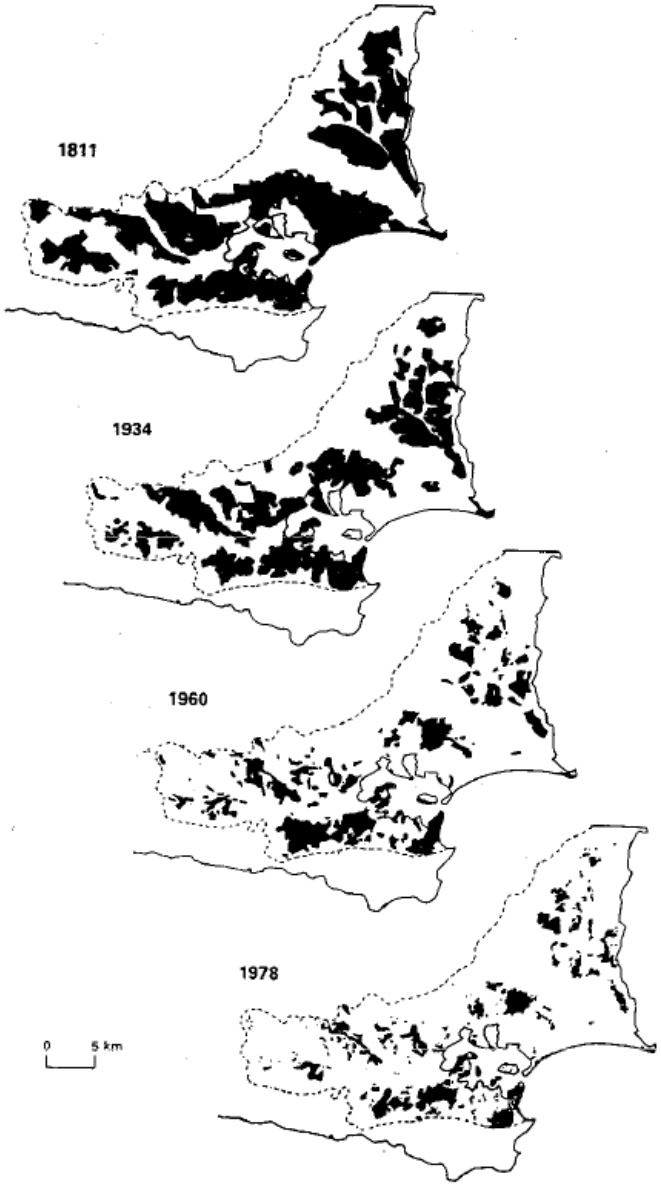
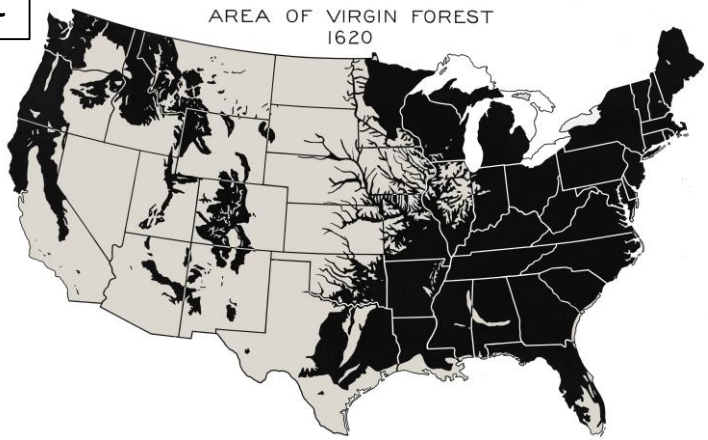
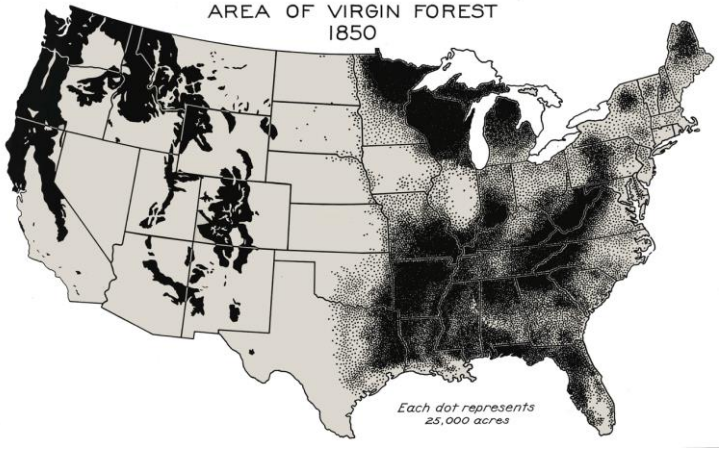
Island Biogeography and Habitat Loss

1. Habitat loss and fragmentation
2. Lessons from islands
- Effects of patch area and shape on species richness
- Macarthur-Wilson equilibrium theory of island biogeography

