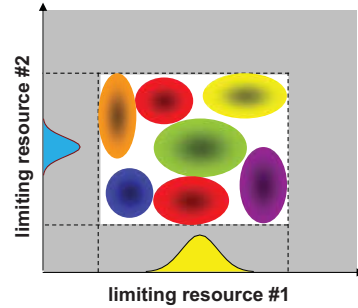


## Part II. How communities & ecosystems work

Unit 4: What are the outcomes of species interactions?

Unit 5: What factors control species diversity in communities?



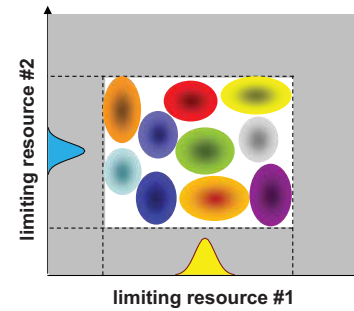
Q: What determines the number that "fit"?

## Part II. How communities & ecosystems work

Unit 4: What are the outcomes of species interactions?

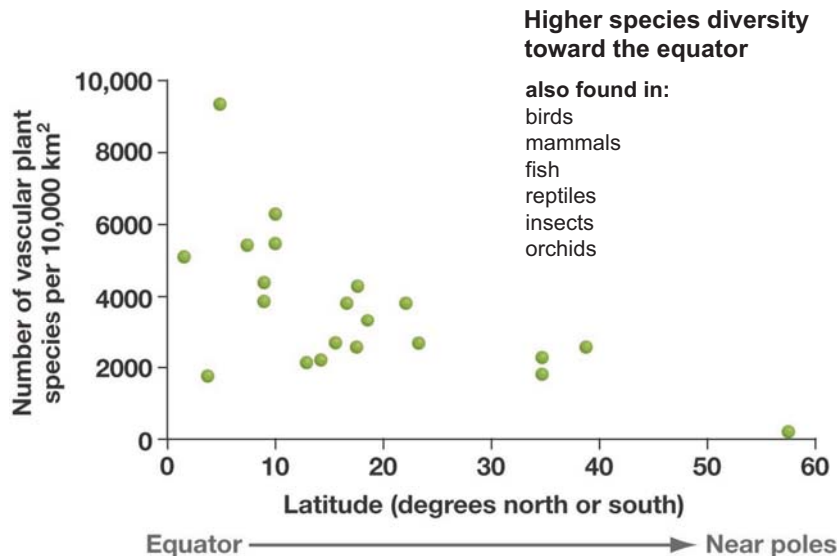
Unit 5: What factors control species diversity in communities?

### 1. Niche sizes



Q: What determines the number that "fit"?

## Part II. How communities & ecosystems work



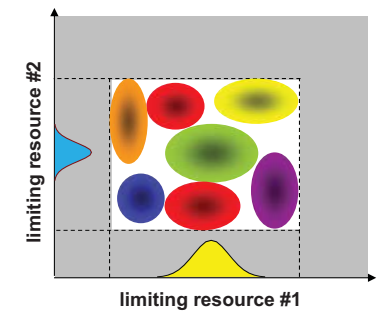
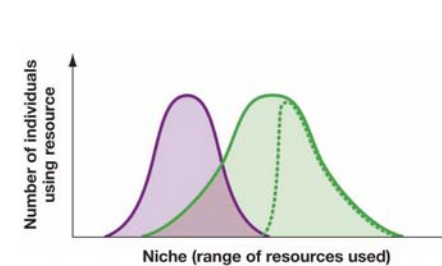
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## Part II. How communities & ecosystems work

Unit 4: What are the outcomes of species interactions?

Unit 5: What factors control species diversity in communities?

