

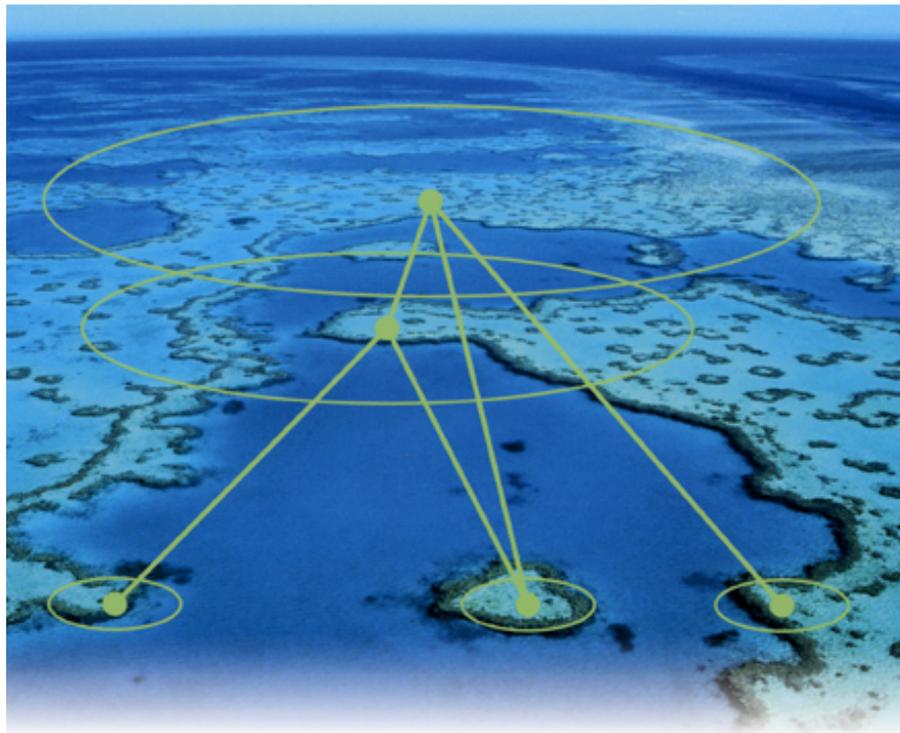
# Ecology 8310

## Population (and Community) Ecology



### Communities in Space (Metacommunities)

- Island Biogeography (an early view)
- Evolving views
- Similarity in space
- Spatial subsidies; linkages across communities



# METACOMMUNITIES

*Spatial Dynamics and Ecological Communities*

EDITED BY

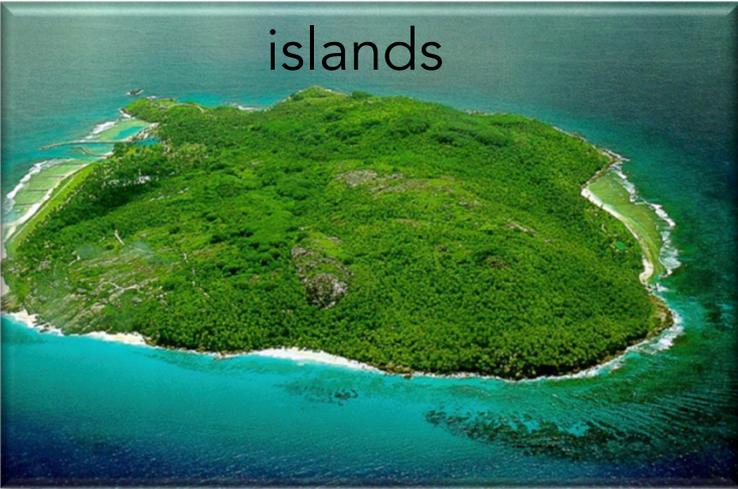
Marcel Holyoak, Mathew A. Leibold,  
and Robert D. Holt

