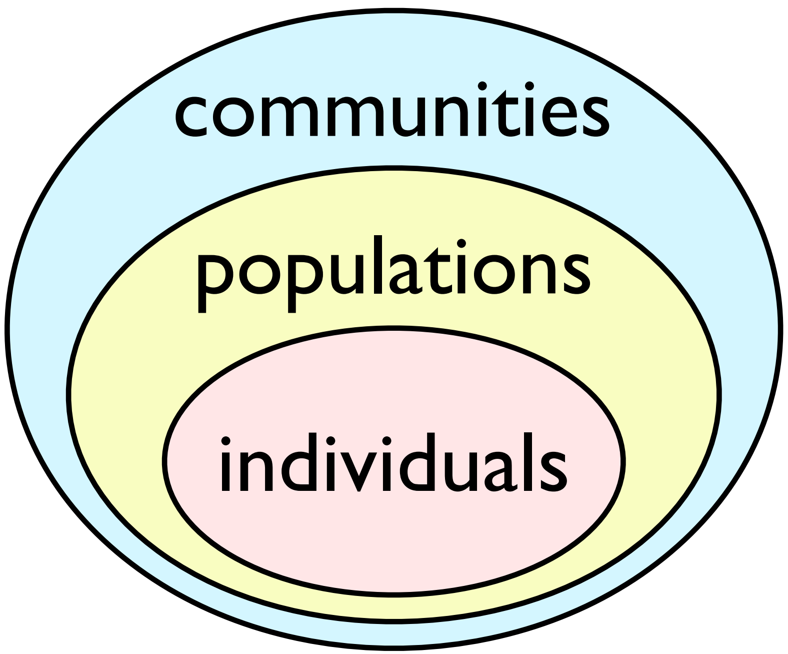
learning

future directions



dispersal

scale of biological organization



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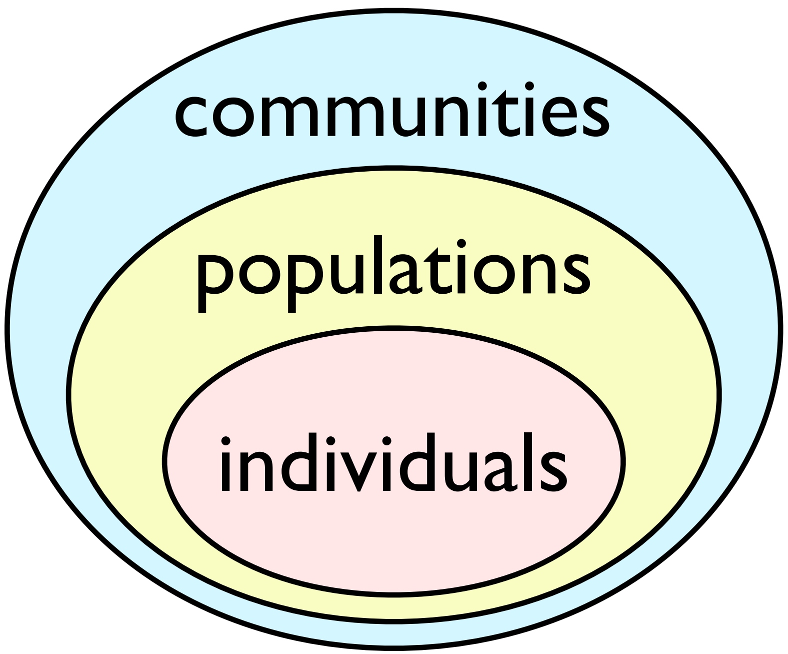
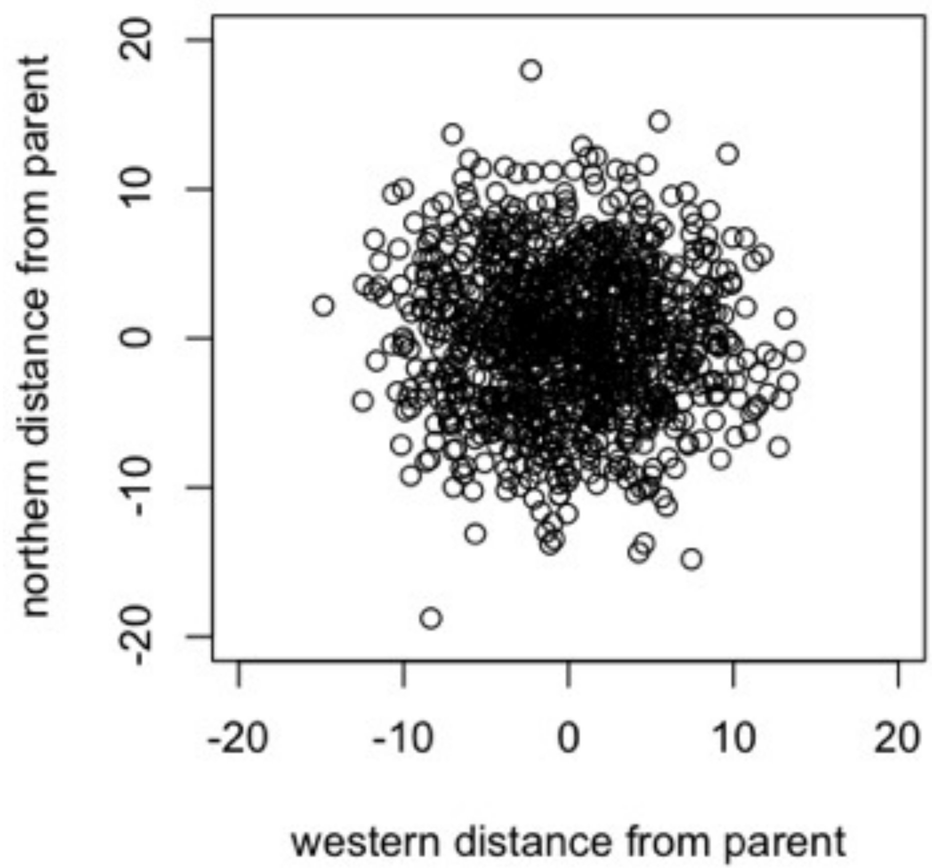


individuals from a parent



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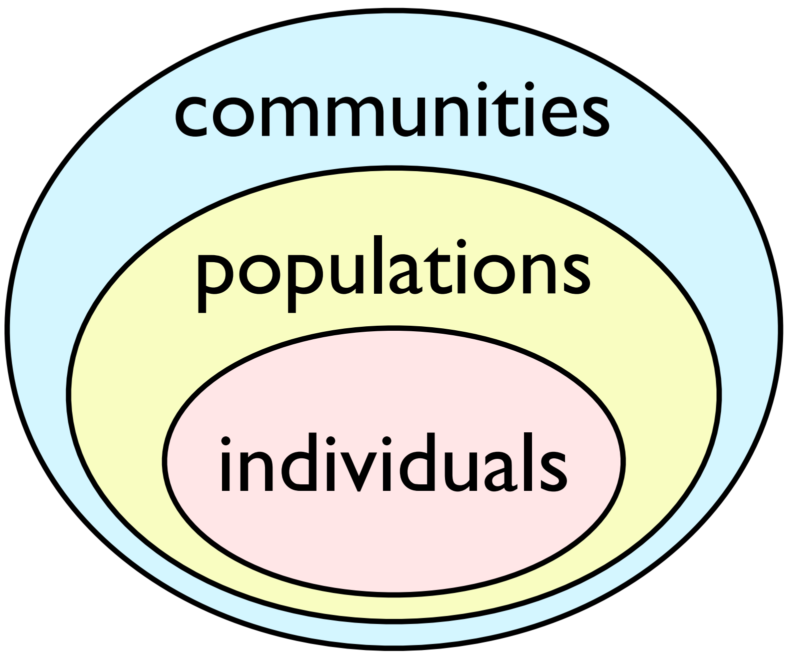
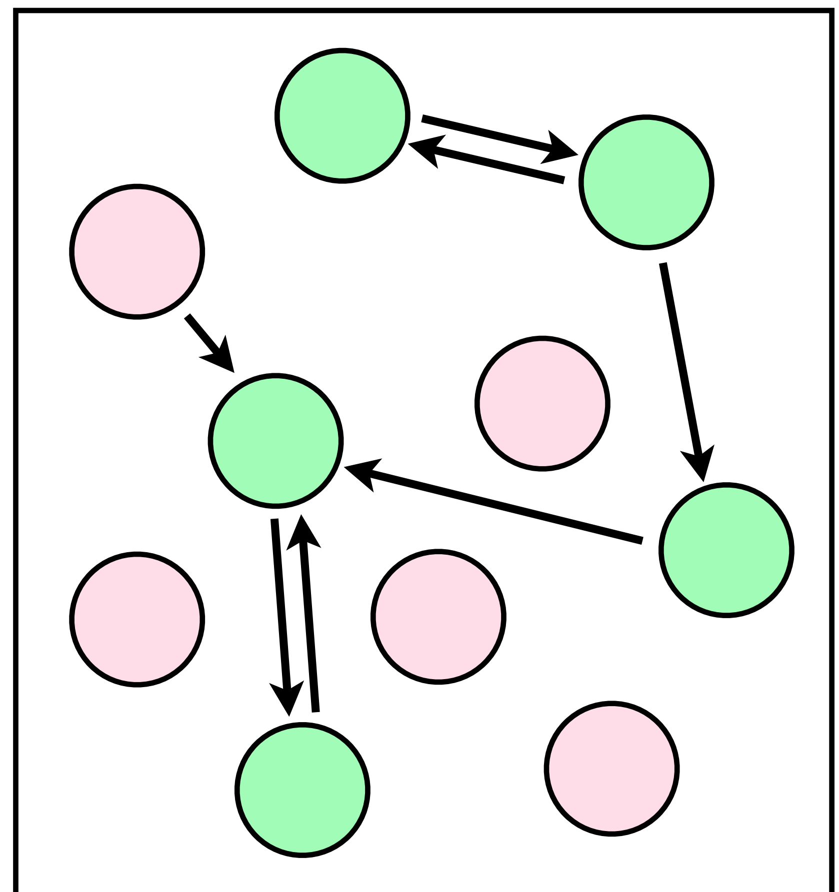