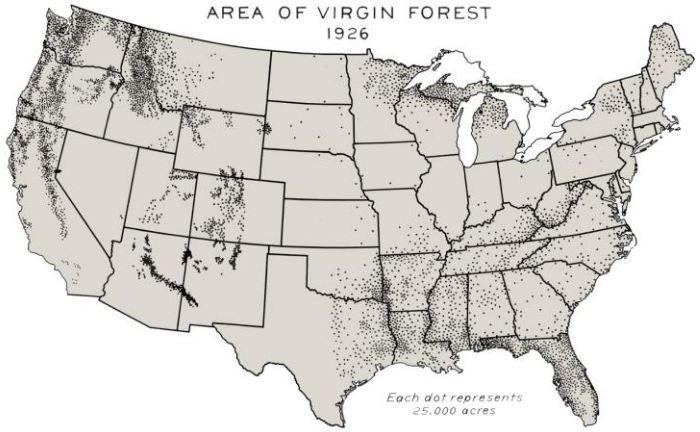


Old Growth Forest



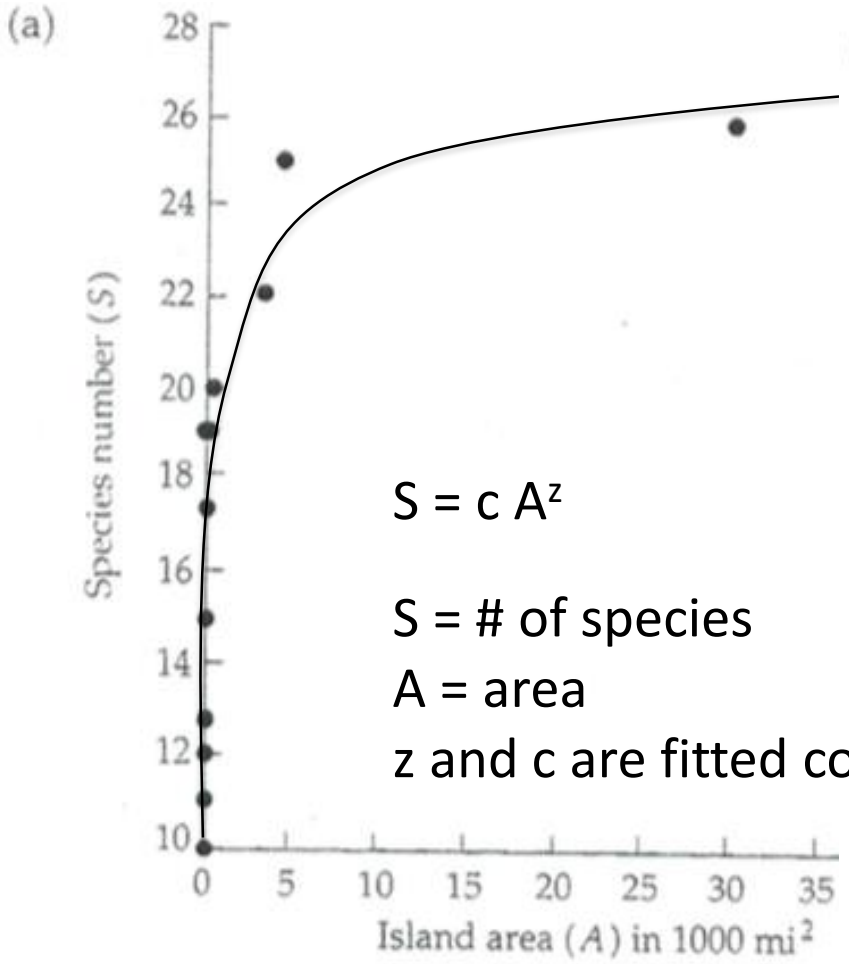


300 years



Aboveground Woody Biomass

AREA effects: Species – Area Curves

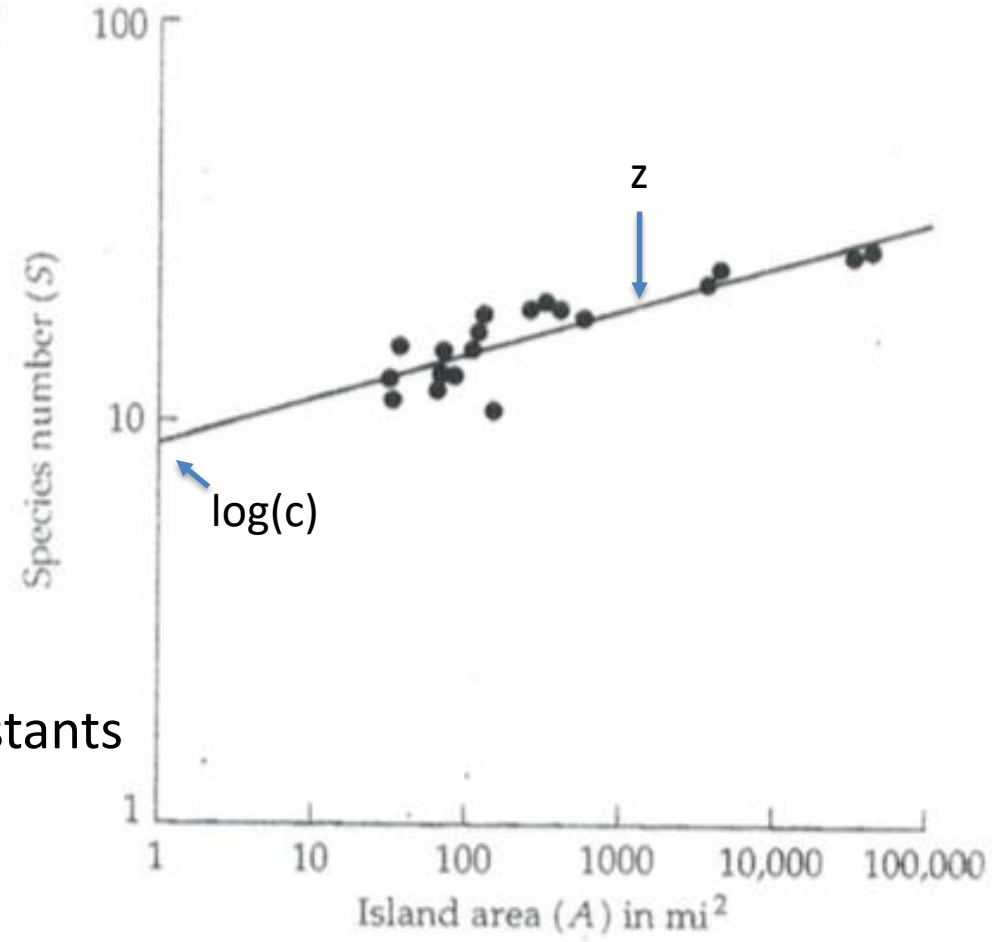


$S = c A^z$

S = # of species

A = area

z and c are fitted constants



Data from **habitat patches is** similar to data from islands

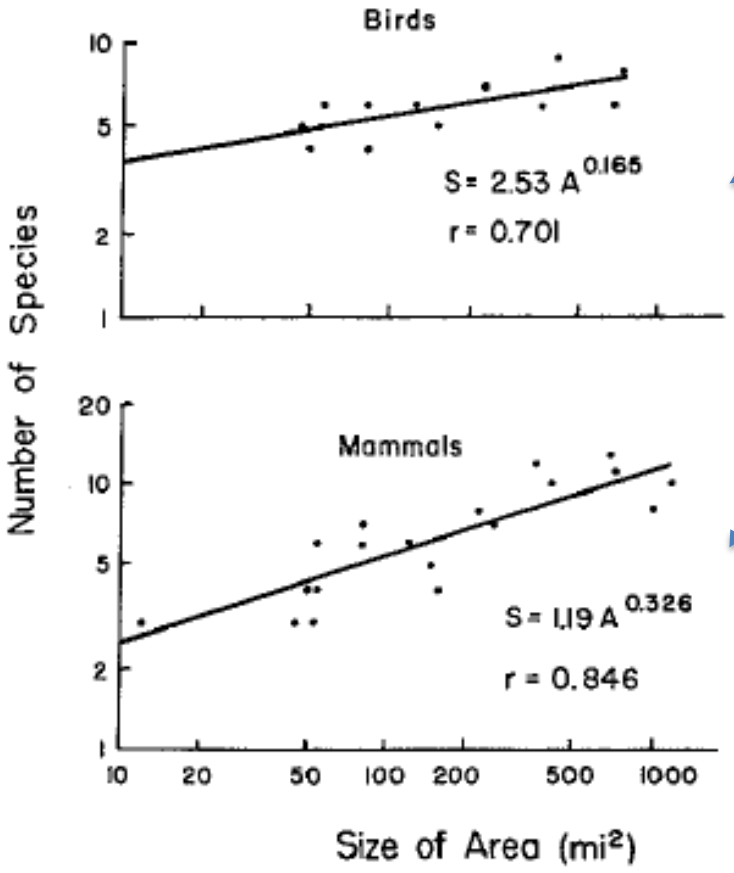
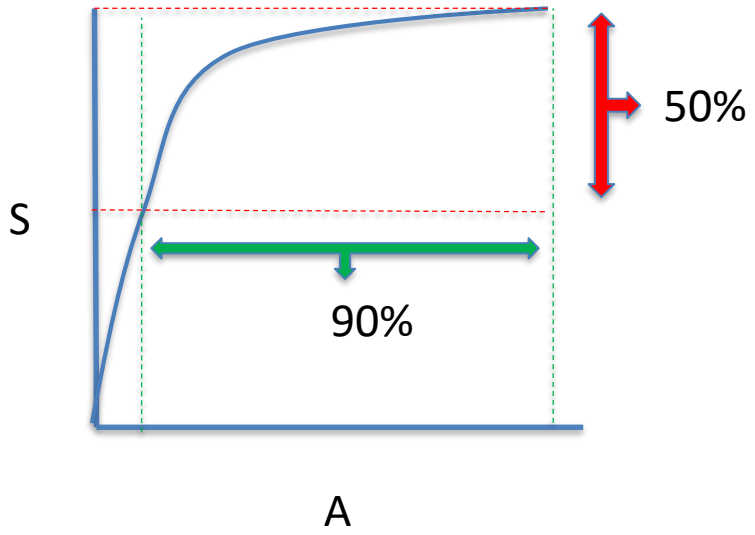


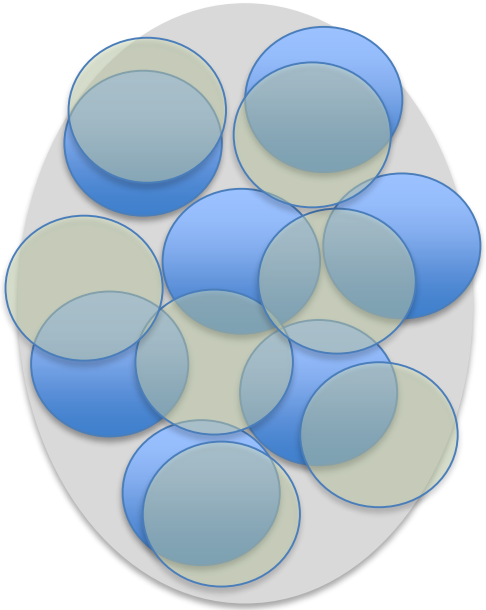
Figure 6.5 Relation between number of permanent resident boreal bird species, the number of small, boreal mammal species, and the size of isolated mountain ranges (>7,500 ft, 2,300 m elev.) in the Great Basin (modified from Brown 1978).