2005

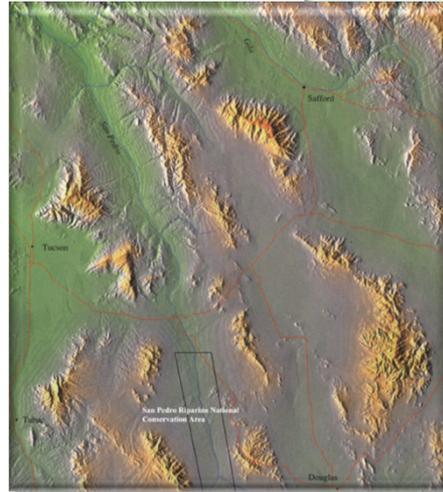
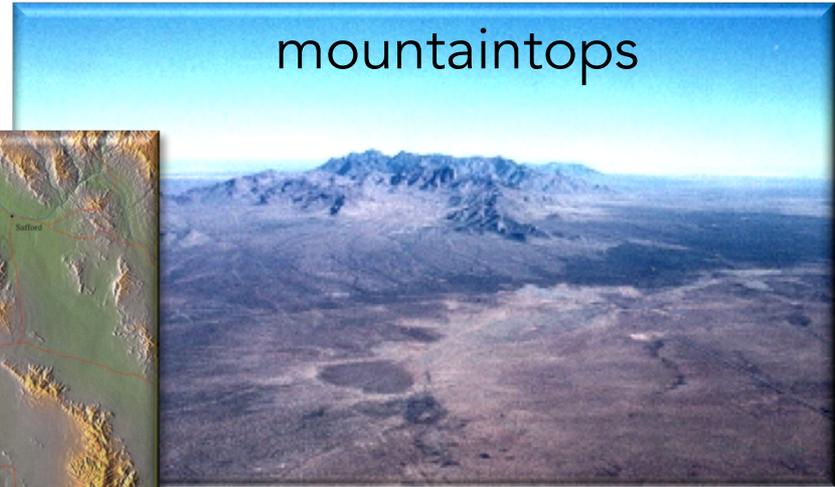
One foundation: island biogeography

# Isolated habitats ("islands"):

islands



mountaintops



lakes and ponds

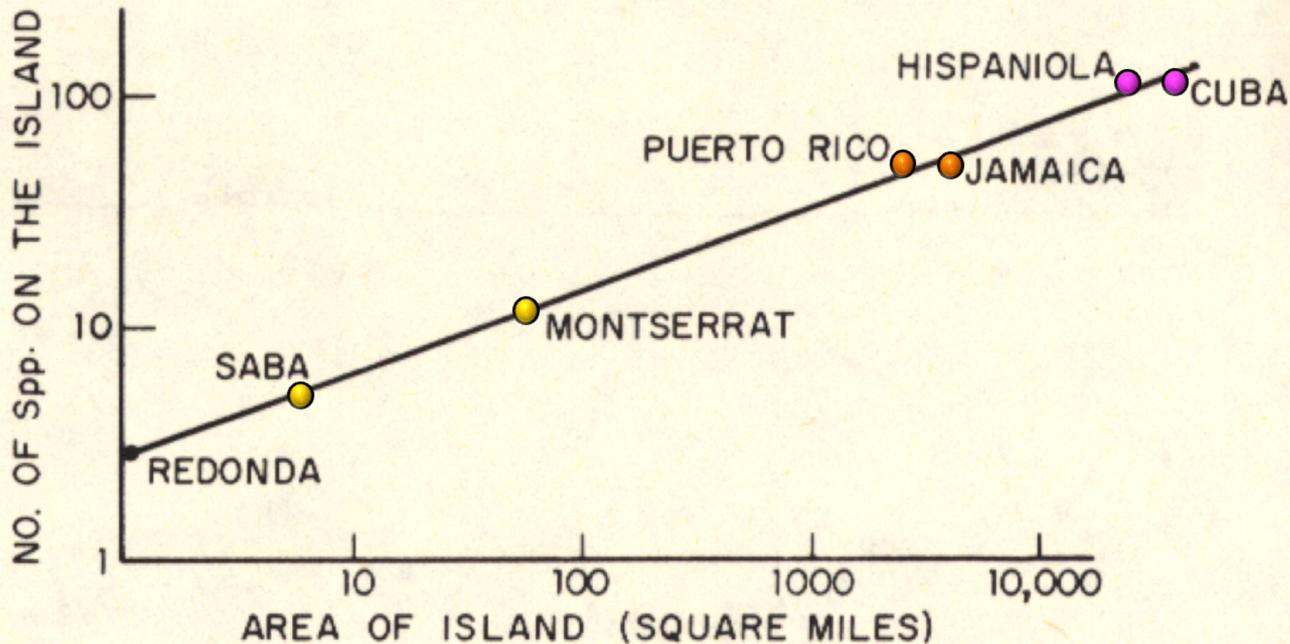


fragmented habitats



Patterns...