populations on a landscape



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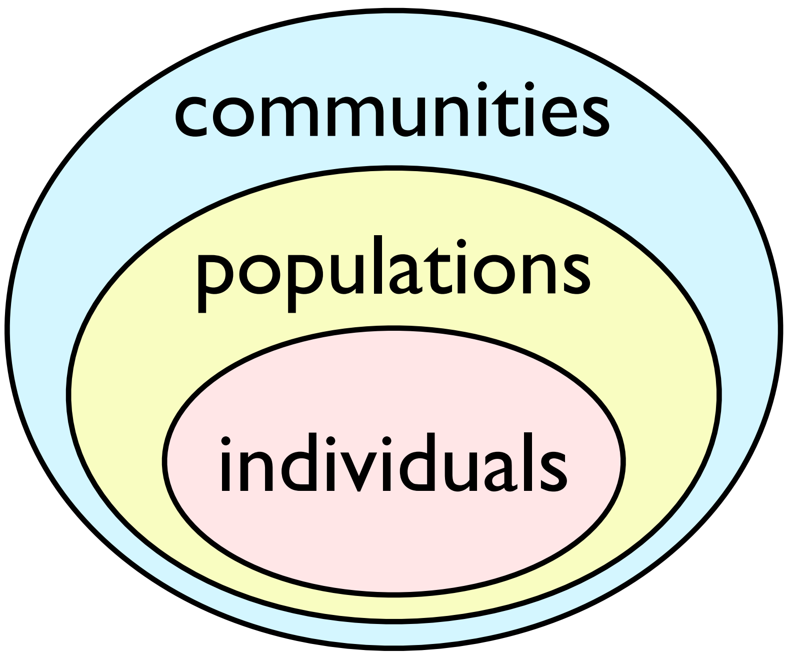
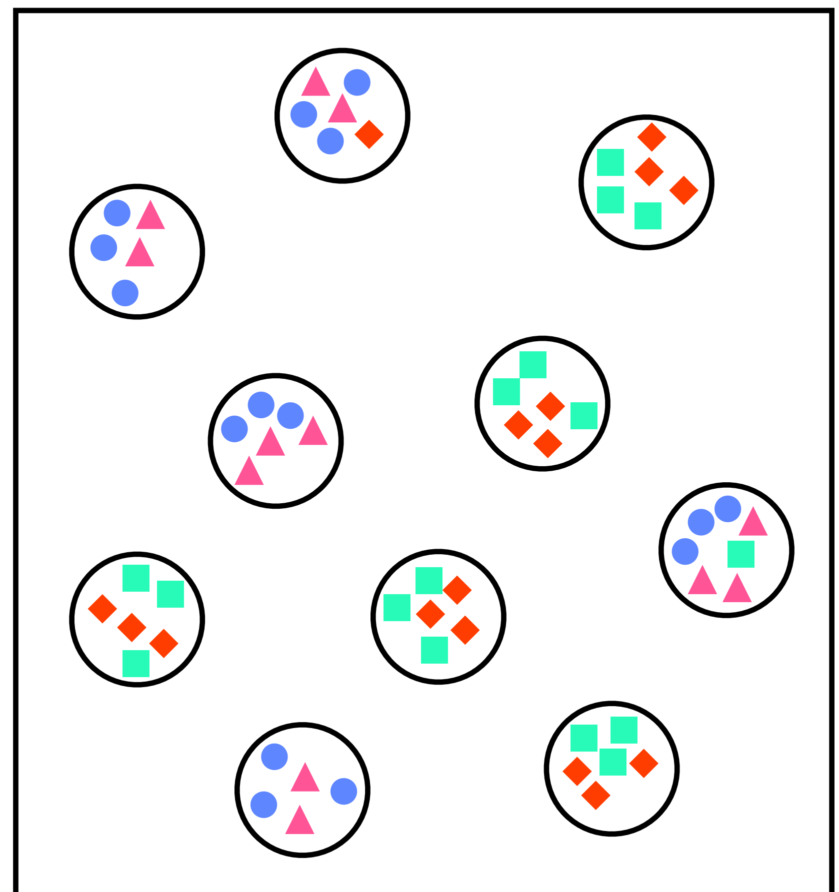


communities on a landscape



EVOLUTION

INTERNATIONAL JOURNAL OF ORGANIC EVOLUTION

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Vol. 17 DECEMBER, 1963 No. 4

AN EQUILIBRIUM THEORY OF INSULAR ZOOGEOGRAPHY

Robert H. MacArthur[1] and Edward O. Wilson[2]

Received March 1, 1963

The Fauna–Area Curve

As the area of sampling A increases in an ecologically uniform area, the number of plant and animal species s increases in an approximately logarithmic manner, or

$$s = bA^k, \tag{1}$$

where $k < 1$, as shown most recently in in the detailed analysis of Preston (1962). The same relationship holds for islands, where, as one of us has noted (Wilson, 1961), the parameters b and k vary among taxa. Thus, in the ponerine ants of Melanesia and the Moluccas, k (which might be called the *faunal coefficient*) is approximately 0.5 where area is measured in square miles; in the Carabidae and herpetofauna of the Greater Antilles and associated islands, 0.3; in the land and freshwater birds of Indonesia, 0.4; and in the islands of the Sahul Shelf (New Guinea and environs), 0.5.

The Distance Effect in Pacific Birds

The relation of number of land and freshwater bird species to area is very orderly in the closely grouped Sunda Islands (fig. 1), but somewhat less so in the islands of Melanesia, Micronesia, and Polynesia taken together (fig. 2). The greater variance of the latter group is attributable primarily to one variable, distance between the islands. In particular, the distance effect can be illustrated by taking the distance from the primary faunal "source area" of Melanesia and relating it to faunal number in the following manner. From fig. 2, take the line connecting New Guinea and the nearby Kei Islands as a "saturation curve" (other lines would be adequate but less suitable to the purpose), calculate the predicted range of "saturation" values among "saturated" islands of varying area from the curve, then take calculated "percentage saturation" as $s_i \times 100/B_i$, where s_i is the real number of species on any island and B_i the saturation number for islands of that area. As shown in fig. 3, the percentage saturation is nicely correlated in an inverse manner with distance from New Guinea. This allows quantification of the rule expressed qualitatively by past authors (see Mayr, 1940) that island faunas become progressively "impoverished" with distance from the nearest land mass.

[1] Division of Biology, University of Pennsylvania, Philadelphia, Pennsylvania.

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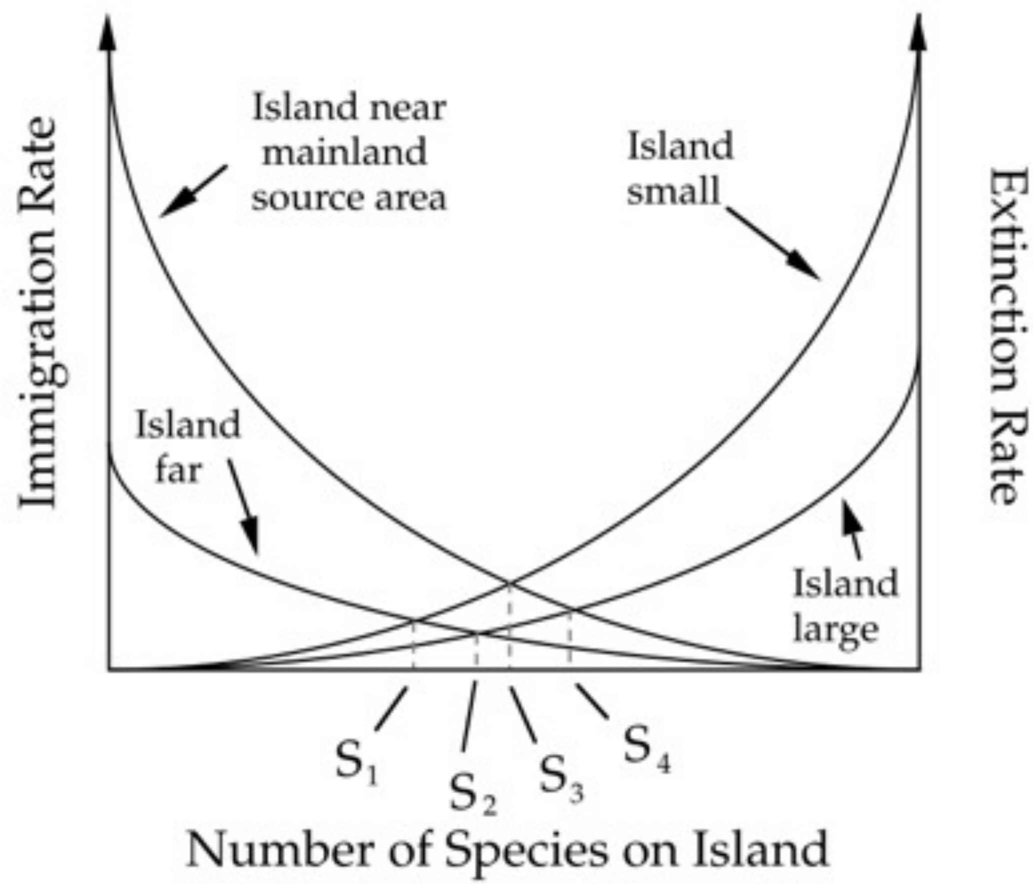

(Munroe 1948; MacArthur and Wilson 1963, 1967)

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GREAT BASIN NATURALIST MEMOIR

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INTERMOUNTAIN BIOGEOGRAPHY: A SYMPOSIUM