1. Niche sizes
2. Niche partitioning



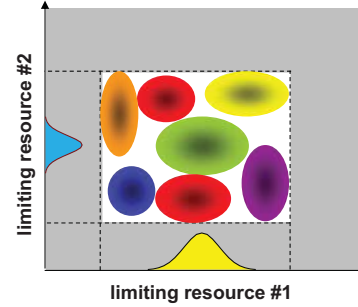
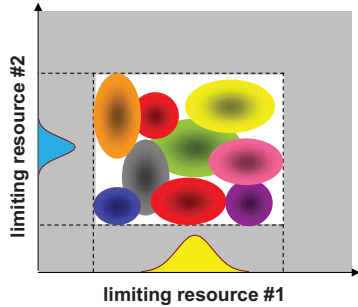
Q: What determines the number that "fit"?

## Part II. How communities & ecosystems work

Unit 4: What are the outcomes of species interactions?

Unit 5: What factors control species diversity in communities?

1. *Niche sizes*
2. *Niche partitioning*



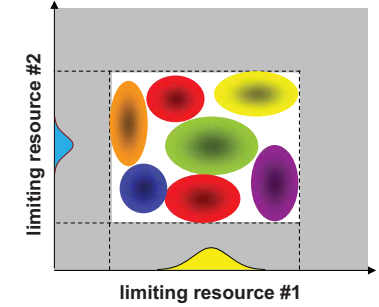
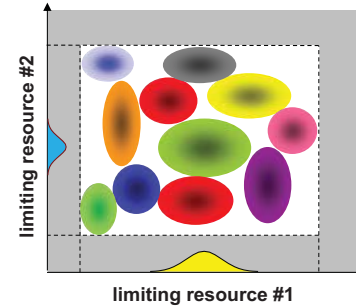
Q: What determines the number that "fit"?

## Part II. How communities & ecosystems work

Unit 4: What are the outcomes of species interactions?

Unit 5: What factors control species diversity in communities?

1. *Niche sizes*
2. *Niche partitioning*
3. *Habitat heterogeneity*

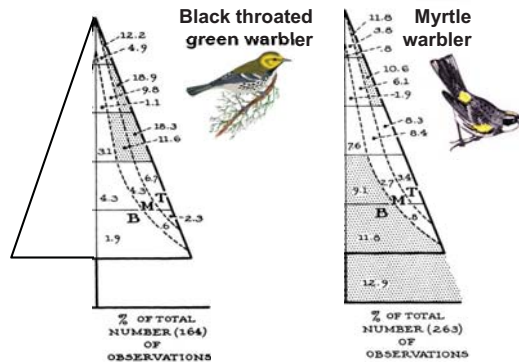


Q: What determines the number that "fit"?

## Explaining patterns of species diversity

3. Habitat heterogeneity can increase the *number of niches*

MacArthur (1958)



for animals:

- diversity of consumables
- complexity of physical structure

for plants:

- diversity of physical factors (pH, light, etc.)
- diversity of limiting nutrients (that limit different species)



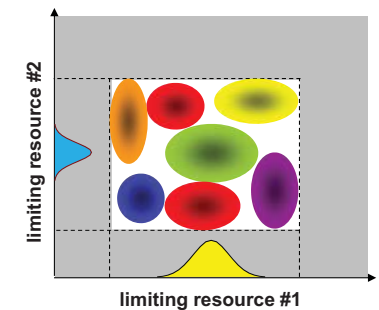
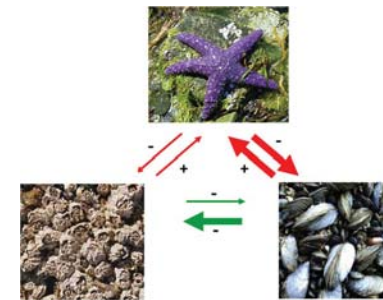
kelp forest

## Part II. How communities & ecosystems work

Unit 4: What are the outcomes of species interactions?

Unit 5: What factors control species diversity in communities?

1. *Niche sizes*
2. *Niche partitioning*
3. *Habitat heterogeneity*
4. *Indirect effects*



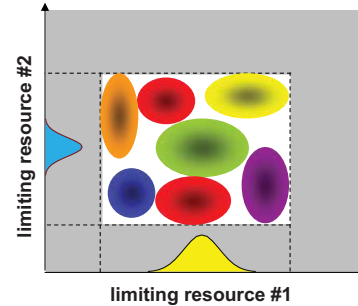
Q: What determines the number that "fit"?