Boreal mountain patches

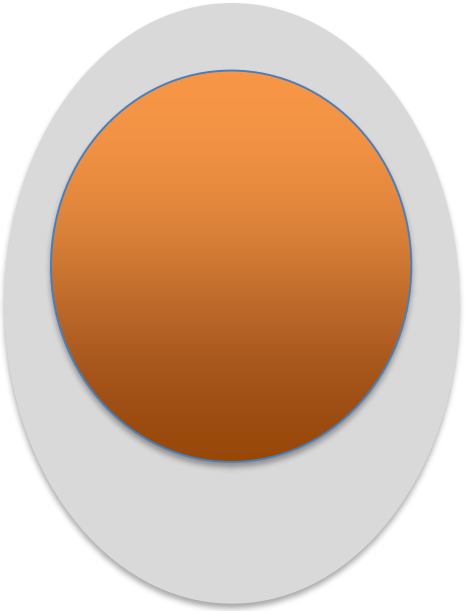
$z \approx 0.15 - 0.35$



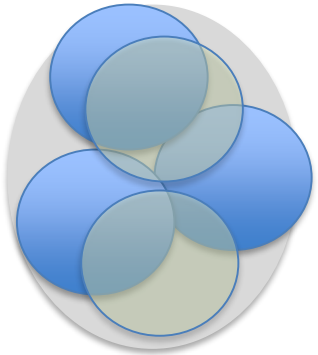
10|2 Rule for z = 0.25

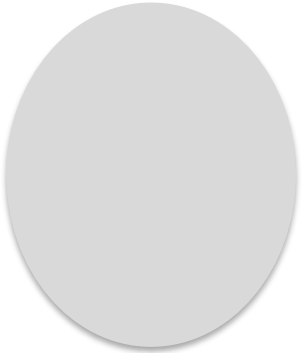


As Area ↓ Population sizes ↓



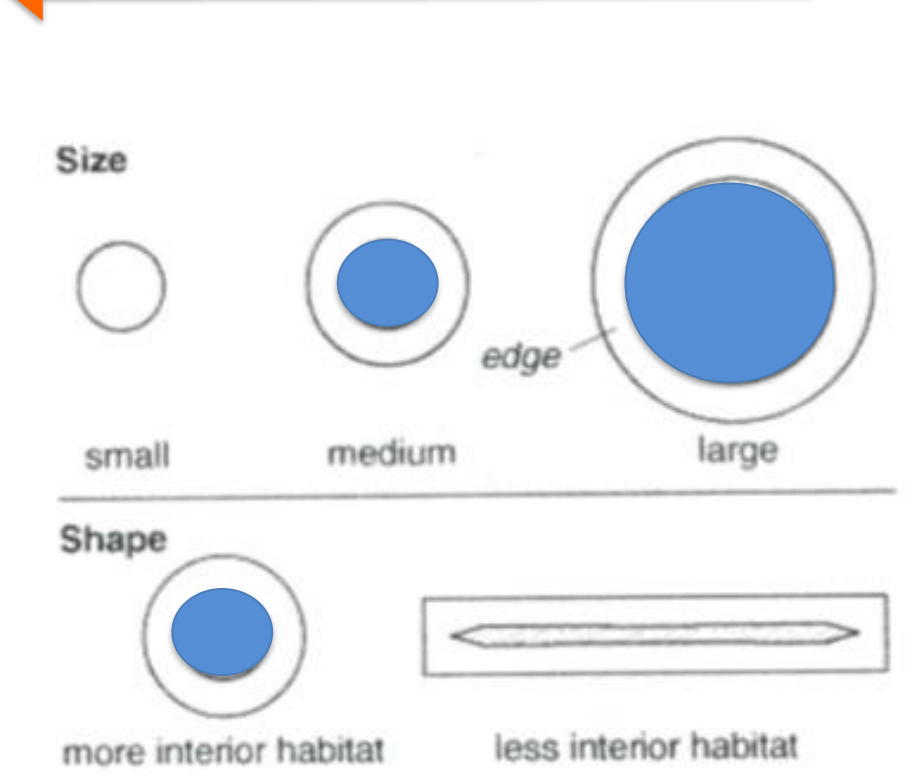
As Area ↓ Wide ranging species ↓





Patch area AND shape affect species richness through **edge effects**

As A **decreases,** edge:interior ratio increases

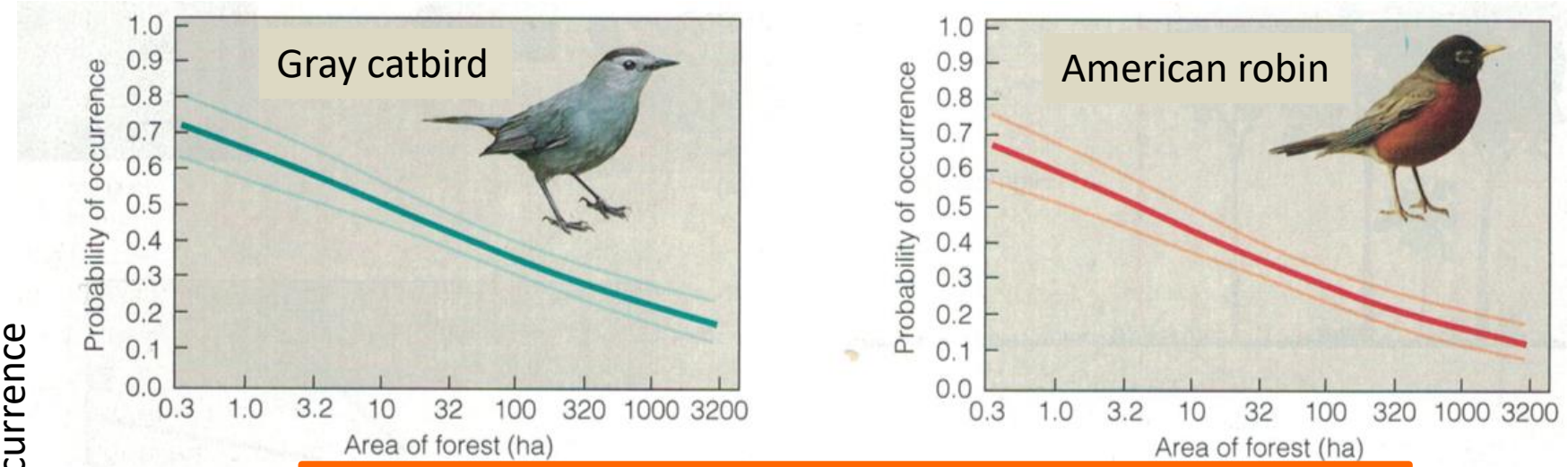


Minimum edge:interior ratio

All edge

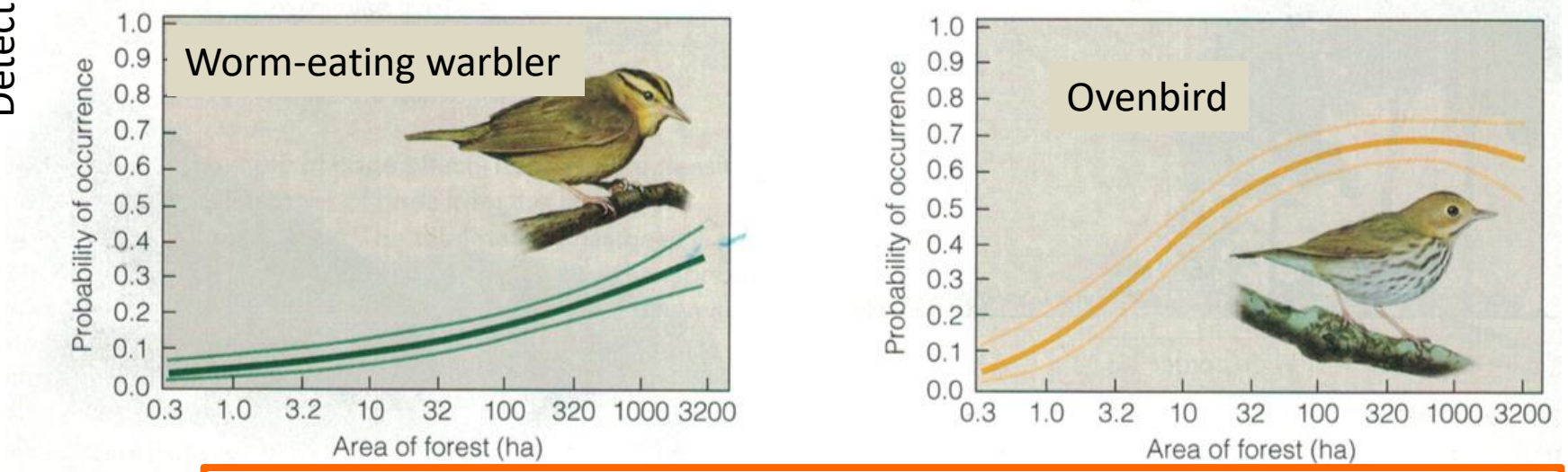
Figure 19.18

Edge species



As area increases, occurrence decreases for the edge species

Interior species



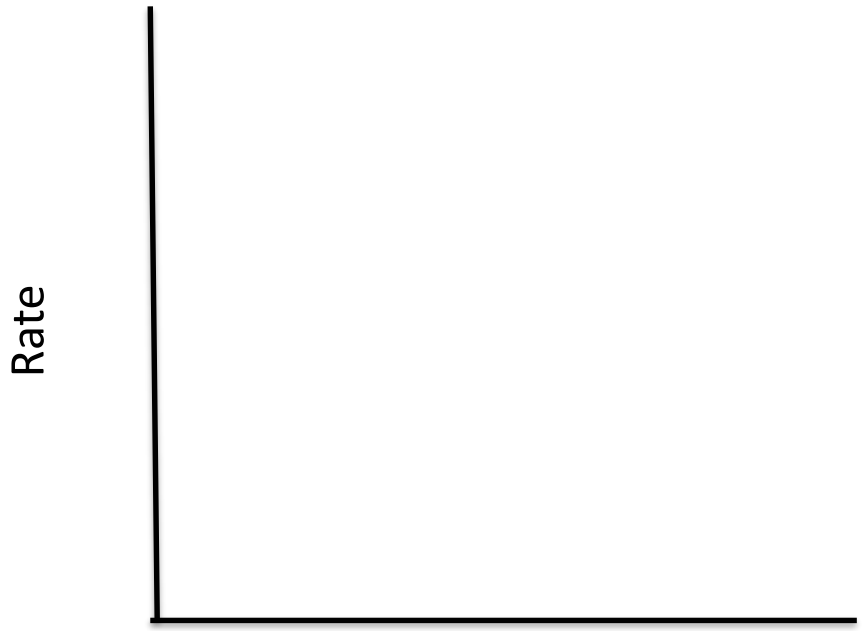
As area increases, occurrence increases for ground-nesting interior species