Yellowstone Natl. Pk.
SAWTOOTH MTNS.
Cassia Mtns.
Albion Mtns.
Warner Mtns.
Santa Rosa R.
Jarbridge Mtns.
Raft R. Mtns.
N. WASATCH MTNS.
Lassen Natl. Pk.
Red Butte
Mt. Timpanogos
Uinta Mtns.
Ruby Mtns.
SIERRA BACKBONE
Deep Cr. R.
E. Tintics Mtns.
Sagehen Cr.
Toiyabe R.
Wheeler Peak
White Mtns.
Bryce Canyon Natl. Pk.
Pine V. Mtns.
Sequoia-Kings Canyon Natl. Pk.
Spring R.
Kaibab Plateau
G. Canyon

THE FLORA OF GREAT BASIN MOUNTAIN RANGES: DIVERSITY, SOURCES, AND DISPERSAL ECOLOGY

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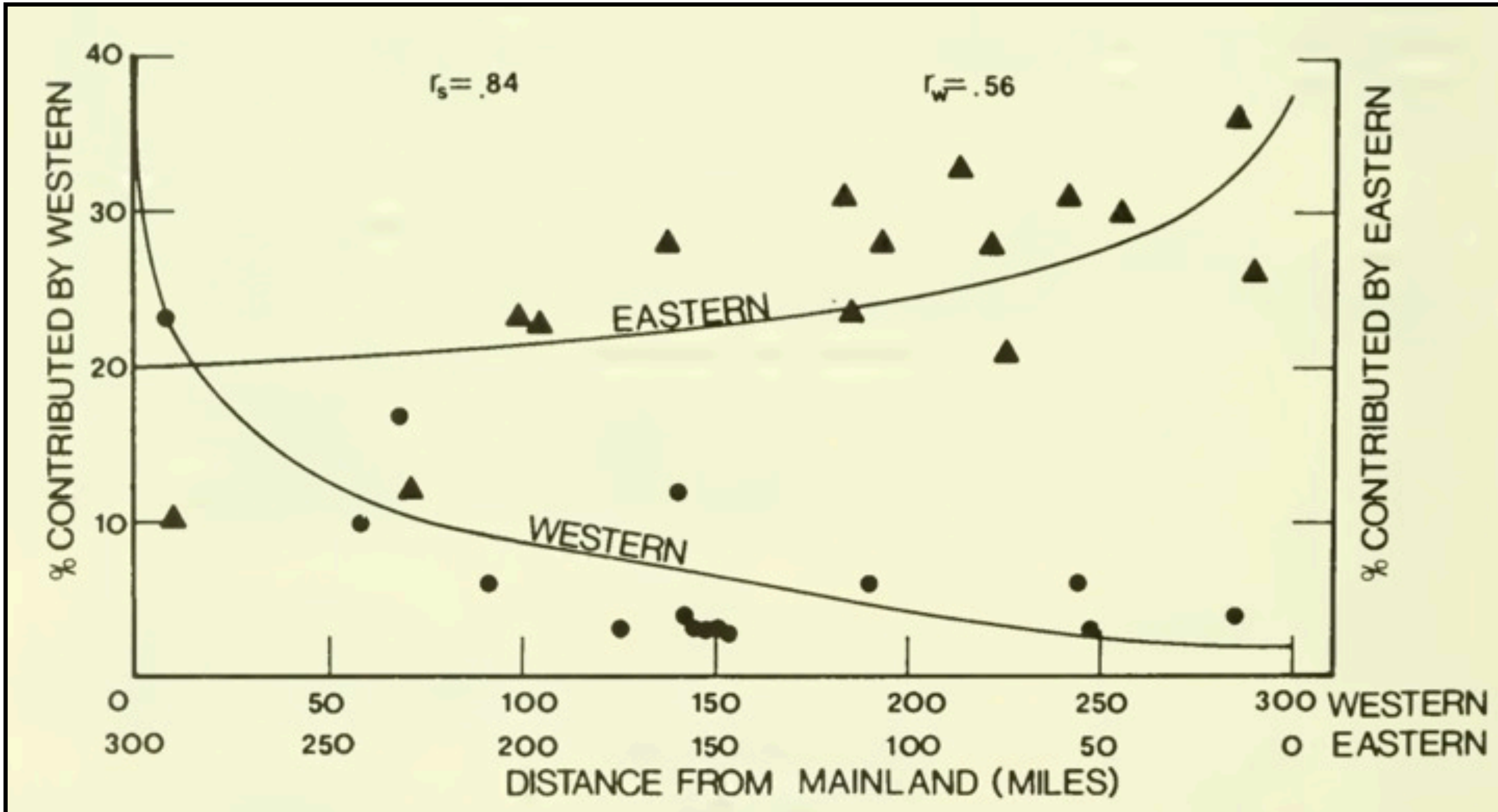
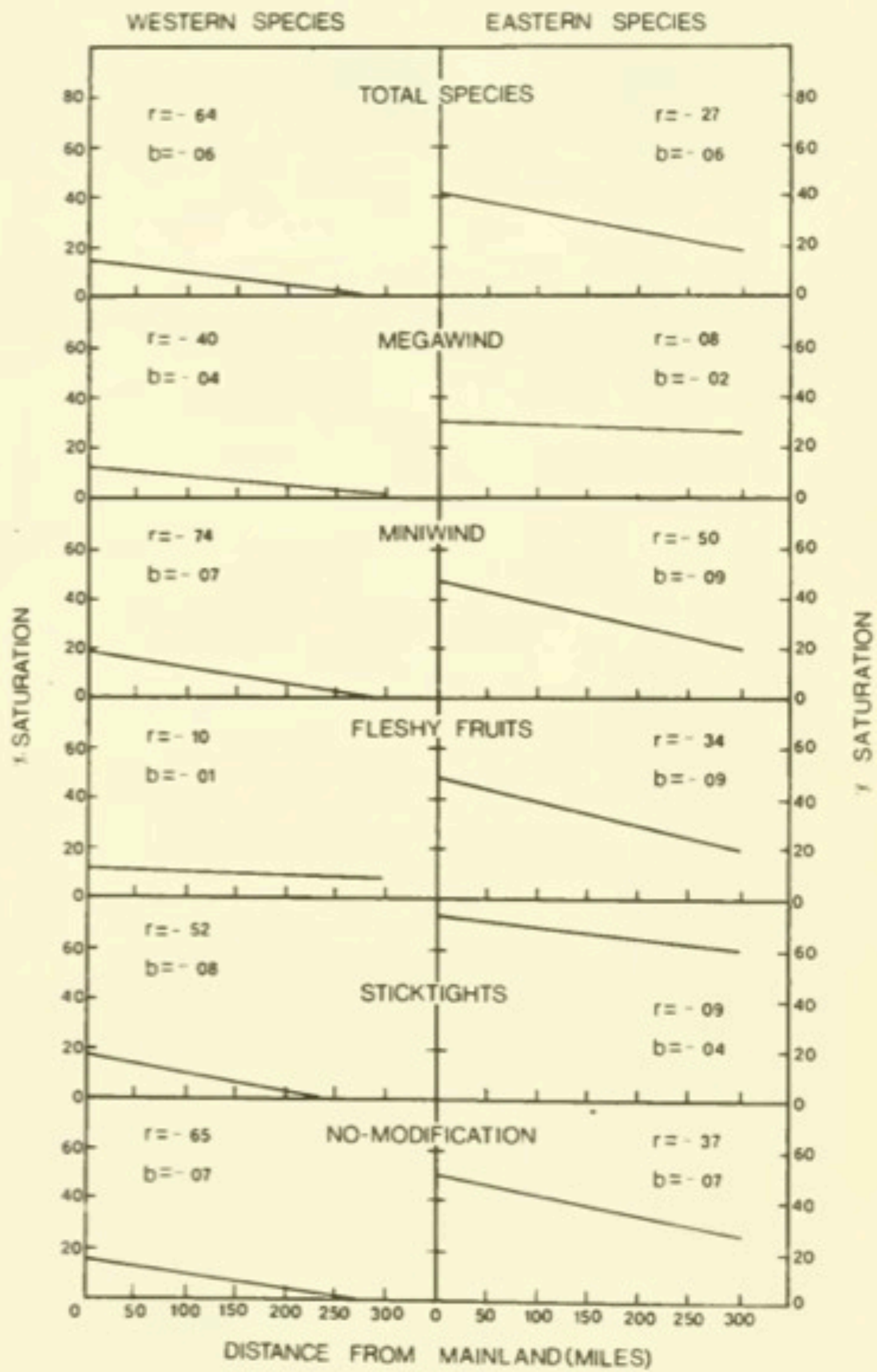



WESTERN SPECIES
EASTERN SPECIES
TOTAL SPECIES
r= - 64
b= - 06
r= - 27
b= - 06
MEGAWIND
r= - 40
b= - 04
r= - 08
b= - 02
MINIWIND
r= - 74
b= - 07
r= - 50
b= - 09
FLESHY FRUITS
r= - 10
b= - 01
r= - 34
b= - 09
STICKTIGHTS
r= - 52
b= - 08
r= - 09
b= - 04
NO-MODIFICATION
r= - 65
b= - 07
r= - 37
b= - 07
% SATURATION
0 50 100 150 200 250 300 0 50 100 150 200 250 300
DISTANCE FROM MAINLAND (MILES)