# Effect of Area



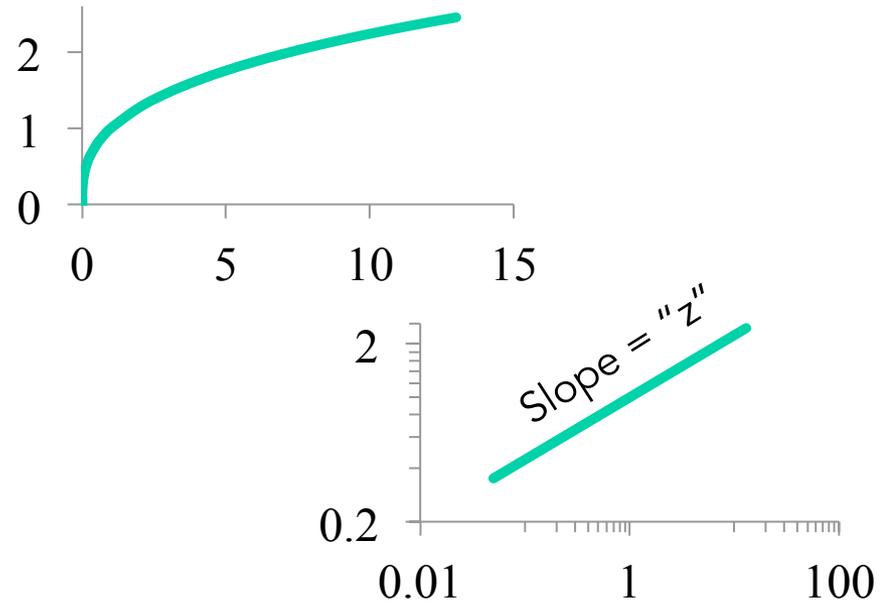
2 AREA-SPECIES CURVE of reptiles and amphibians in the West Indies.

- larger islands contain more species than smaller islands
- note log scales (power function)

# Species Area Relationship

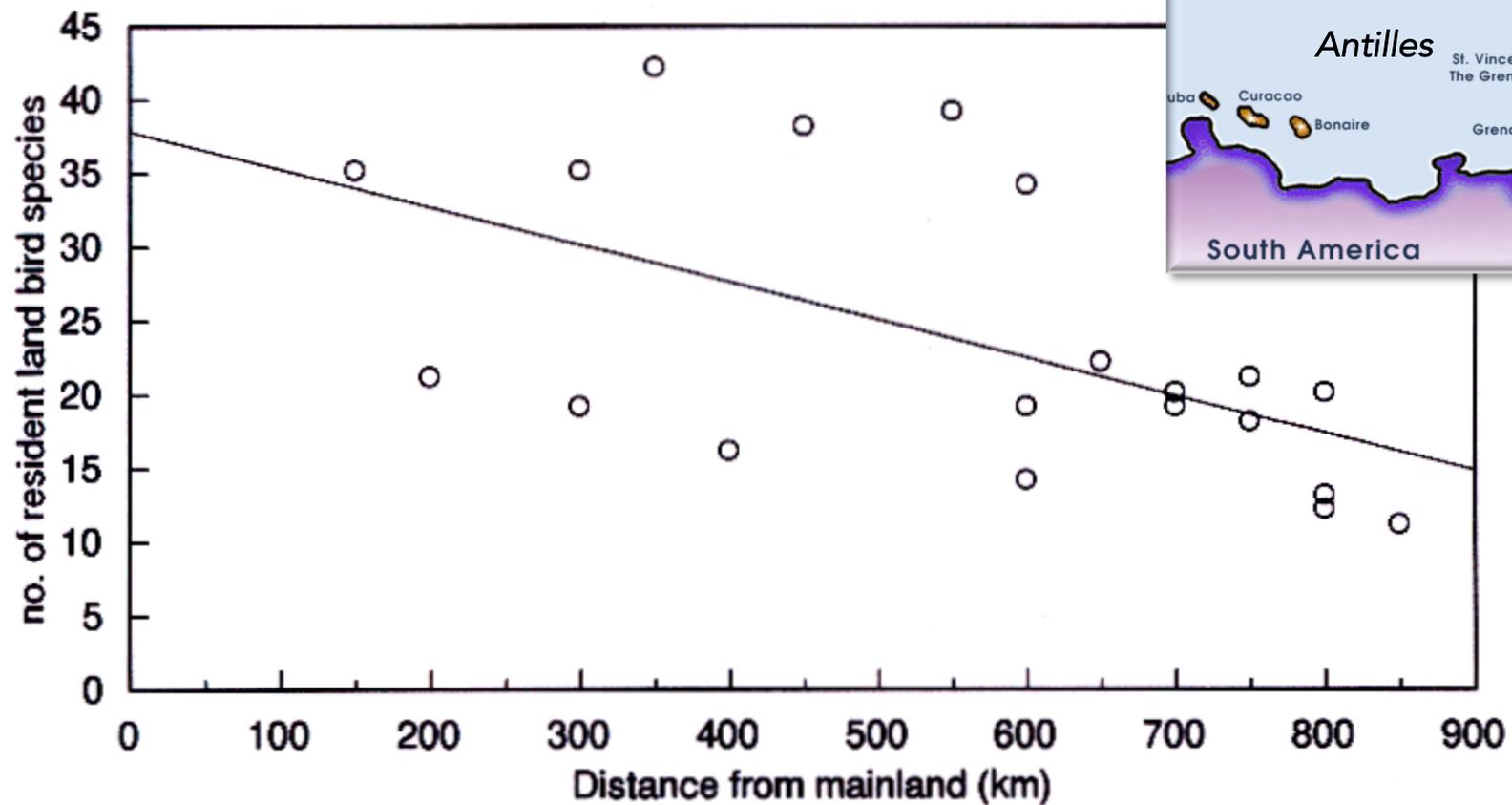
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$$S = cA^z$$