Detection or occurrence

Equilibrium Theory of Island Biogeography

Island size and connectivity determine species richness
MacArthur and Wilson 1963

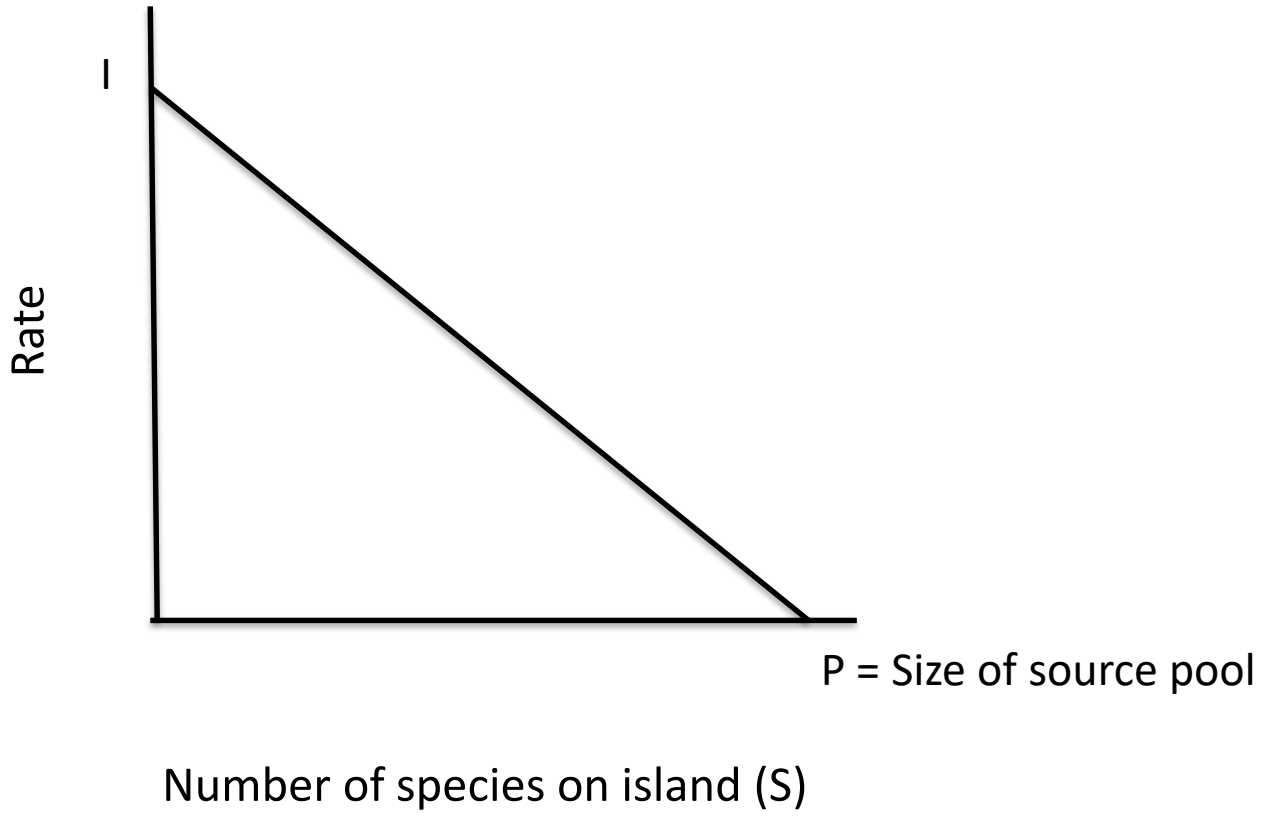
Theory



S is a balance between ***immigration*** of new species and ***extinction*** of resident species

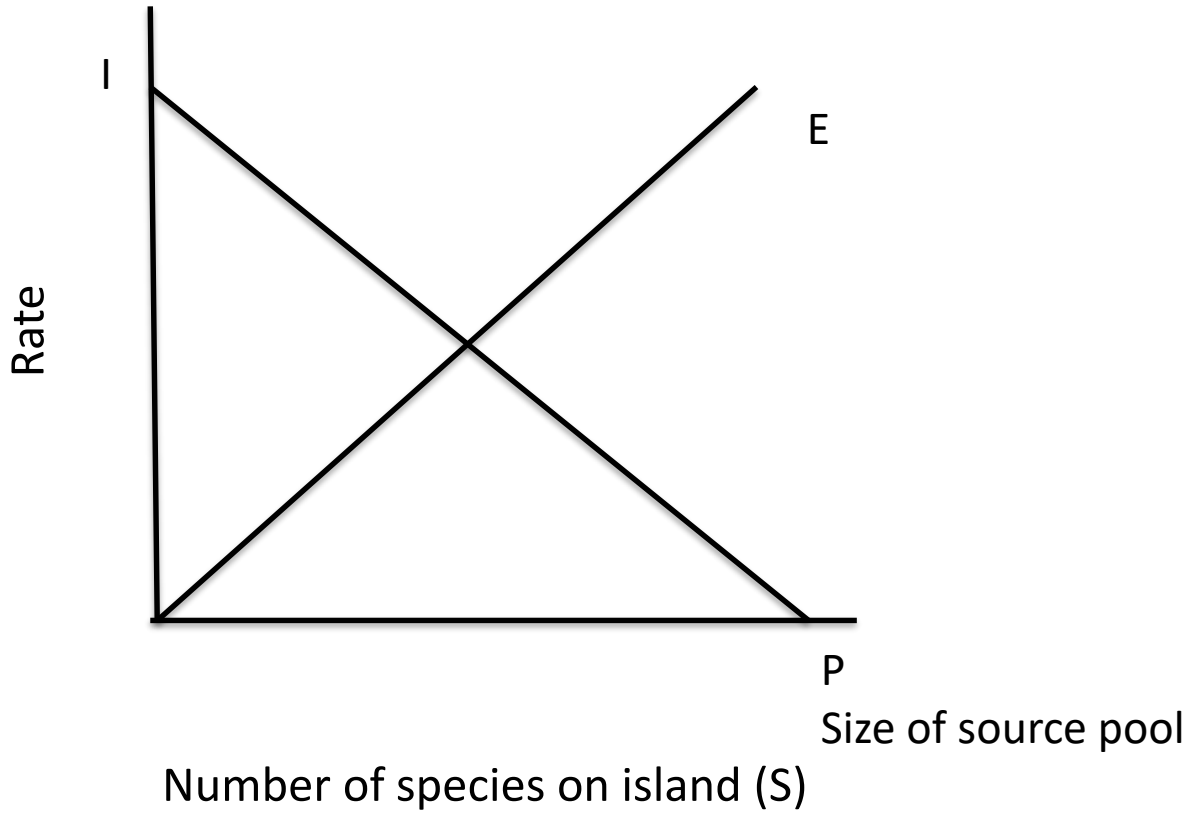
Equilibrium Theory of Island Biogeography