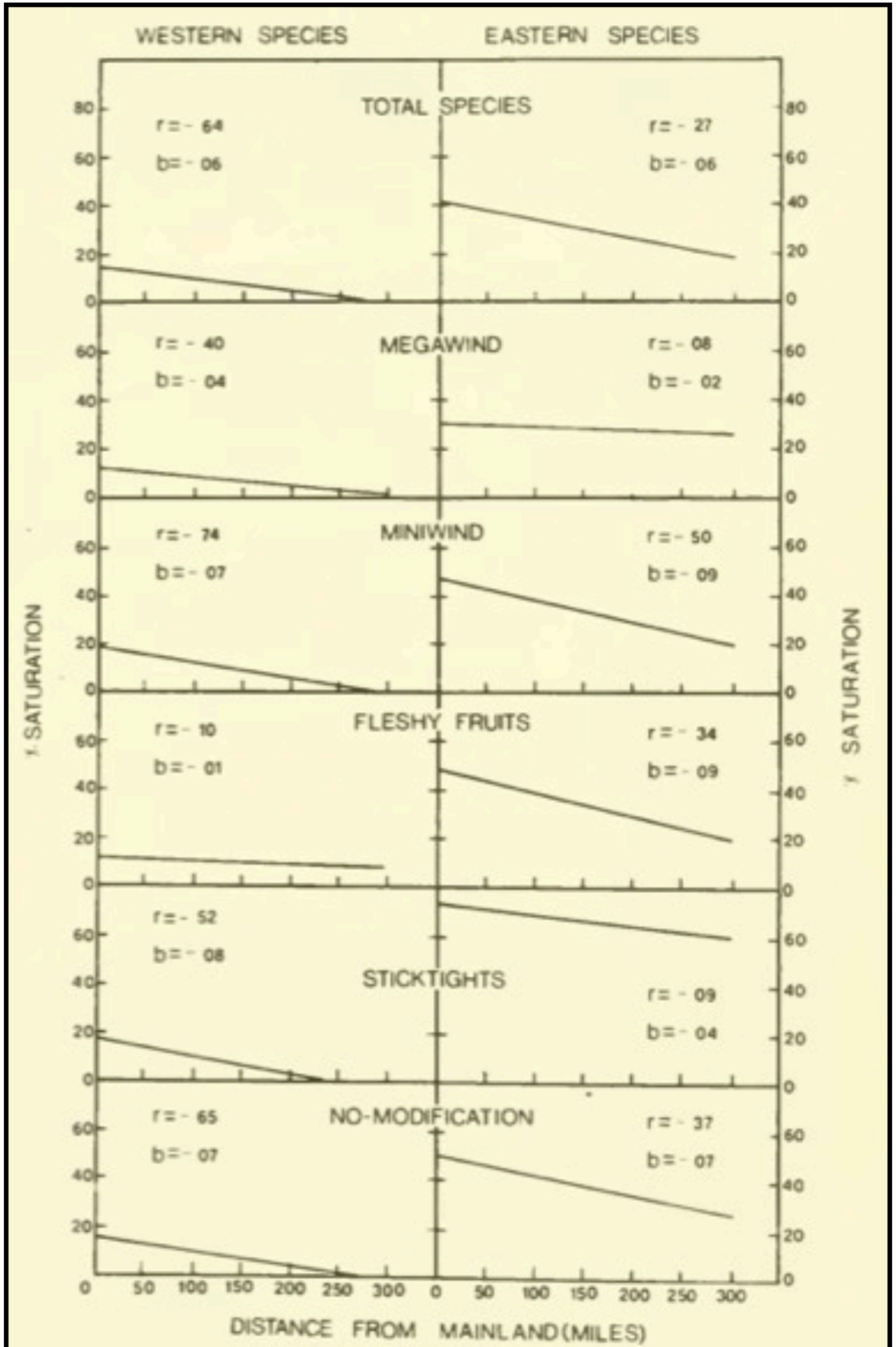
n = 235

n = 1,436

n = 273

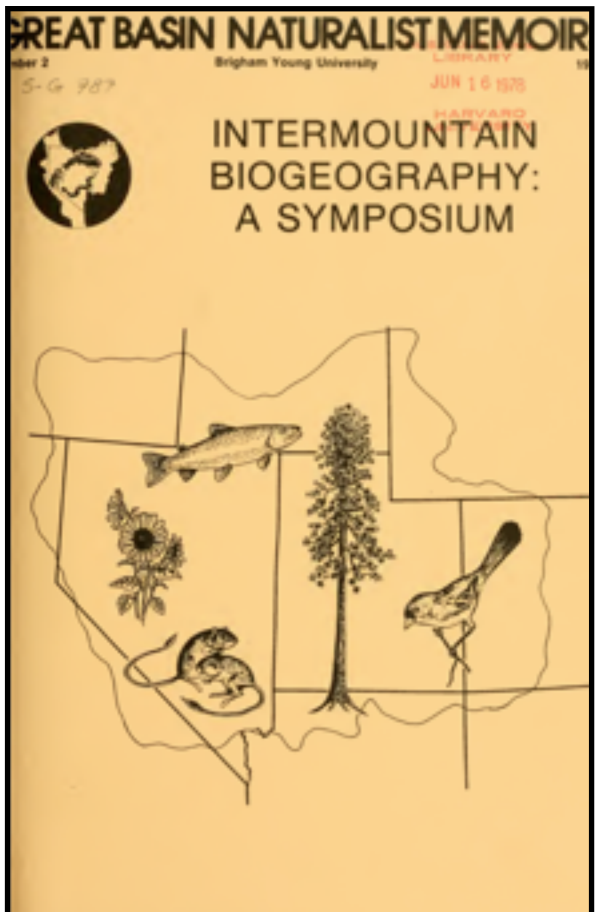
n = 112

n = 2,346



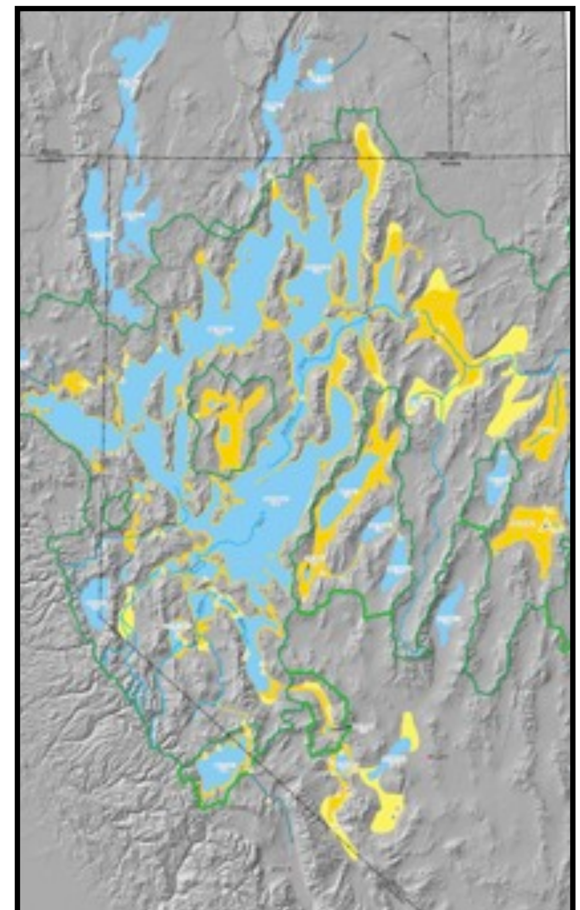
outline

beginnings



learning

future directions



tree - shrub - forb - grass

tree - shrub - forb - grass

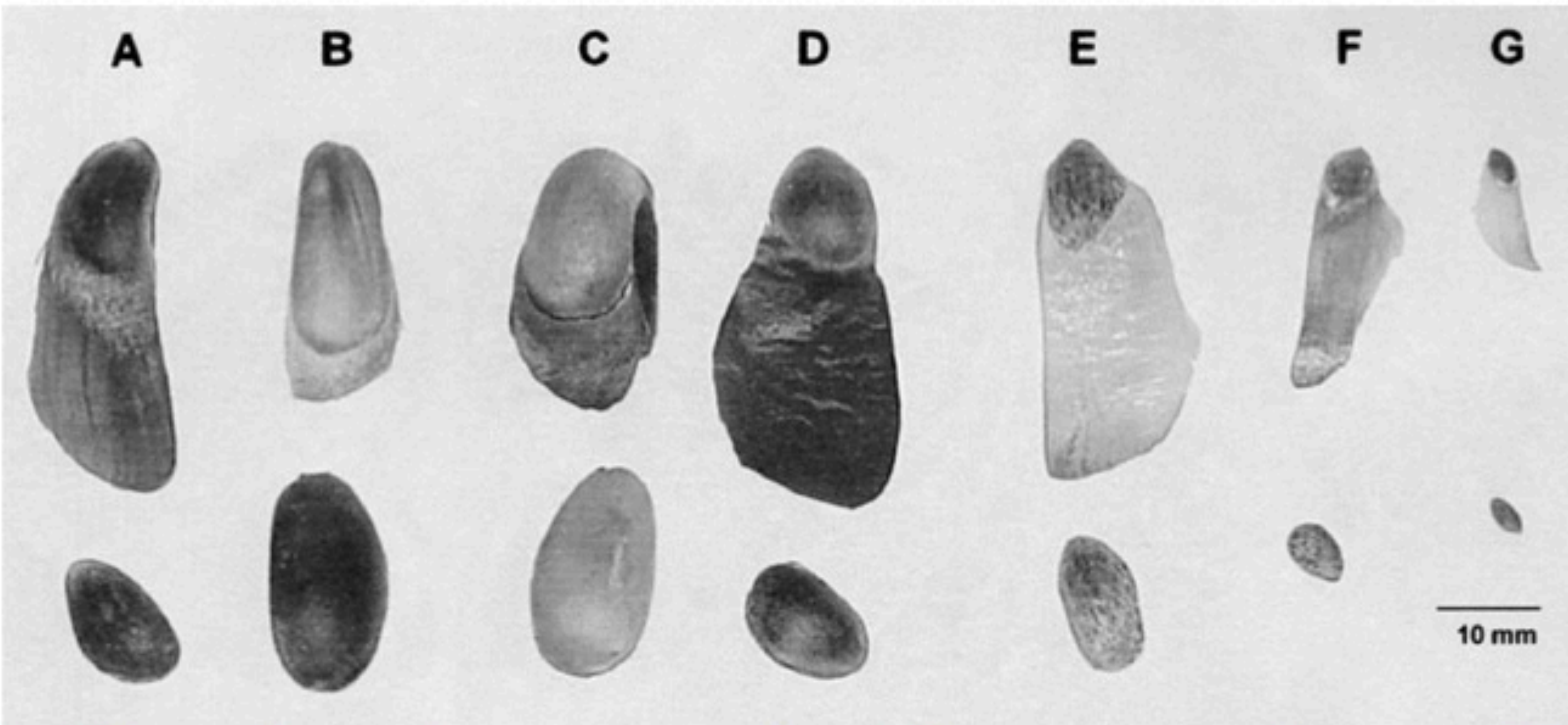


Figure 2. The seeds of three species of pines in the subsection *Sabinianae* (A–C) compared to four species of pines growing in the Sierra Nevada (D–G). Species are: A, Coulter pine; B, gray pine; C, Torrey pine; D, sugar pine; E, Jeffrey pine; F, ponderosa pine; G, lodgepole pine.