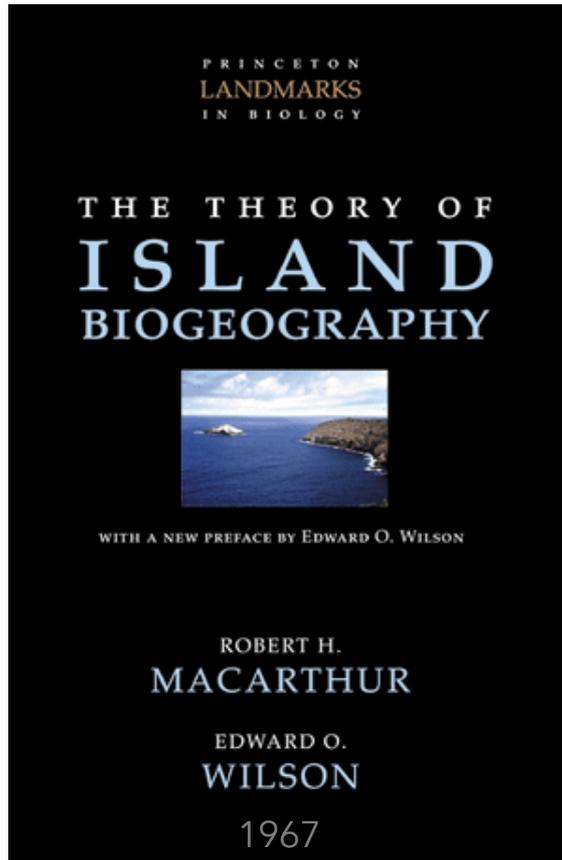
- $S$  = species richness
- $A$  = sampling plot size (island size)
- $c$  = constant (region-specific)
- $z$  = constant (slope): approx .25 - .45  
(e.g., 10x increase in  $A \rightarrow 2x$  increase in  $S$ )