## Part II. How communities & ecosystems work

Unit 4: What are the outcomes of species interactions?

Unit 5: What factors control species diversity in communities?

1. *Niche sizes*
2. *Niche partitioning*
3. *Habitat heterogeneity*
4. *Indirect effects*
5. *Disturbance*



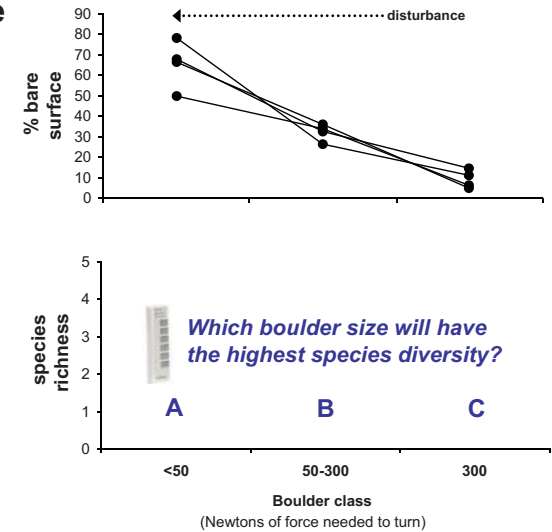
Q: What determines the number that "fit"?

## Explaining patterns of species diversity

### 5. Levels of disturbance

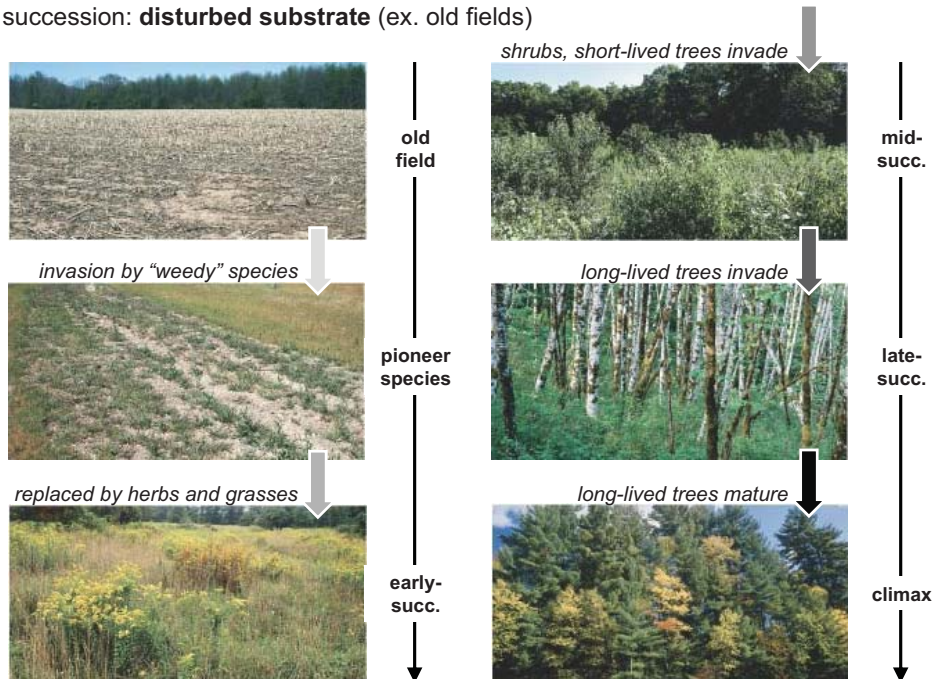
#### Biological communities on intertidal boulders (Sousa, 1979)

- boulders vary in size
- frequency of turning depends on size



## Succession

2° succession: **disturbed substrate** (ex. old fields)