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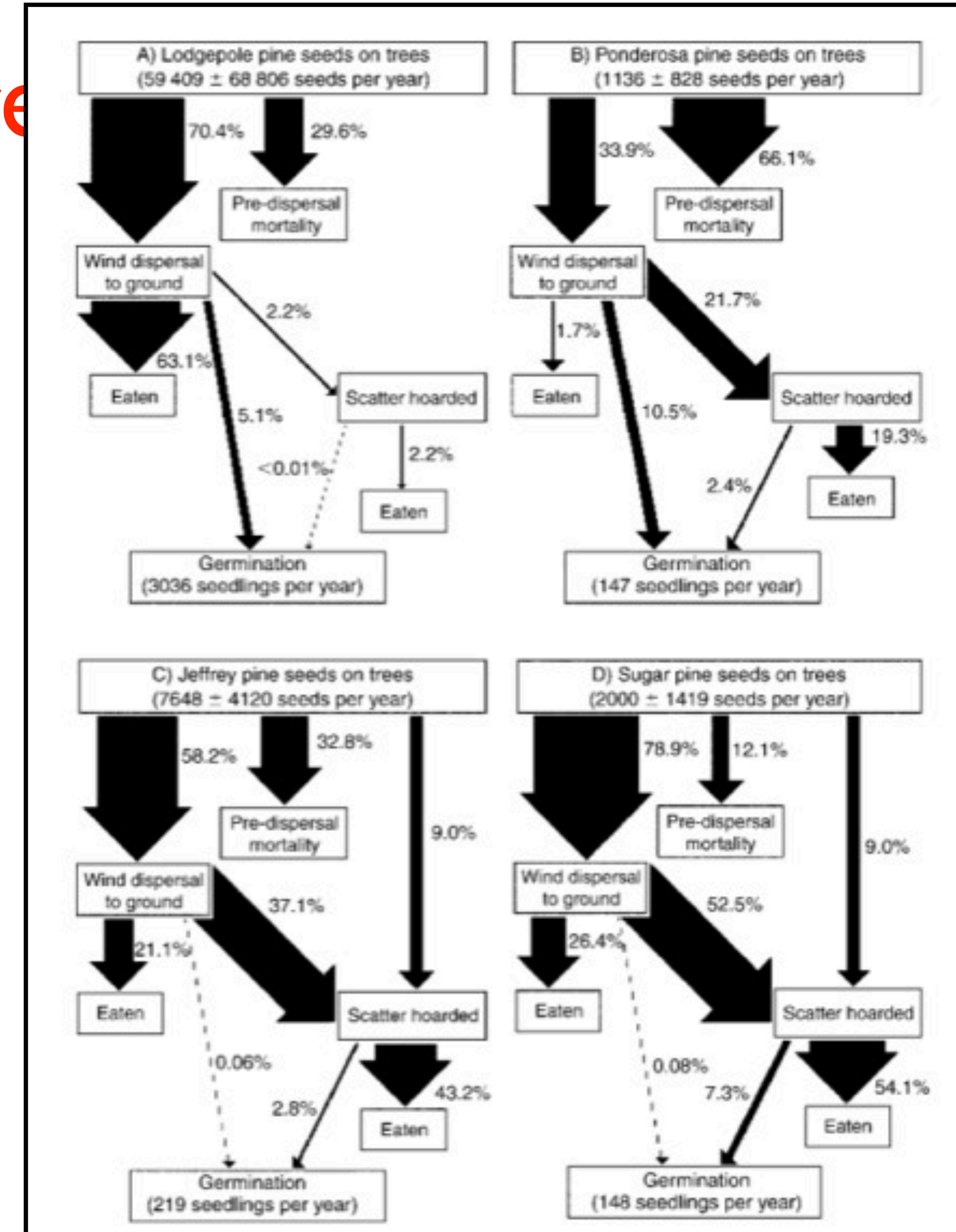
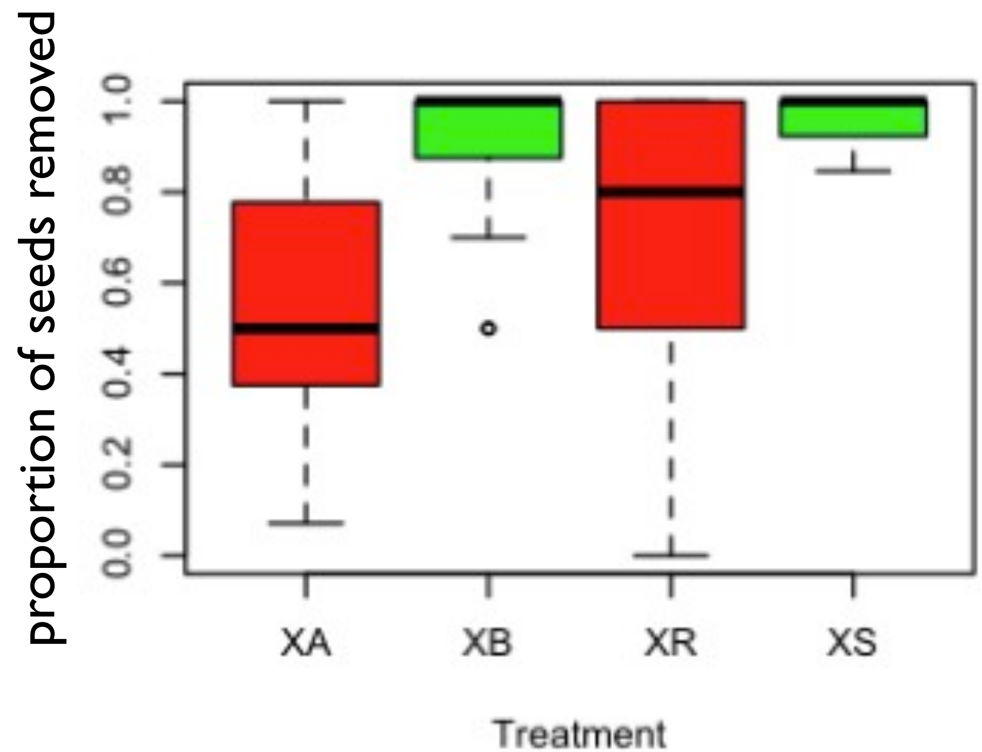


A) Lodgepole pine seeds on trees
(59 409 ± 68 806 seeds per year)
70.4%
29.6%
Pre-dispersal mortality
Wind dispersal to ground
2.2%
63.1%
Eaten
5.1%
Scatter hoarded
<0.01%
2.2%
Eaten
Germination
(3036 seedlings per year)
B) Ponderosa pine seeds on trees
(1136 ± 828 seeds per year)
33.9%
66.1%
Pre-dispersal mortality
Wind dispersal to ground
21.7%
1.7%
Eaten
10.5%
Scatter hoarded
19.3%
2.4%
Eaten
Germination
(147 seedlings per year)
C) Jeffrey pine seeds on trees
(7648 ± 4120 seeds per year)
58.2%
32.8%
Pre-dispersal mortality
9.0%
Wind dispersal to ground
37.1%
21.1%
Eaten
Scatter hoarded
0.06%
43.2%
2.8%
Eaten
Germination
(219 seedlings per year)
D) Sugar pine seeds on trees
(2000 ± 1419 seeds per year)
78.9%
12.1%
Pre-dispersal mortality
9.0%
Wind dispersal to ground
52.5%
26.4%
Eaten
Scatter hoarded
0.08%
7.3%
54.1%
Eaten
Germination
(148 seedlings per year)