# Effect of Isolation



- isolated (distant) islands contain fewer species

# MacArthur and Wilson (1967)



Isolation and area affect colonization rate

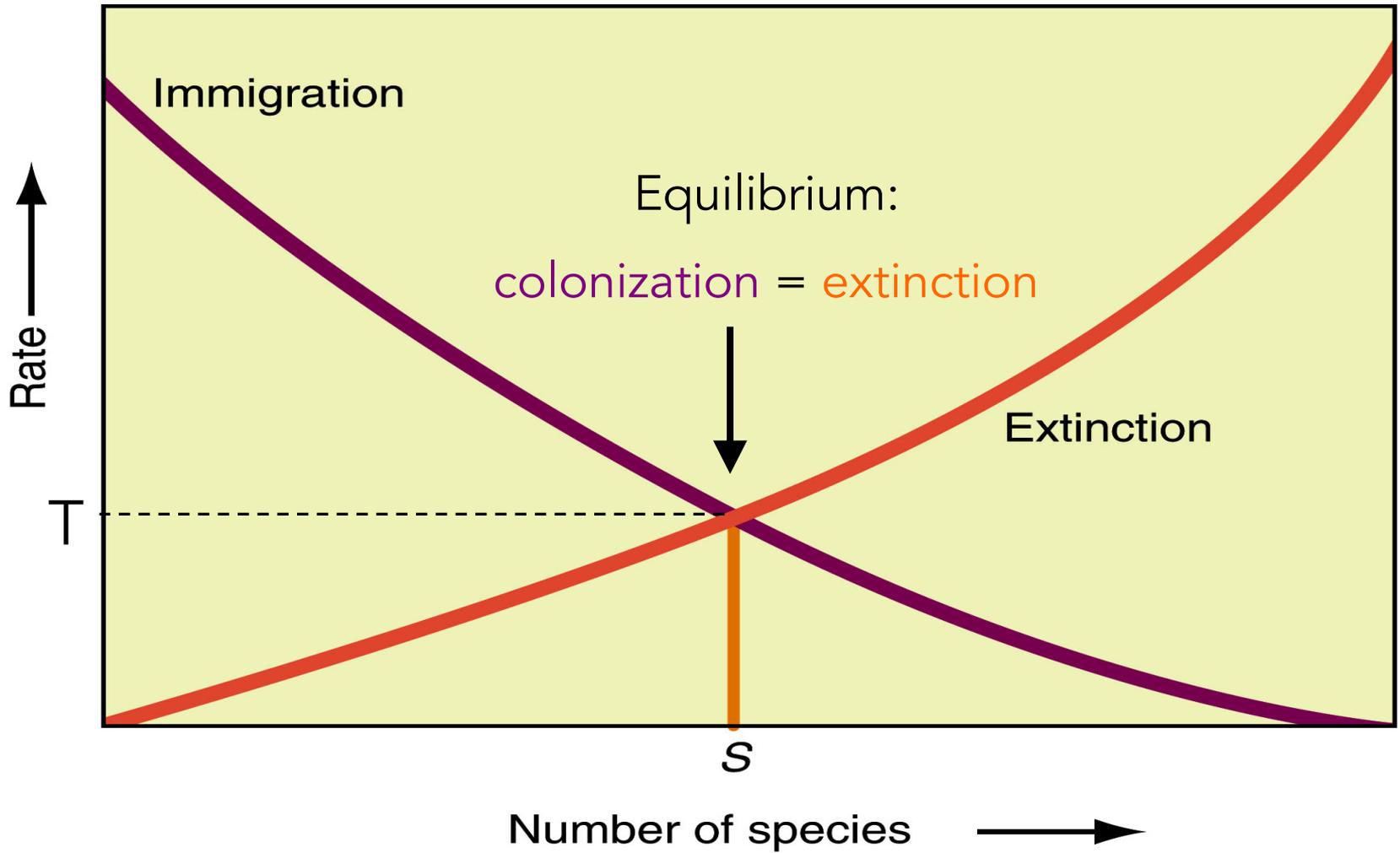
- Near > Far
- Large > Small

Area affects extinction rate

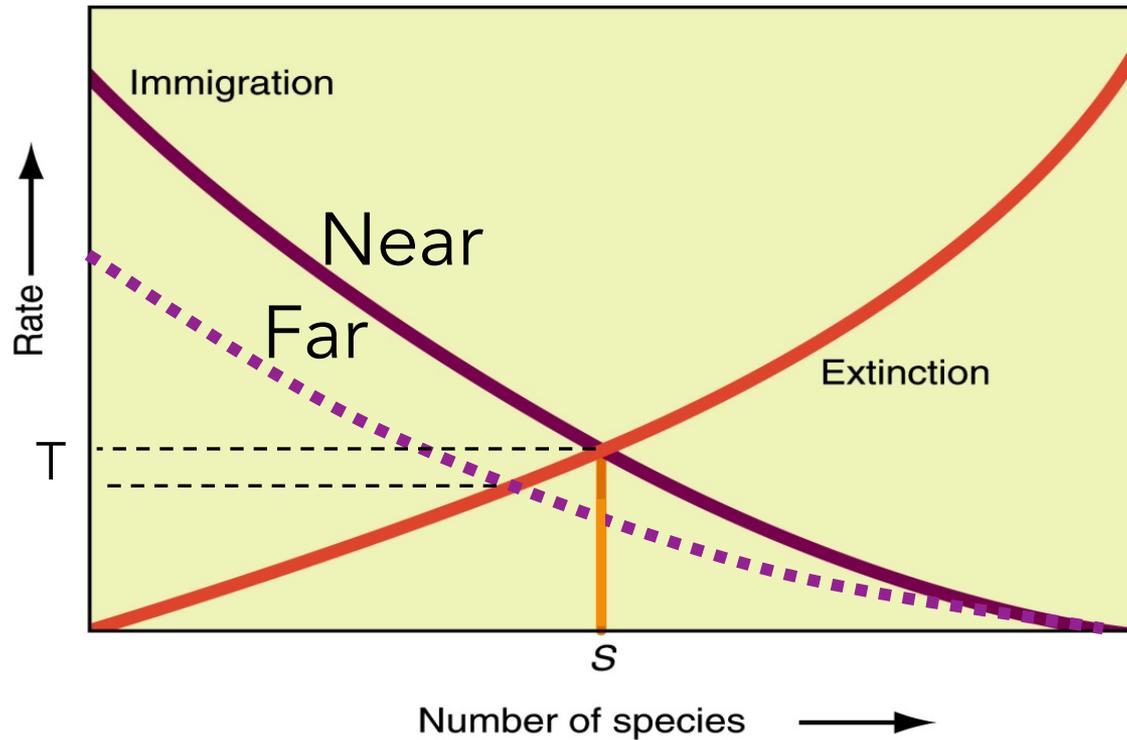
- Large < Small
  - more habitats
  - larger population

# Island Biogeography:

- No. species is a dynamic equilibrium between colonization and extinction.
- Without colonization....all species eventually go extinct.
- Recall meta-population island-mainland model (similar concepts).