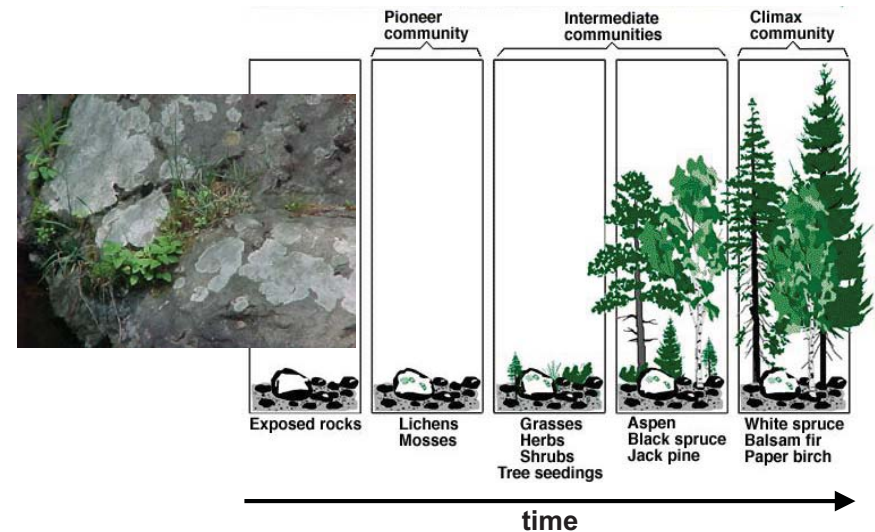


## Succession

1° succession: **new substrate** created by geological event (ex. sand dunes, lava flows, rocks scoured by glaciers, etc.)

*Which species are the...*

- *best colonizers?*
- *best competitors?*



## Explaining patterns of species diversity

**Succession:** tradeoffs in species characteristics

body size

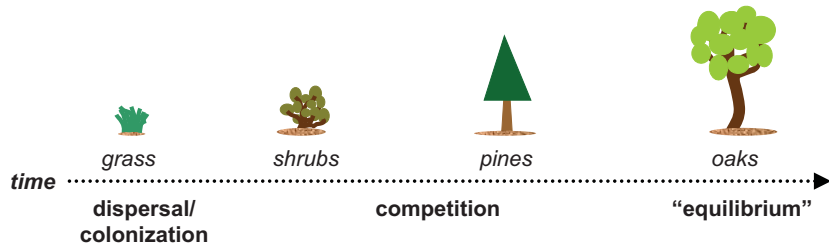
dispersal ability

competitive ability

investment in growth / reproduction

offspring number / size

A	B	C	D	E
H	H	H	H	H
L	L	H	L	H
H	H	L	H	H
L	H	H	H	L
L	H	L	L	H



## Explaining patterns of species diversity

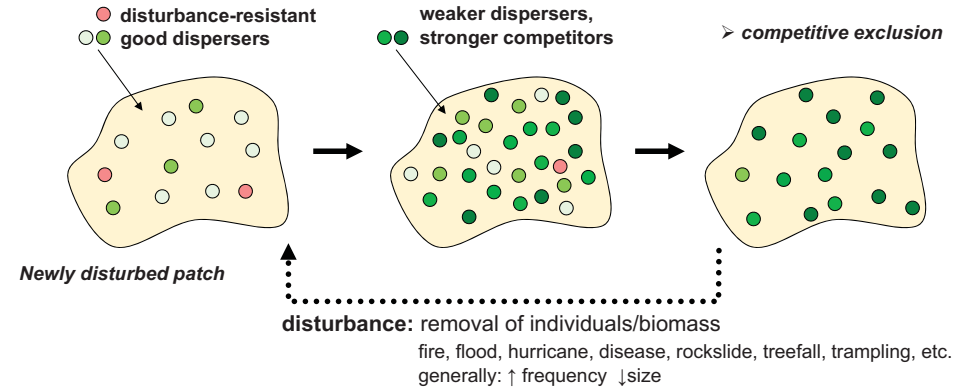
**Succession:** a sequence of changes in community composition initiated by a **disturbance**

**Phase:**

dispersal & colonization

competition

"equilibrium"



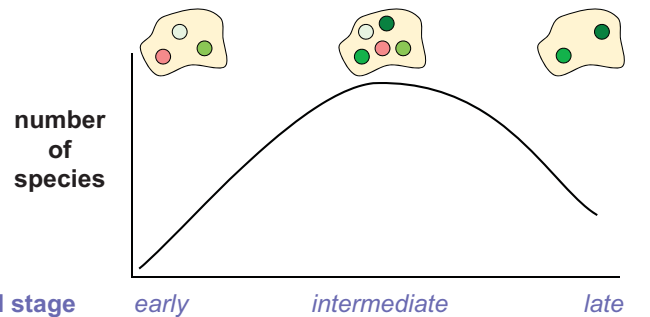
## Explaining patterns of species diversity

Highest diversity expected...