Theory



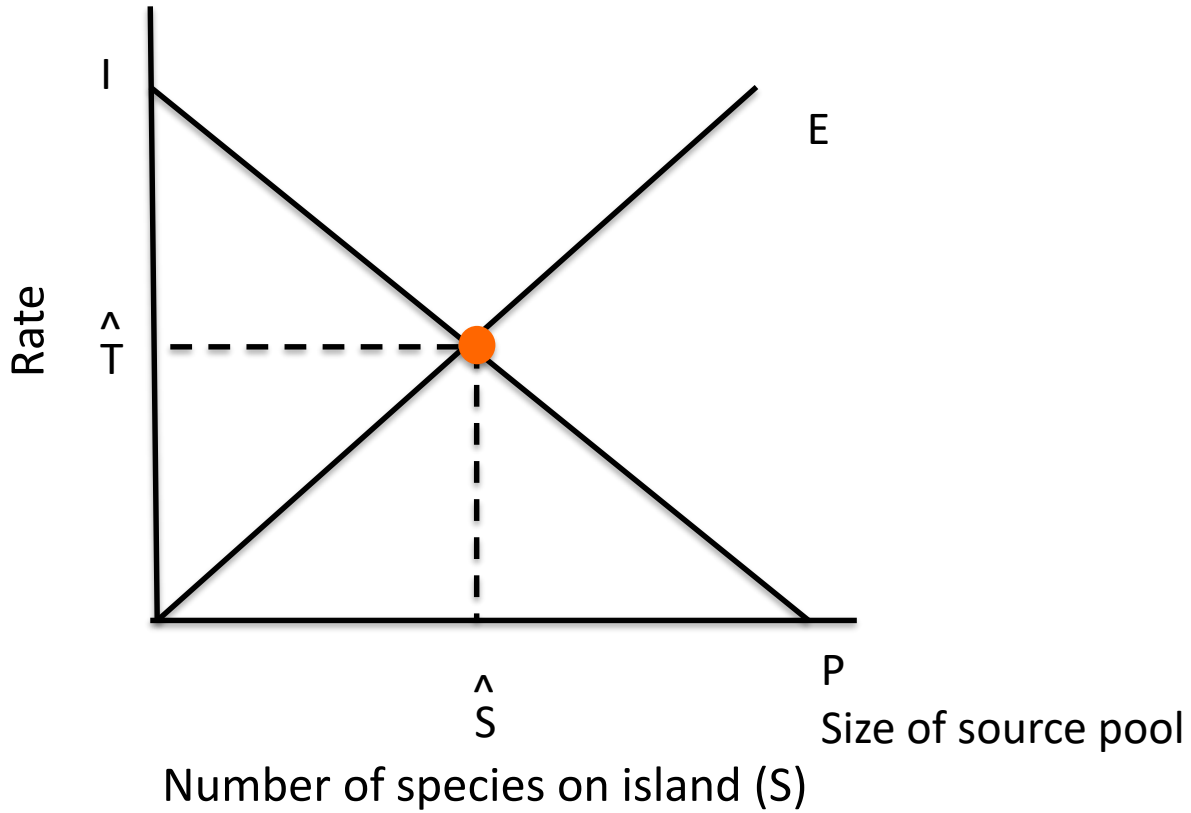
Equilibrium Theory of Island Biogeography

Theory



Equilibrium Theory of Island Biogeography

Theory



# of species present is a balance between ***immigration*** of new spp. and ***extinction*** of resident spp.; **species composition continually changing, but total number of species constant**

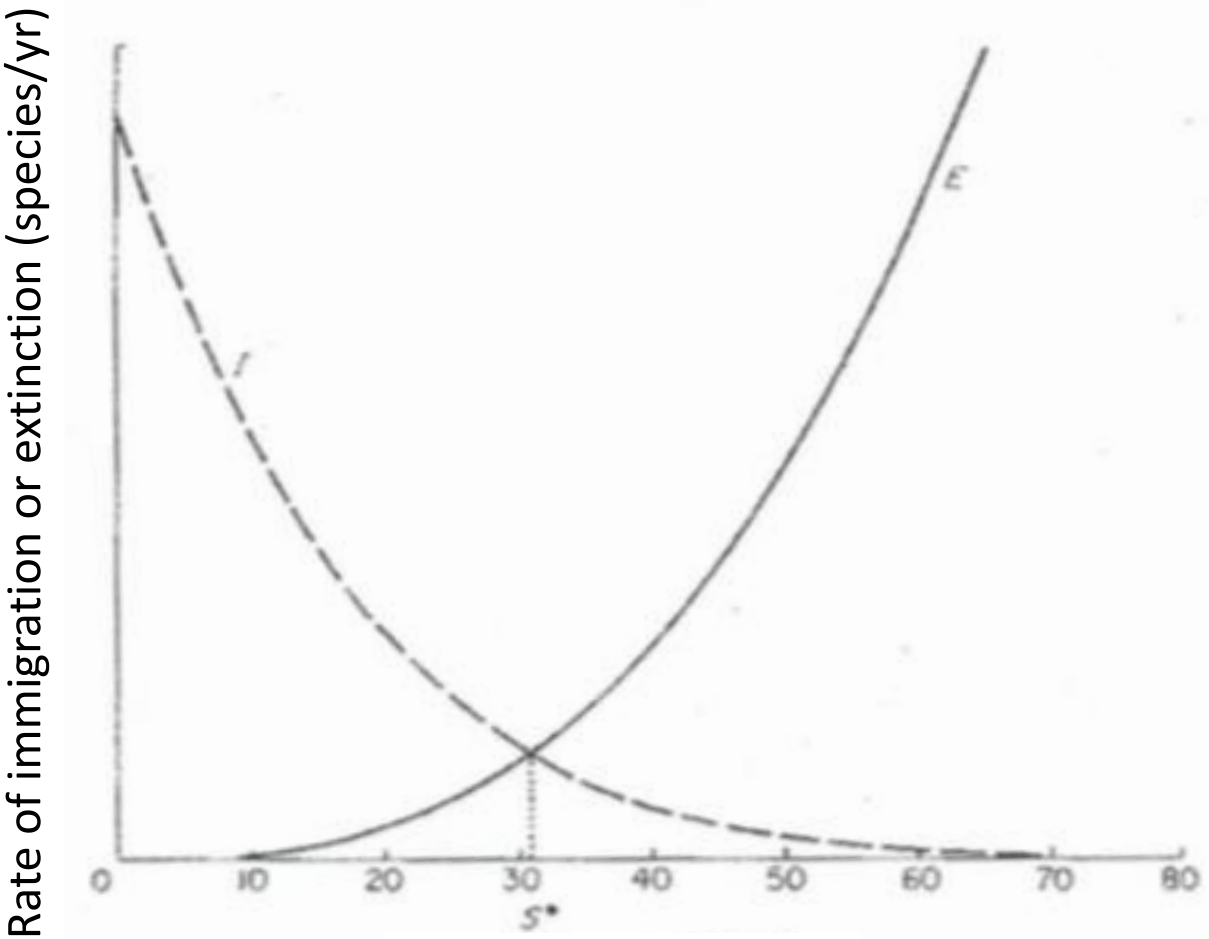


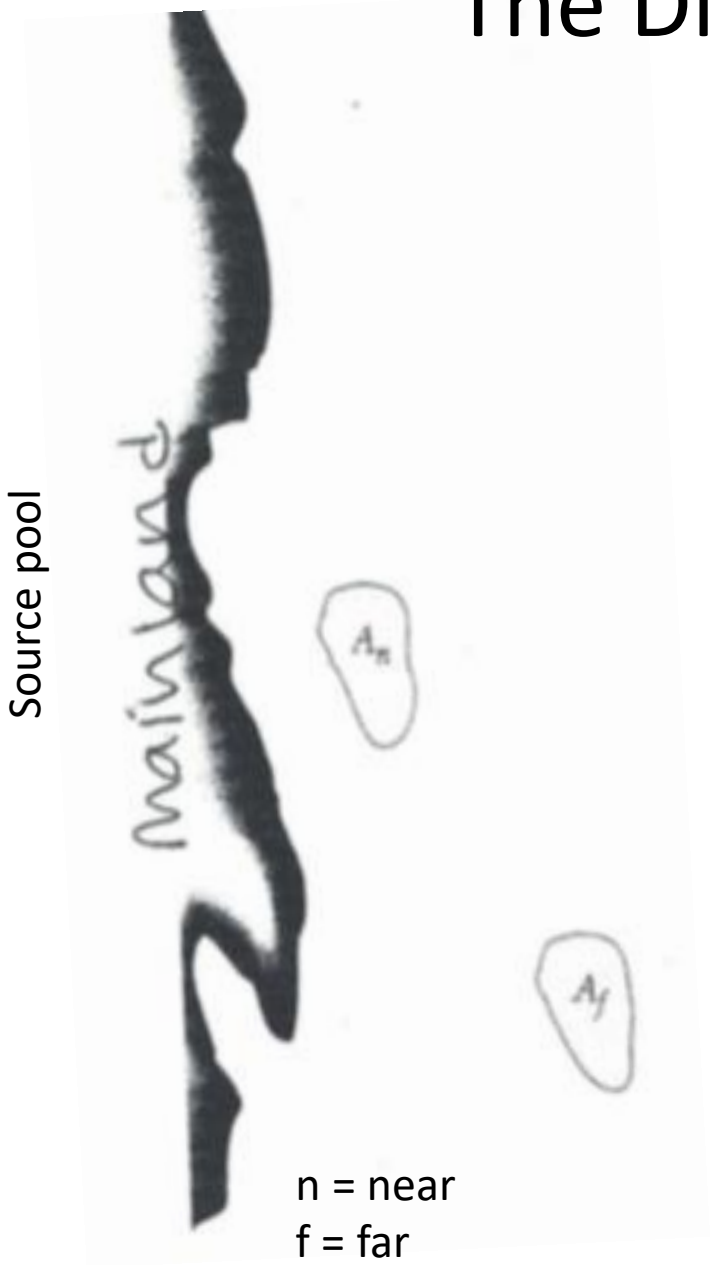
Fig. 9.7. The actual extinction (solid line) and immigration (dashed line) curves for the avifauna on Three Sisters, one of the smaller Solomon islands: the rates are plotted as relative number of species to go extinct, or to immigrate, per year as a function of the number of species on the island.