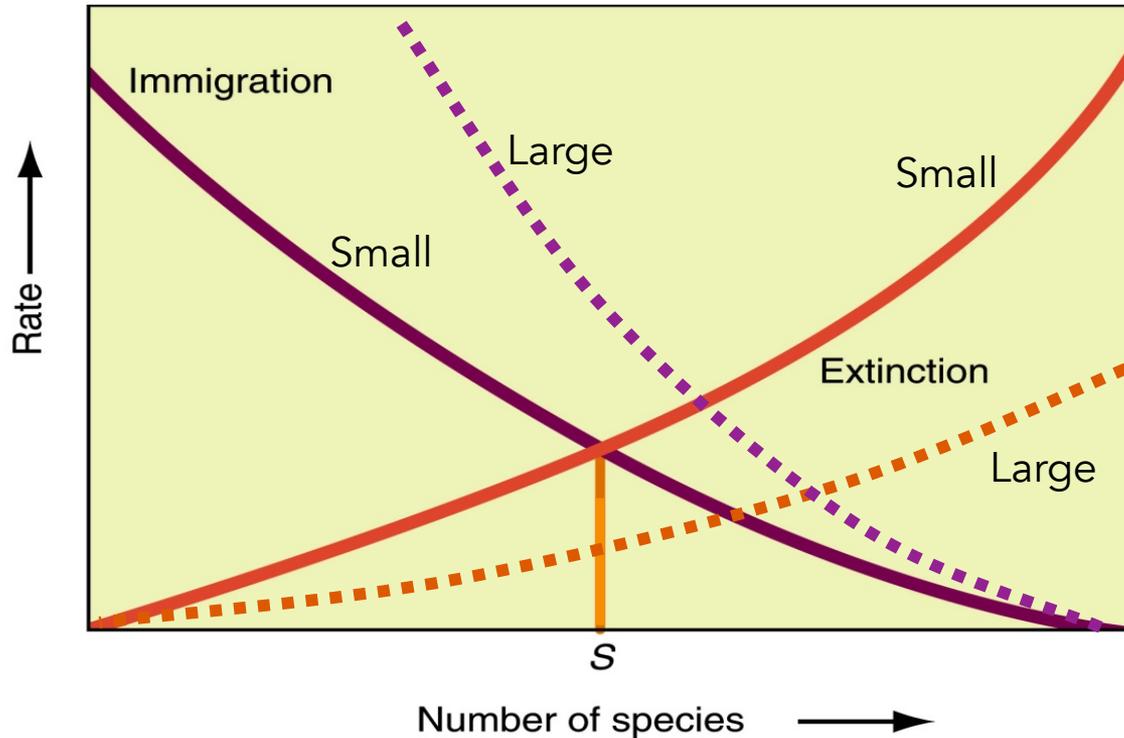


# Effect of *isolation* ?

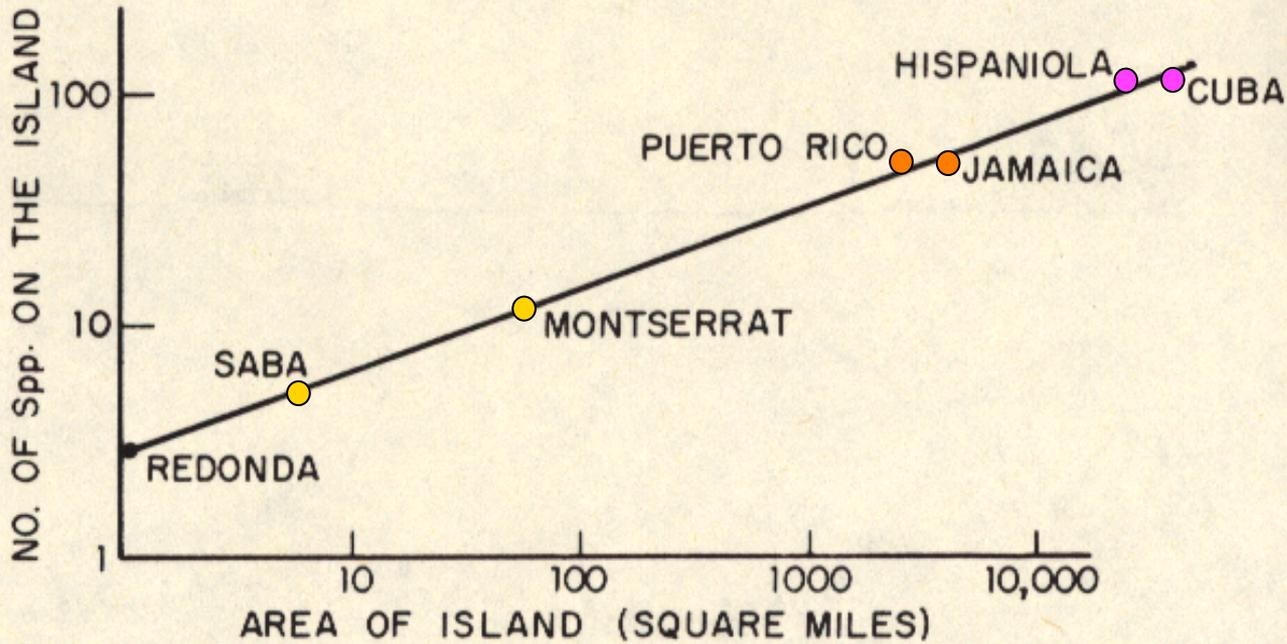


Far: fewer species (slower turnover)