Q1: When during **succession**?

Q2: At what time after **disturbance**?

Q3: Under what **disturbance** level?



time since disturbance

short

intermediate

long

community type

"pioneer"

"intermediate"

"climax"

frequency of disturbance

frequent

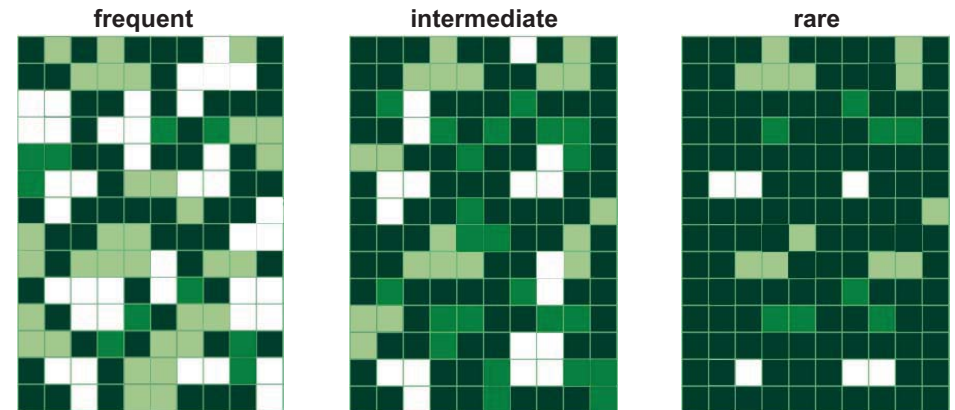
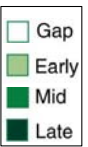
intermediate

rare

## Explaining patterns of species diversity

**"Shifting mosaic" model of succession**

- periodic, small-scale disturbance across a landscape
- patches are at different successional stages

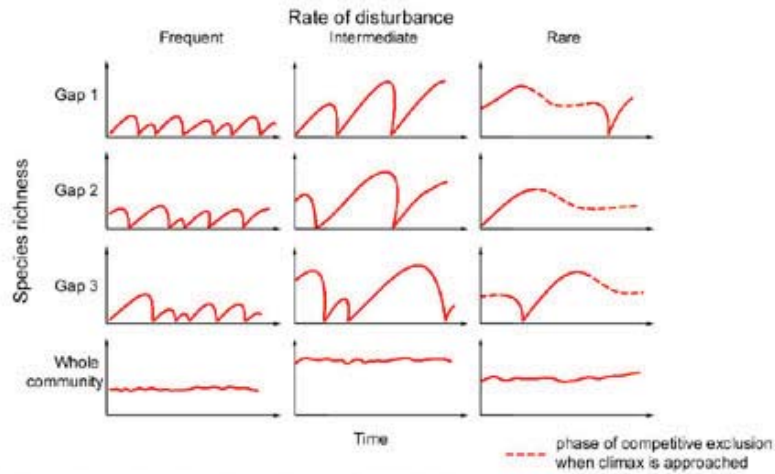


**So, why does intermediate disturbance produce greater diversity?**

1. intermediate stages of succession are **more common**
2. overall biodiversity is the **sum across all patches**

## Explaining patterns of species diversity

*Summing diversity over a “shifting mosaic”*



## Implications for conservation: how to protect and restore biodiversity?

### By protecting natural processes that promote diversity

1. reintroduce natural disturbance regimes
  - promotes succession
  - can promote diversity



2. protect/reintroduce keystone species
  - predators
  - mutualists
  - ecosystem “engineers”