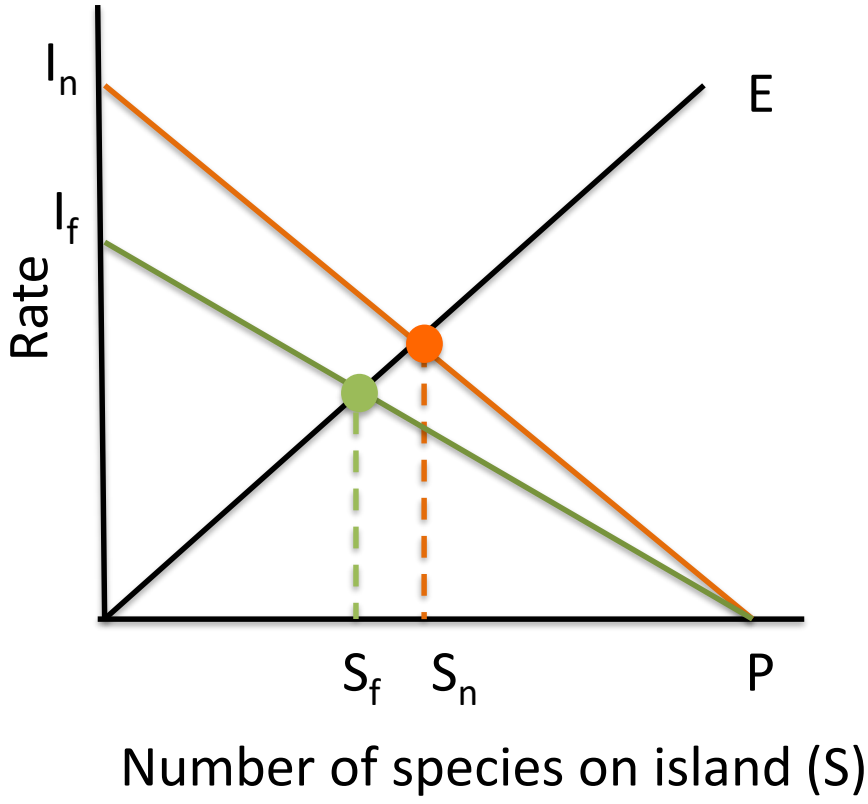
Data for birds in Solomon Islands

Shapes of I and E curves:

r/K selected species

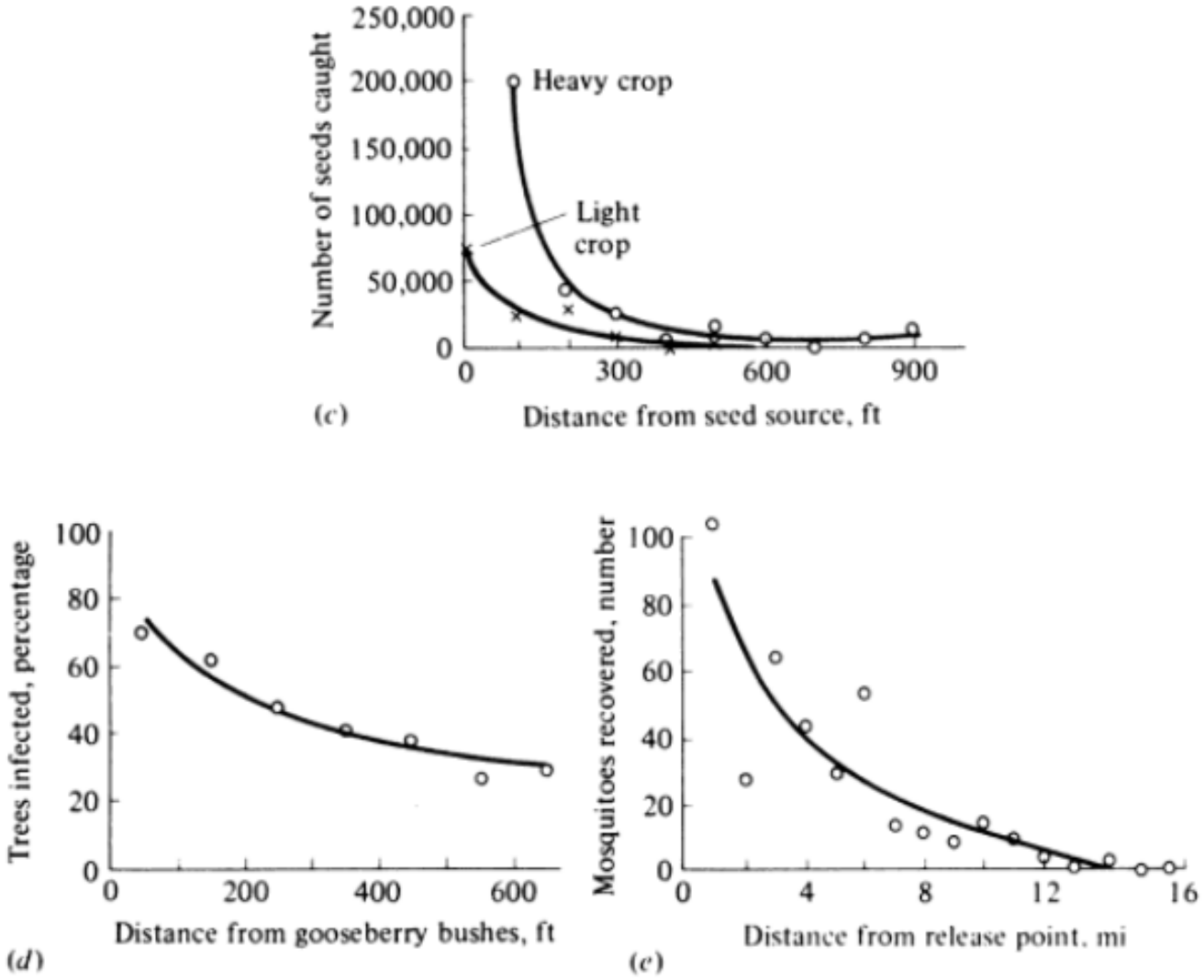
The Distance Effect: Theory





The Distance Effect: Data

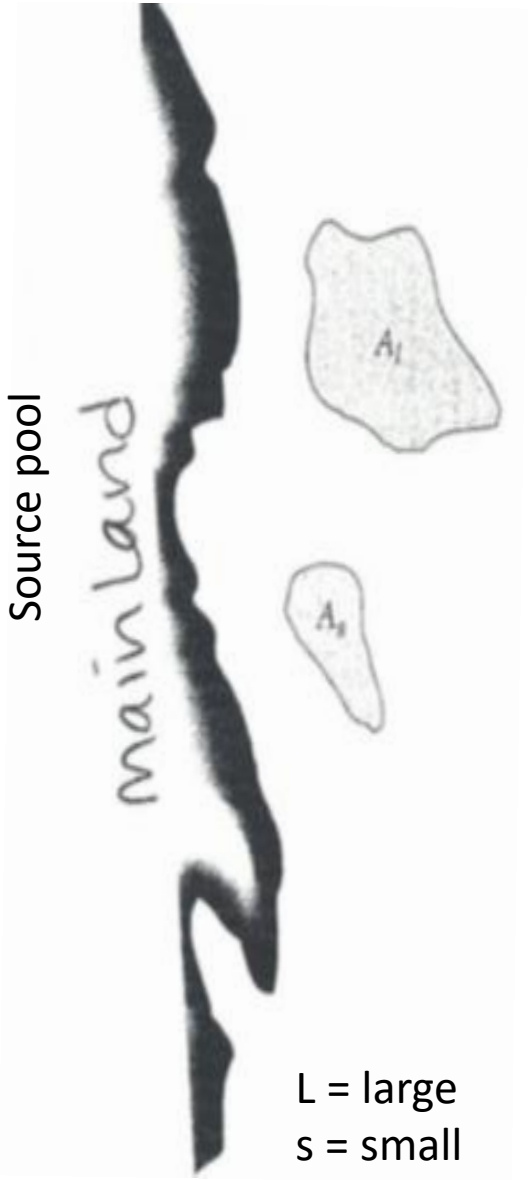
Dispersal

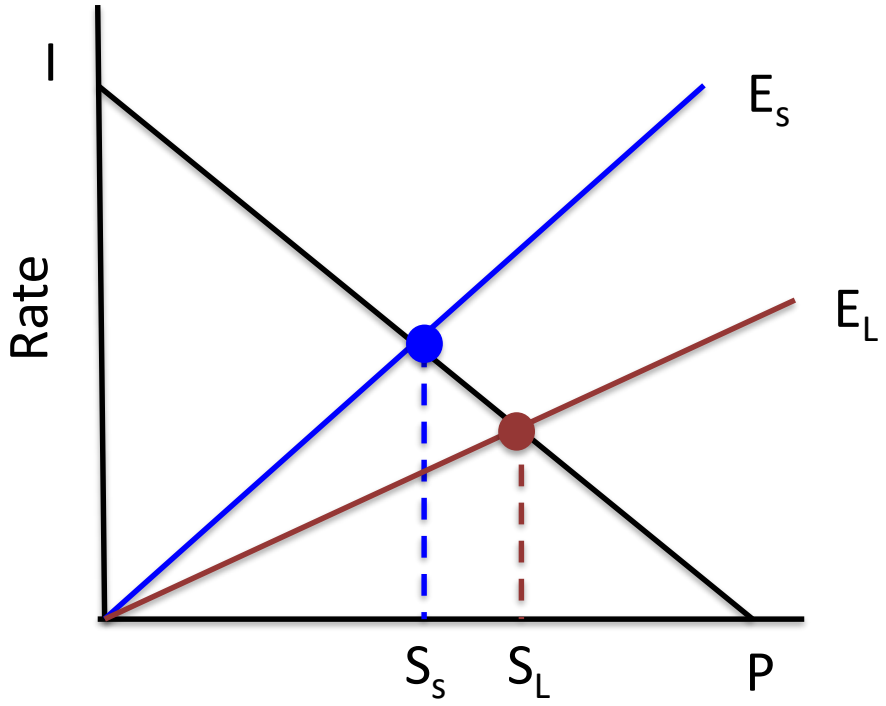


Distance from source

Odum 1959; Wolfenbarger 1976

The Area Effect: Theory





DATA: S-A curves

The Area Effect: Data

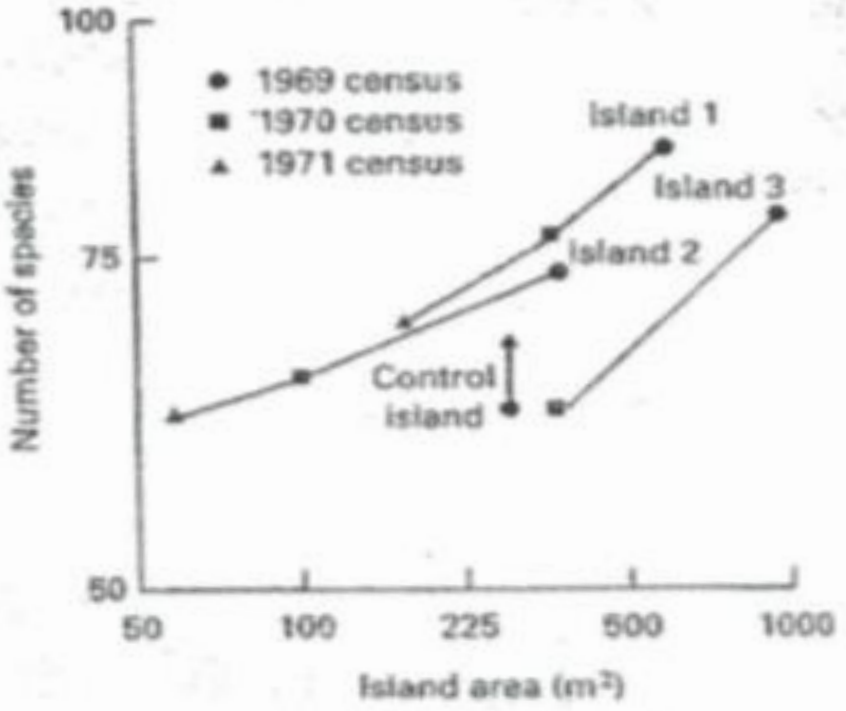
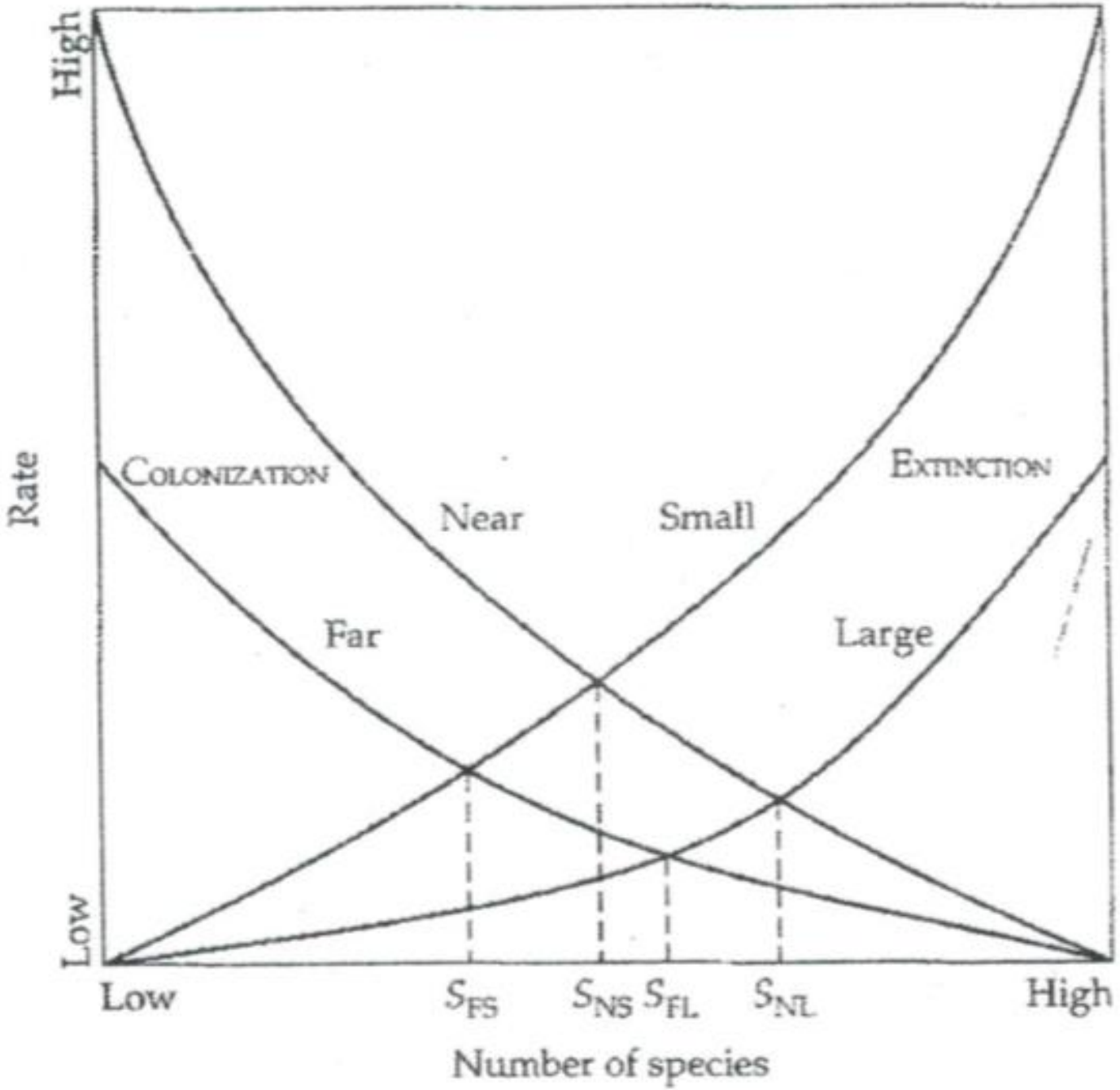


Figure 23.7 The effect on the number of arthropod species of artificially reducing the size of mangrove islands. Islands 1 and 2 were reduced in size after both the 1969 and 1970 censuses. Island 3 was reduced only after the 1969 census. The control island was not reduced, and the change in its species richness was attributable to random fluctuations. (After Simberloff. 1976.)