tree - shrub - forb - grass

tree - shrub - forb - grass



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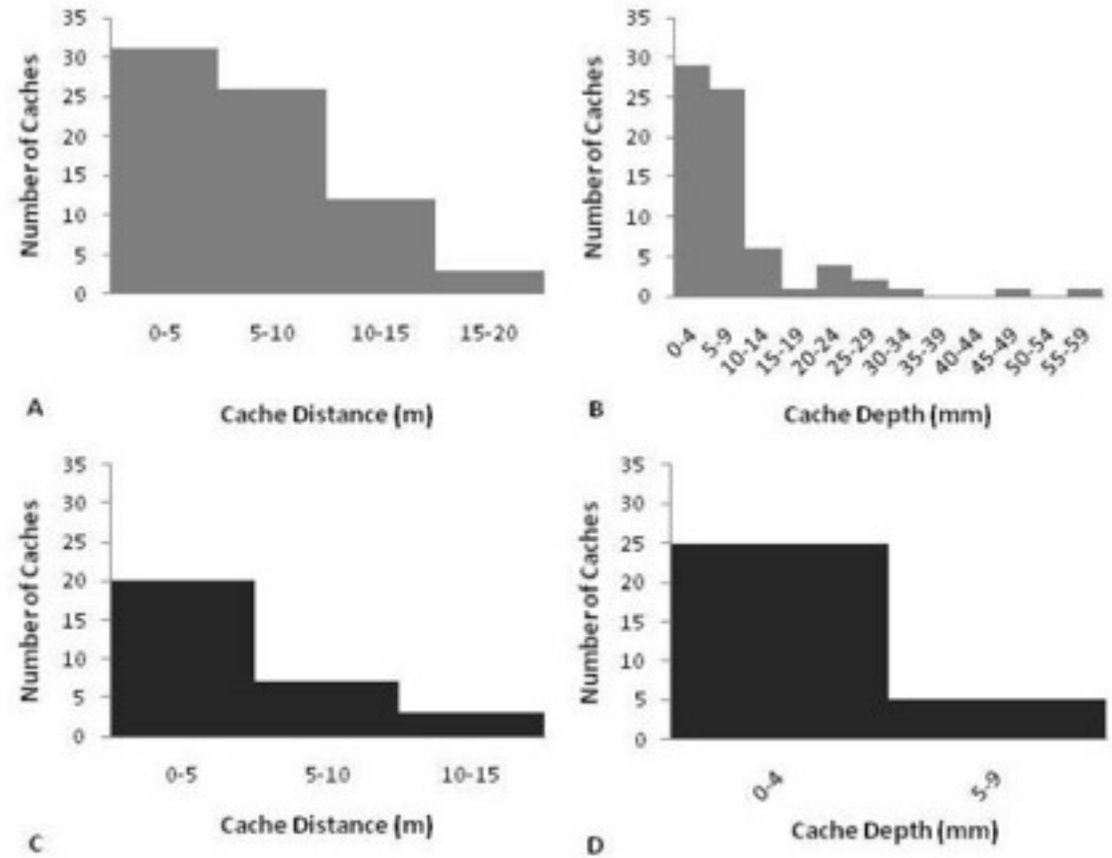

(Sarah Barga, *in prep*)

tree - shrub - forb - grass

TABLE 5. Estimates of probabilities of seed harvest by rodents and ants and of emergence of seedlings from seeds.

Parameter	Description	Exact estimate	Median of bootstrap estimates	95% confidence interval
P_r	probability of harvest by a rodent	0.965	0.964	0.883–0.991
P_a	probability of harvest by an ant	0.044	0.072	0–0.787
q_o	probability of emergence if unharvested	0.0048	0.0046	0.0018–0.0088
q_r	probability of emergence if harvested by a rodent	0.0067	0.0068	0.0032–0.0109
q_a	probability of emergence if harvested by an ant	0.0052	0	0.005–0.0054

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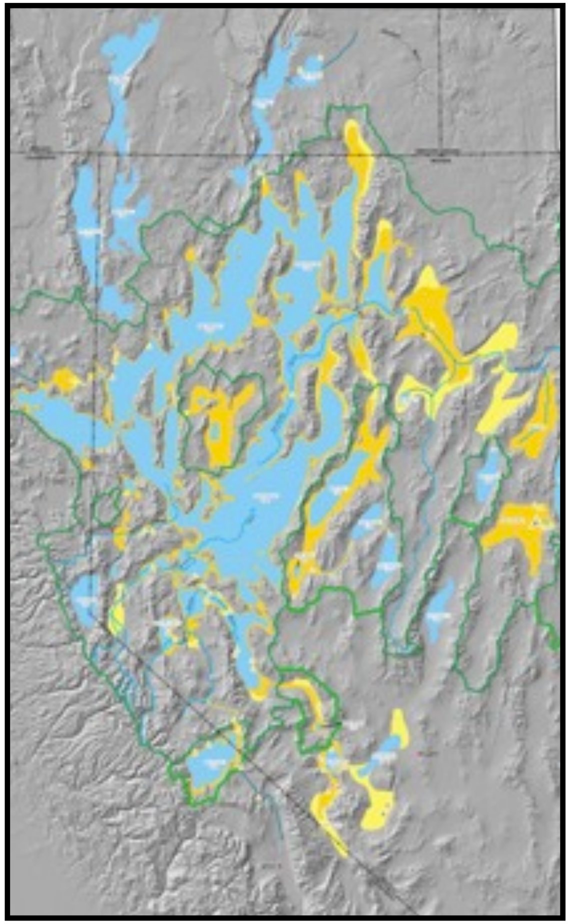