## Part II. How communities & ecosystems work

### A. Species interactions

### B. Factors that influence local species diversity

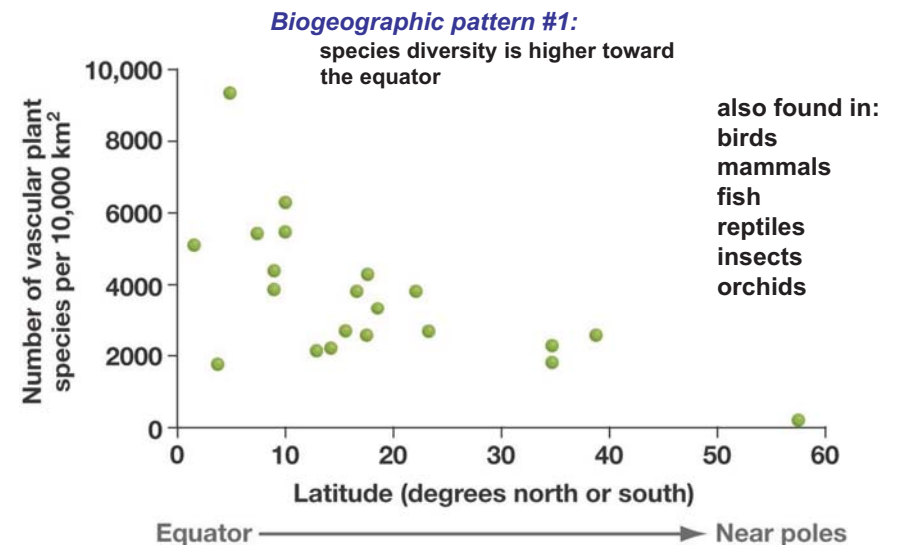
1. *Niche size*
2. *Niche partitioning*
3. *Habitat heterogeneity*
4. *Indirect effects*
5. *Disturbance*



### C. Factors that influence species diversity on a larger scale

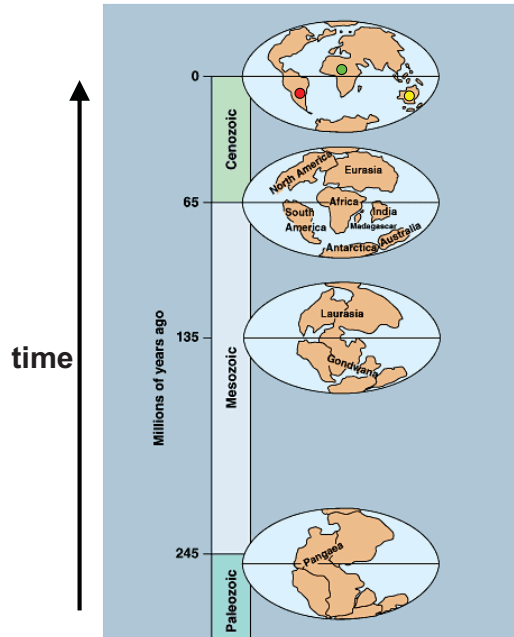
- *Why are particular species found in particular parts of the world?*
- *Why do some areas show higher biodiversity than others?*

## Biogeography — geographic patterns of species diversity and distribution



*What can explain latitudinal patterns?*

## Biogeography — reflects *dispersal, isolation, and speciation*



### Biogeographic pattern #2:

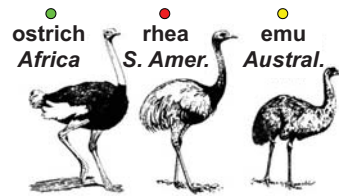
similar distinctive organisms on different continents (marsupials, ratites)

#### Process:

vicariance resulting from continental drift

When did ratites (ostriches, emus, rheas) originate?