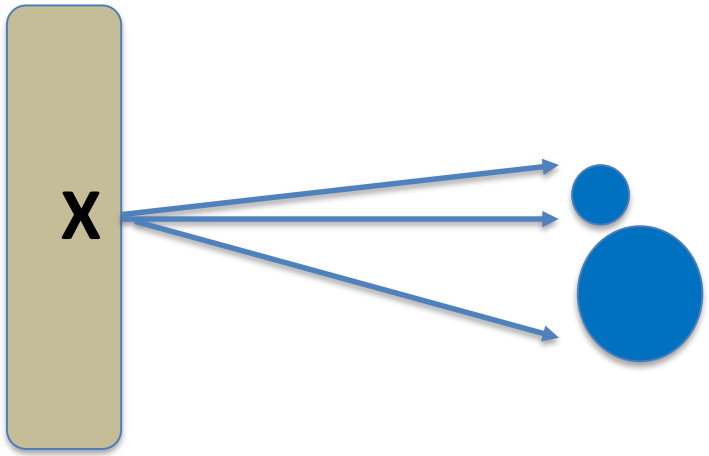
MW Equilibrium Model of Island Biogeography

combined distance-area effects

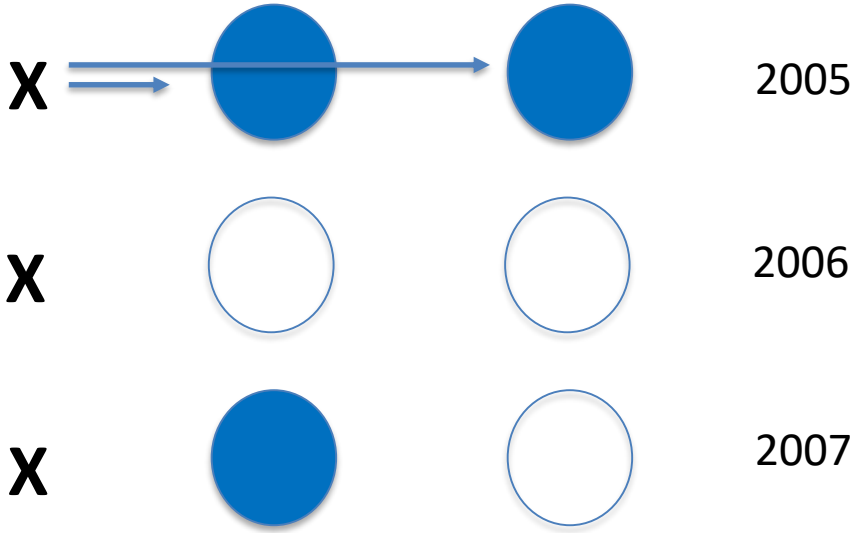


Modifying Effects for MW model

Target effect
= immigration is higher on large islands



Rescue effect
= extinction is lower on near islands



Simberloff's mangrove island experiments
"Defaunation"

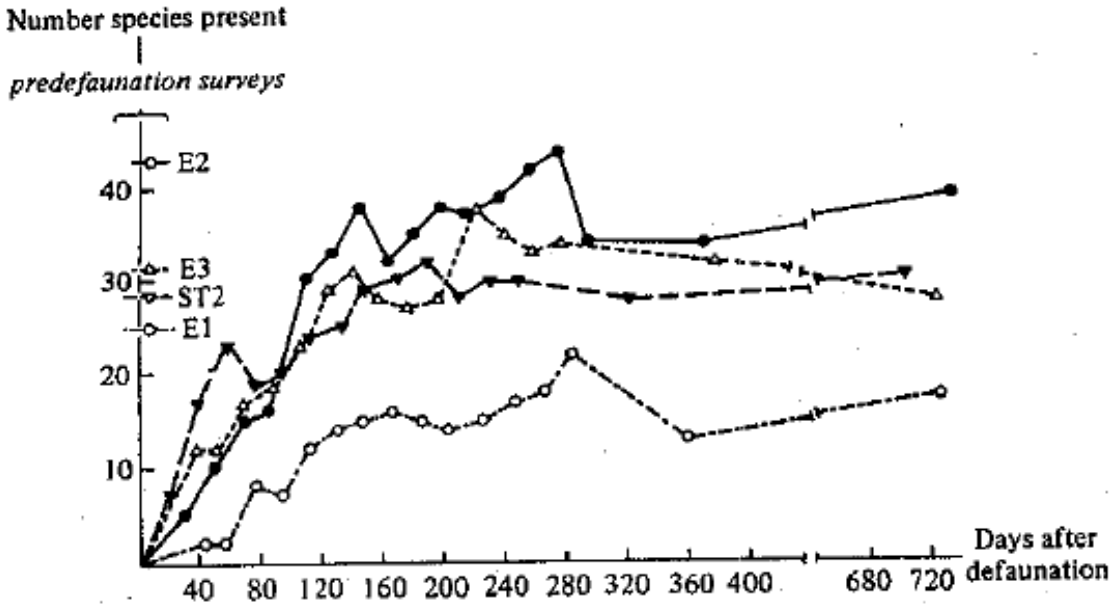
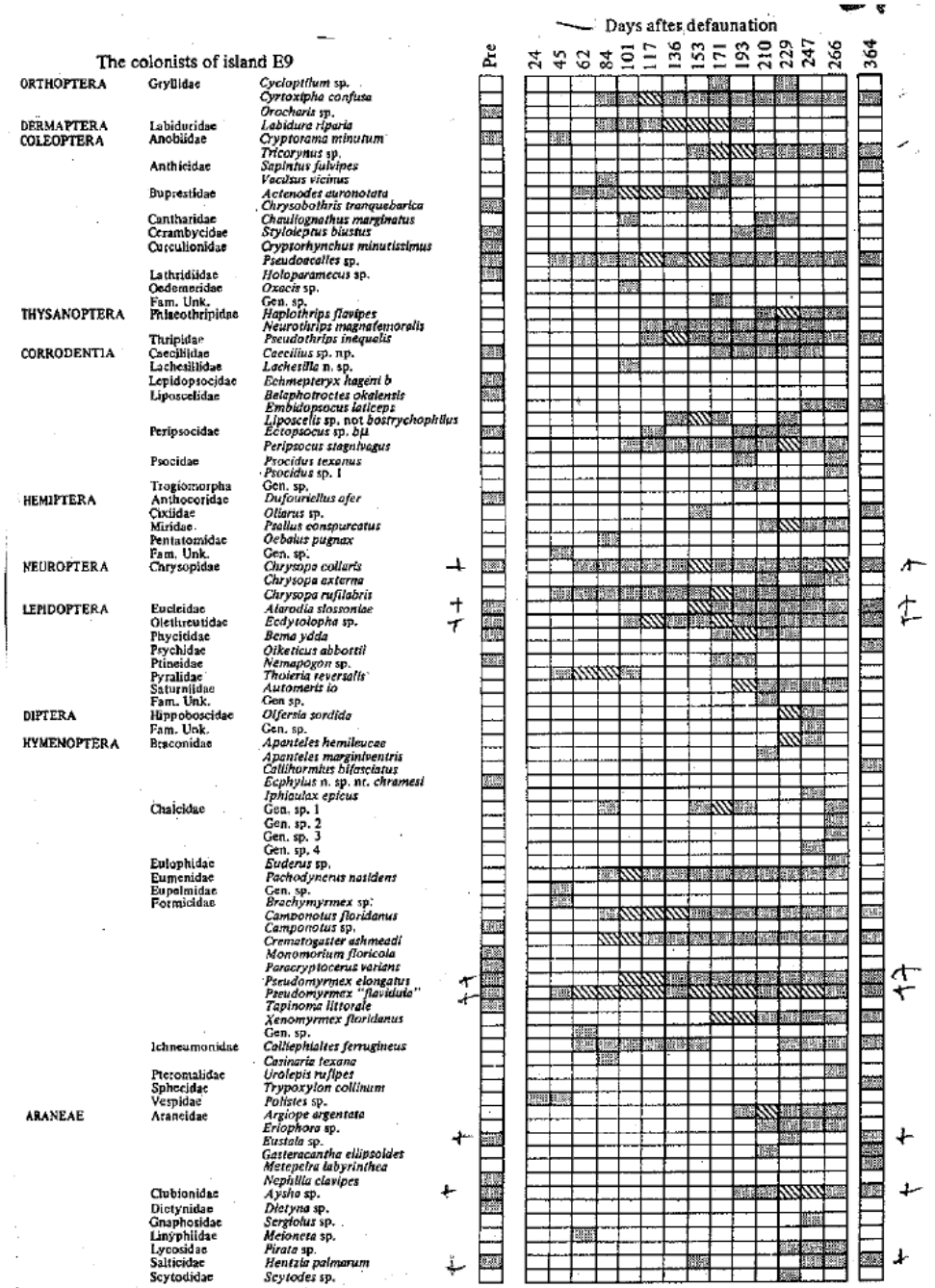


Fig. 5-2

The colonization curves of four small mangrove islands in the lower Florida Keys whose entire faunas, consisting mostly of arthropods, were removed by methyl bromide fumigation. The species numbers just before defaunation and at intervals following it are shown. The number of species is an inverse function of the distance from the nearest source. This effect was evident in the predefaunation census and was preserved when the faunas regained equilibrium after defaunation. Thus, the near island E2 has the most species, the distant island E1 the fewest, and the intermediate islands E3 and ST2 intermediate numbers of species. (From Simberloff and Wilson, 1970.)



Island E9

Pre: 29 species
Post: 24 species

Overlap: 8 species