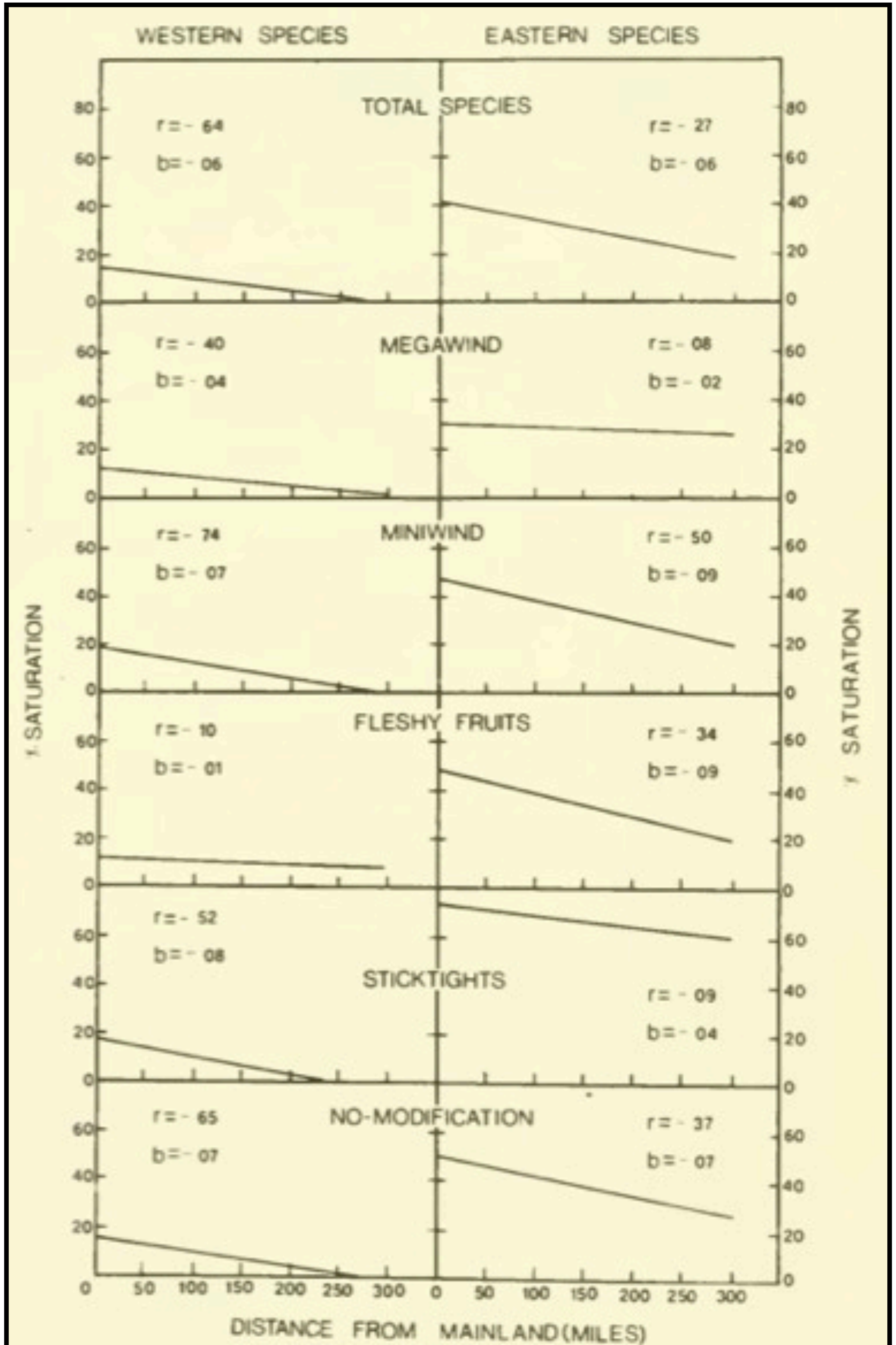
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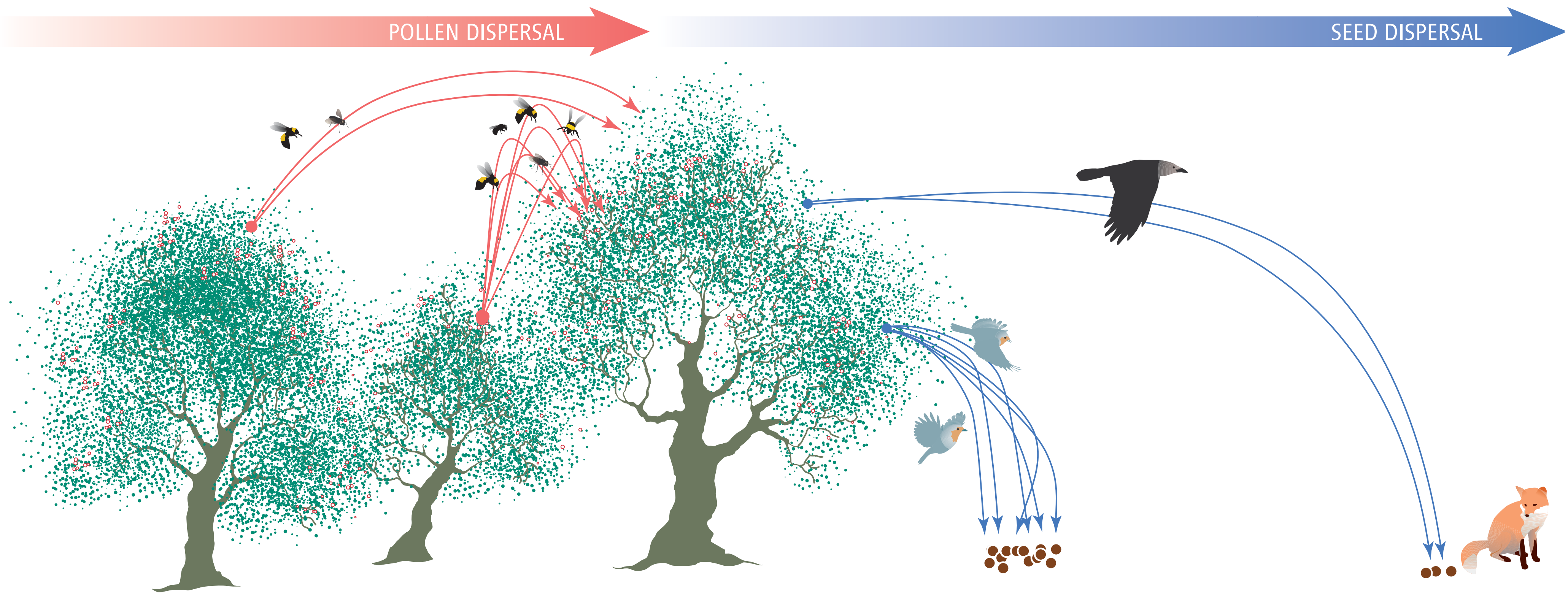
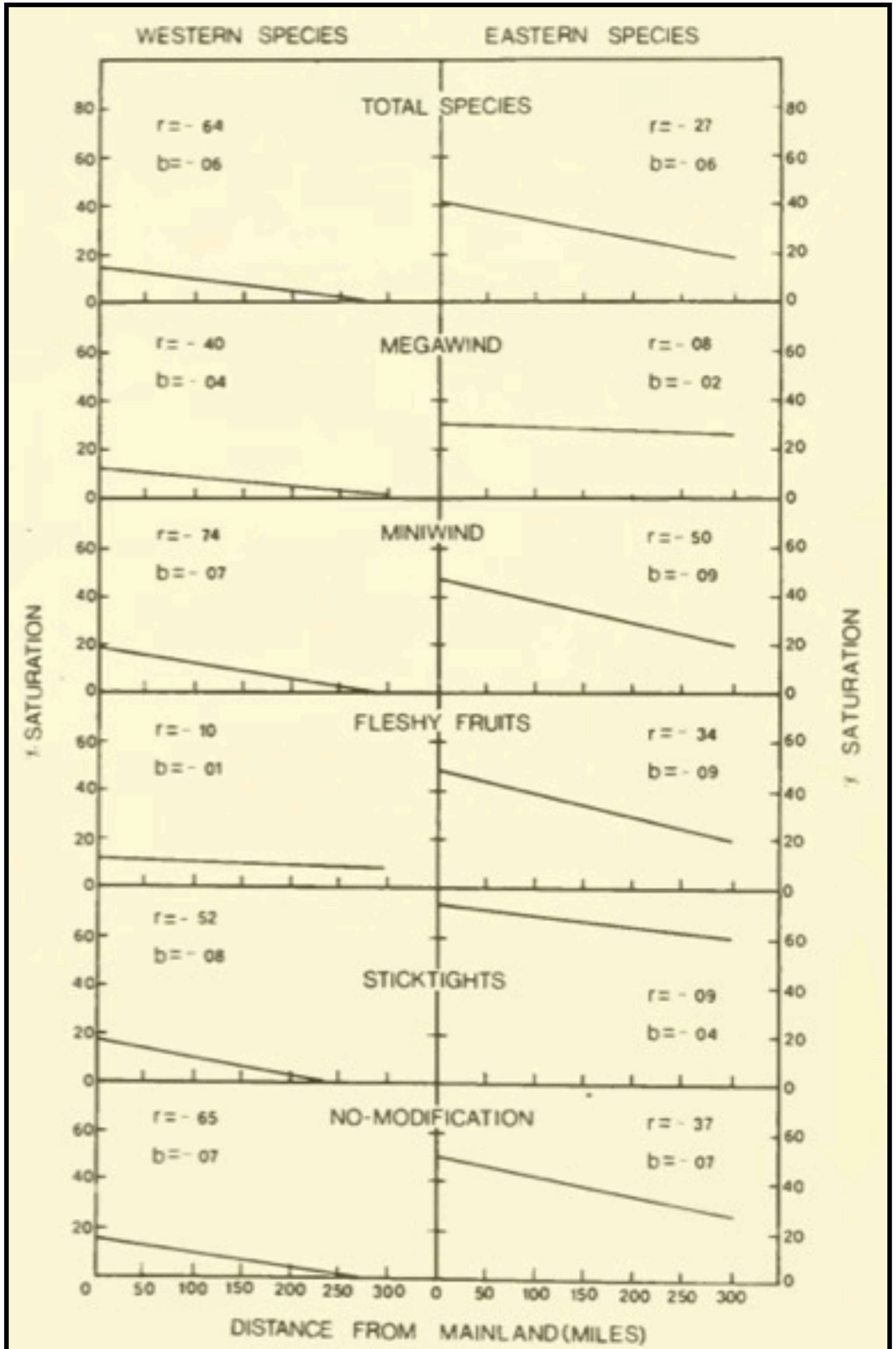
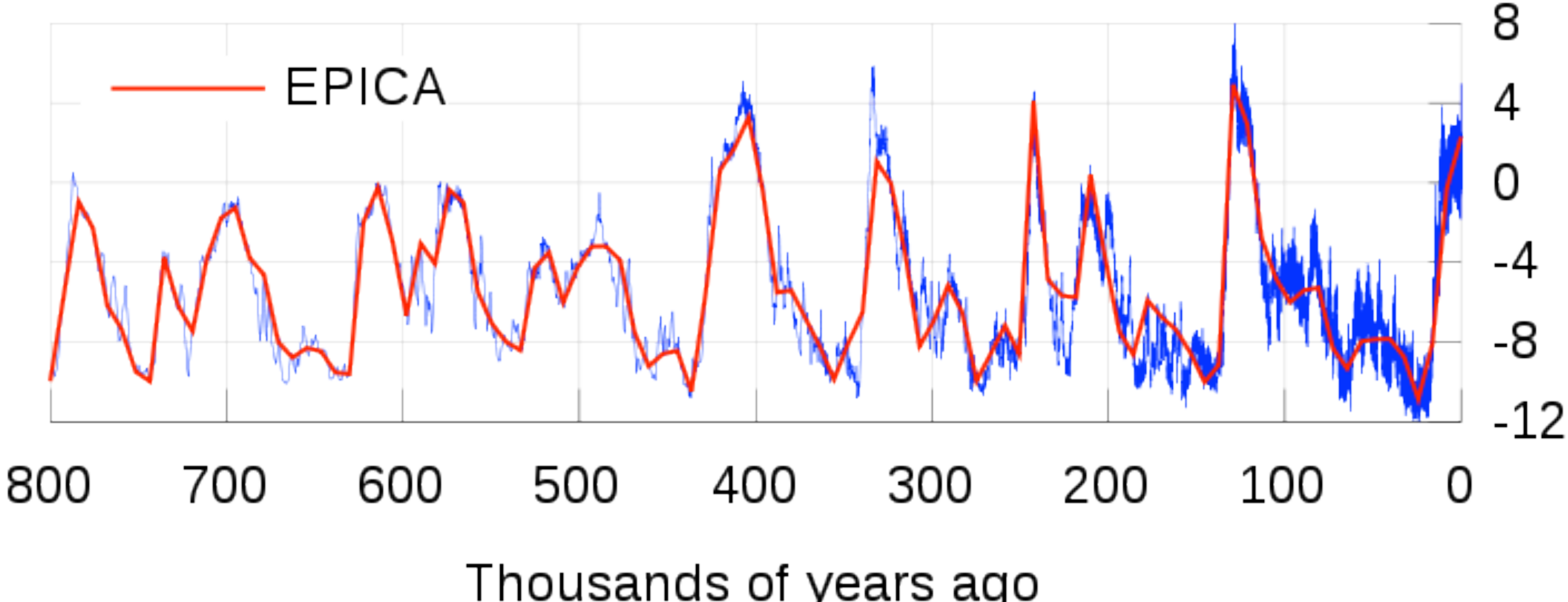


POLLEN DISPERSAL
SEED DISPERSAL



dispersal trade-off hypothesis:
a trade-off exists between dispersal distance and effectiveness. i.e., horizontal and vertical movement

dispersal (*i.e.*, migration)