- A) ~65 mya
- B) ~135 mya
- C) ~245 mya



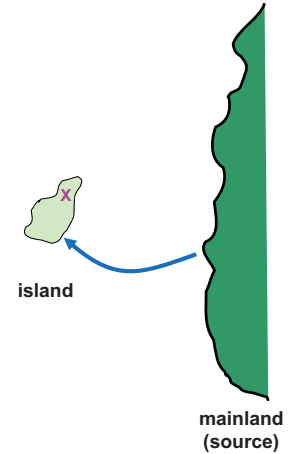
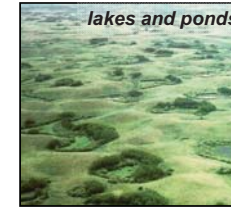
## Biogeography — reflects *dispersal, isolation, and speciation*

### Biogeographic pattern #3:

islands have fewer species than equivalent areas of mainland

#### “Island Biogeography Theory”

• predicts equilibrium balance between **colonization** and **local extinction**



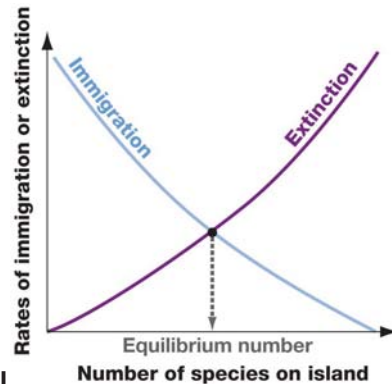
As more species accumulate on an island...  
 ...the **colonization** rate decreases  
 ...the **extinction** rate increases

#### Immigration

- good dispersers arrive quickly
- poor dispersers arrive slowly
- the island saturates with species that have already arrived

#### Extinction

- competition intensifies as niches fill
- smaller populations at greater risk of extinction

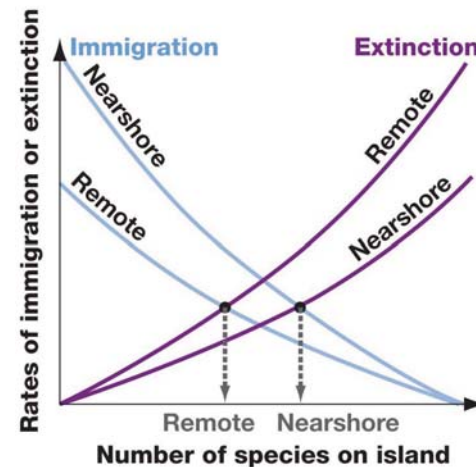


Why does the equilibrium number of species vary among “islands”?

- What affects extinction? What affects colonization?

Number of species should decrease with **isolation**...

- fewer species can disperse to more distant islands
- “rescue effect” is less likely on more distant islands

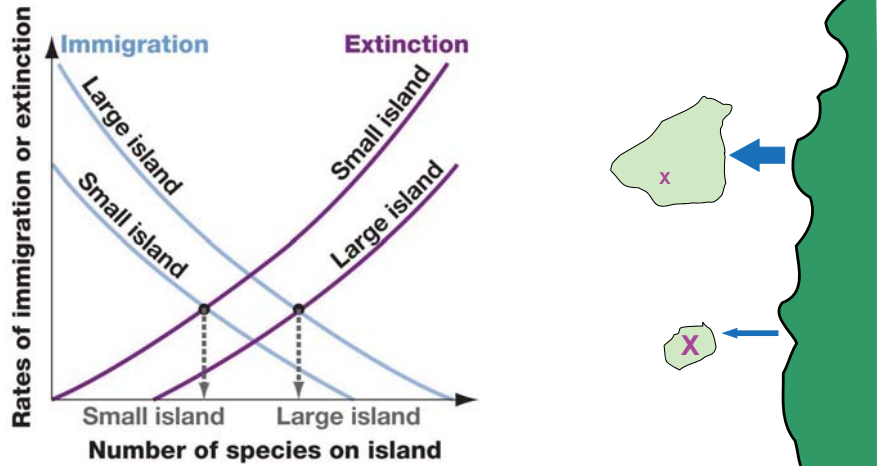


Which is true for a more distant island?

- A) equilibrium number decreases
- B) equilibrium number increases
- C) I rate > E rate
- D) I rate < E rate

Number of species should increase with island size...