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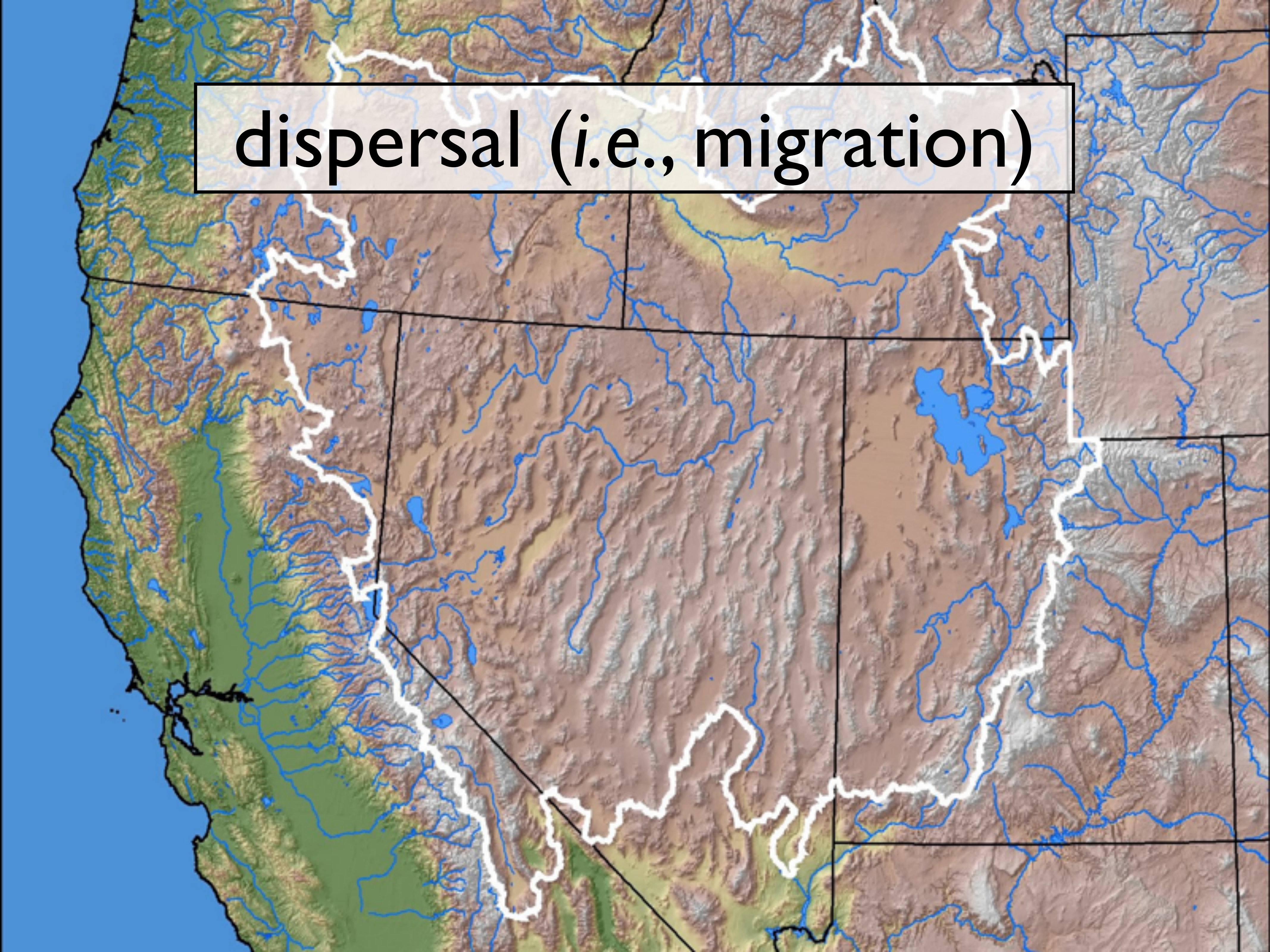

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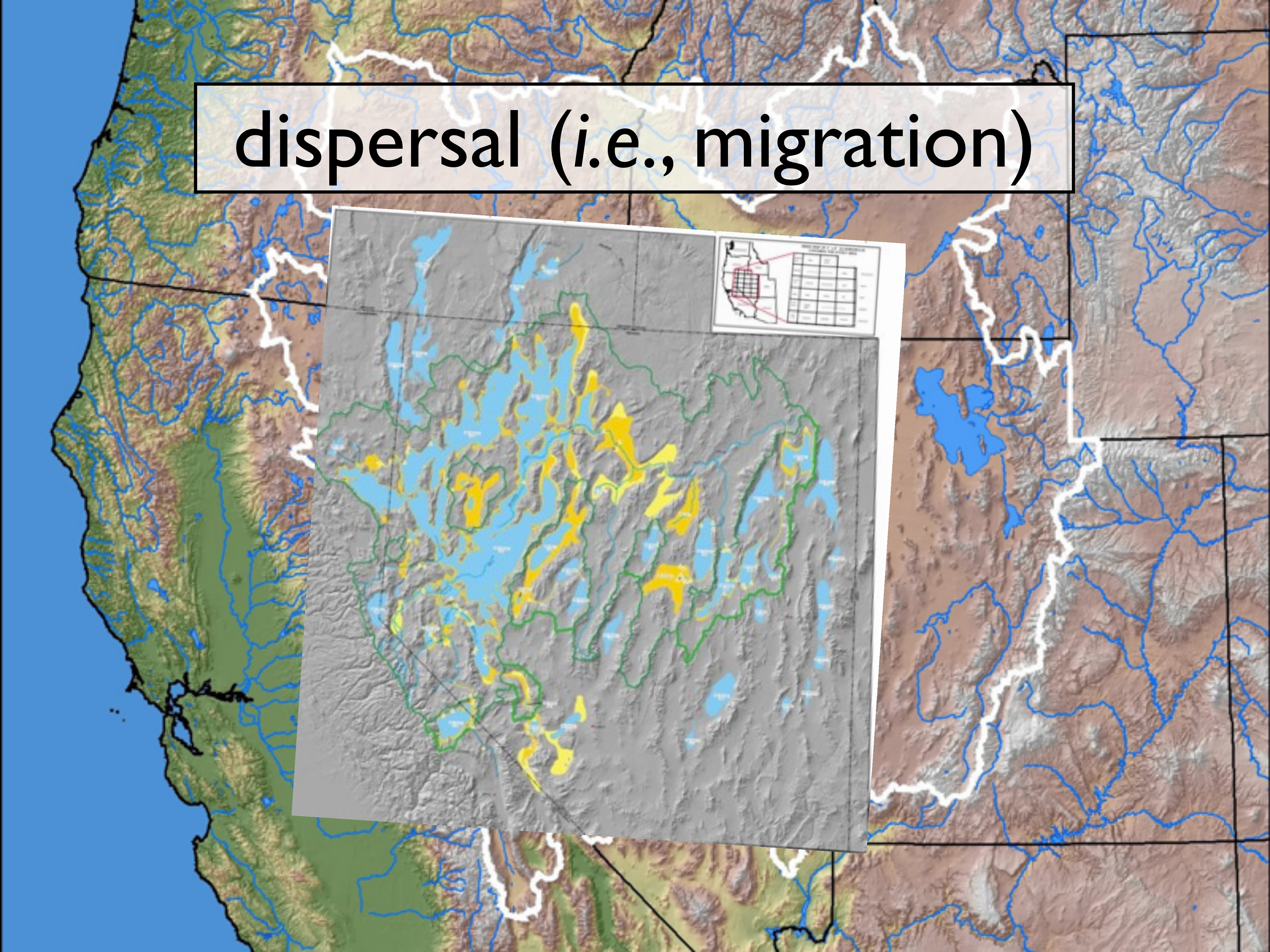

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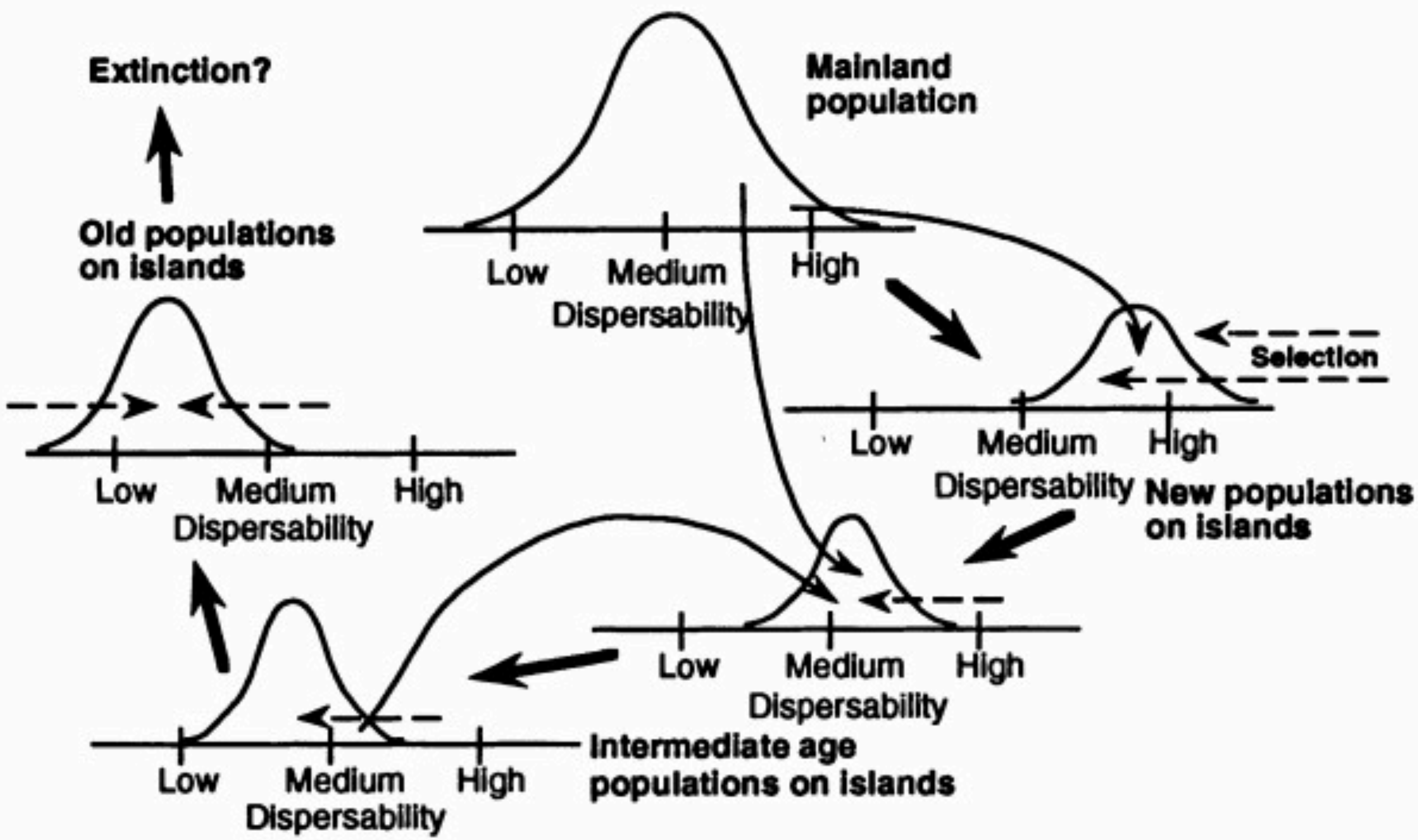


thank you.
questions?