- more immigrants can reach larger islands
- more niches and larger populations on larger islands

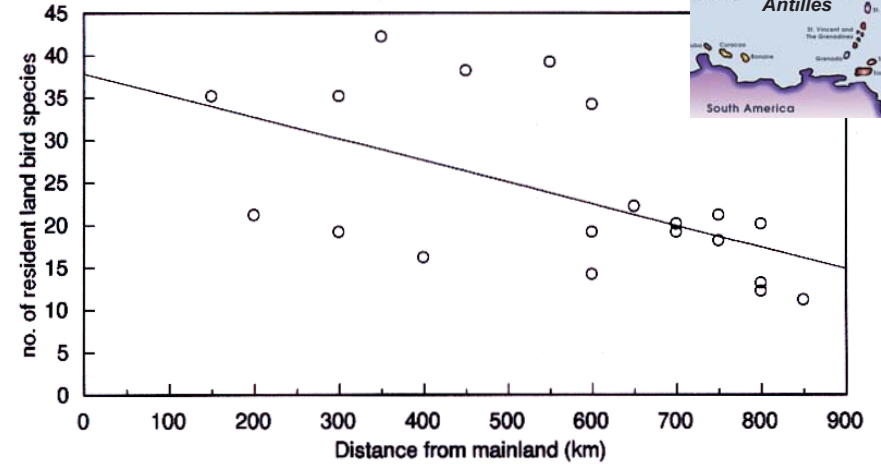
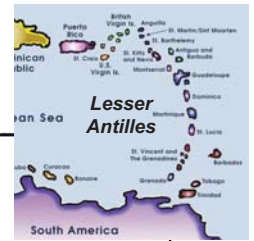


Which is true for a larger island?

- A) equilibrium number decreases
- B) equilibrium number increases
- C) I rate > E rate
- D) I rate < E rate

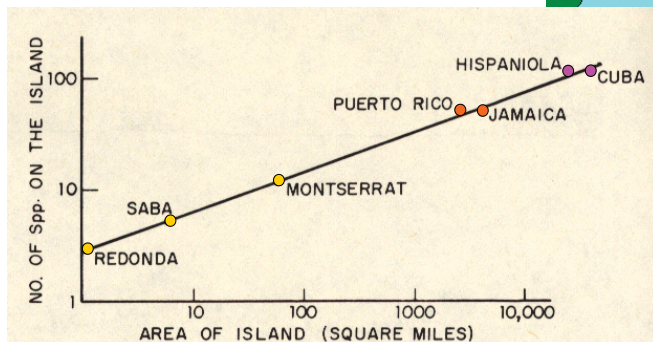
Does species number decrease with distance from source?

- Lesser Antilles: more isolated (distant) islands contain fewer species



Does species number increase with island size?

- Greater Antilles: larger islands contain more species

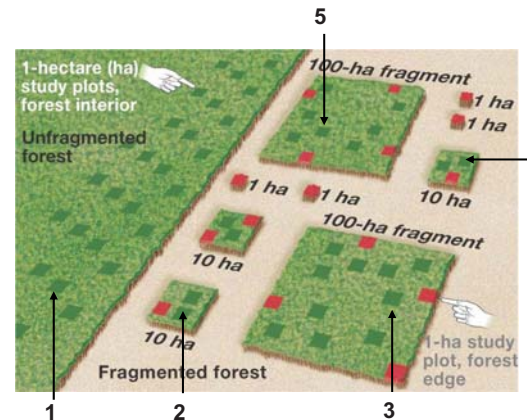


2 AREA-SPECIES CURVE of reptiles and amphibians in the West Indies.

How is this theory useful in conserving biodiversity?

Island Biogeography Theory and Conservation Biology

Q: How do fragment **size** and **isolation** influence biodiversity?



Manaus, Brazil

- in 1979, ranchers were convinced to pattern their fragmentation of rainforest when clearcutting
- changes in species diversity and composition have been measured ever since in non-edge (green) and edge (red) plots

Q: Using Island Biogeography theory, which plots are expected to have the highest and lowest species diversity, respectively?

- A) 1, 2
- B) 2, 1
- C) 3, 2
- D) 5, 4
- E) 1, 4