# Effect of island size ?

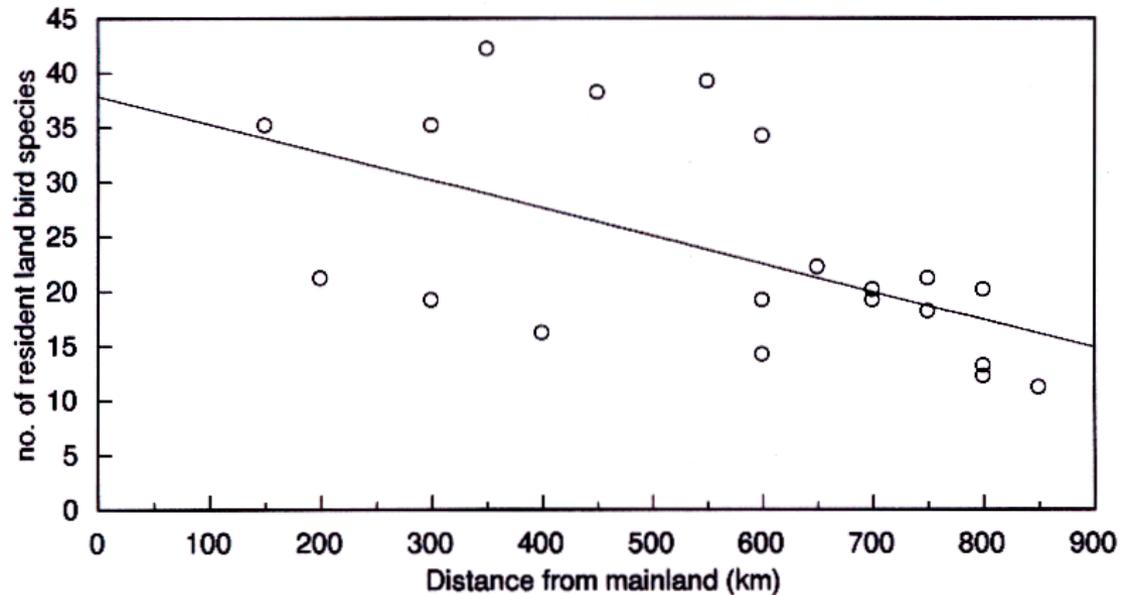


Large islands: more species (turnover ??)



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

So, the model captures the two key features from data on islands...



More recent views

REVIEW

## The metacommunity concept: a framework for multi-scale community ecology

M. A. Leibold,<sup>1\*</sup> M. Holyoak,<sup>2</sup>  
N. Mouquet,<sup>3,4</sup> P. Amarasekare,<sup>5</sup>  
J. M. Chase,<sup>6</sup> M. F. Hoopes,<sup>7</sup>  
R. D. Holt,<sup>8</sup> J. B. Shurin,<sup>9</sup> R. Law,<sup>10</sup>  
D. Tilman,<sup>11</sup> M. Loreau<sup>12</sup> and  
A. Gonzalez<sup>13</sup>

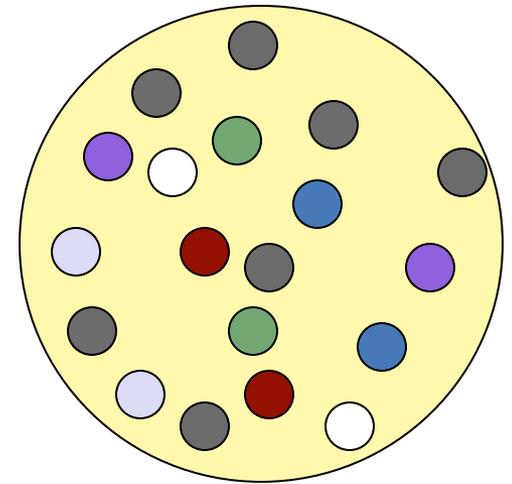
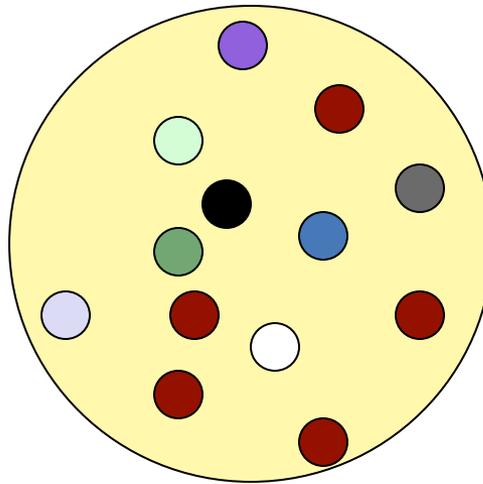
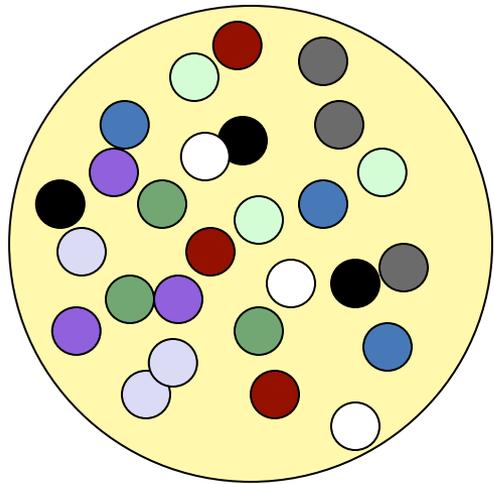
### *Metacommunity:*

"a set of local communities that are linked by dispersal of multiple potentially interacting species"

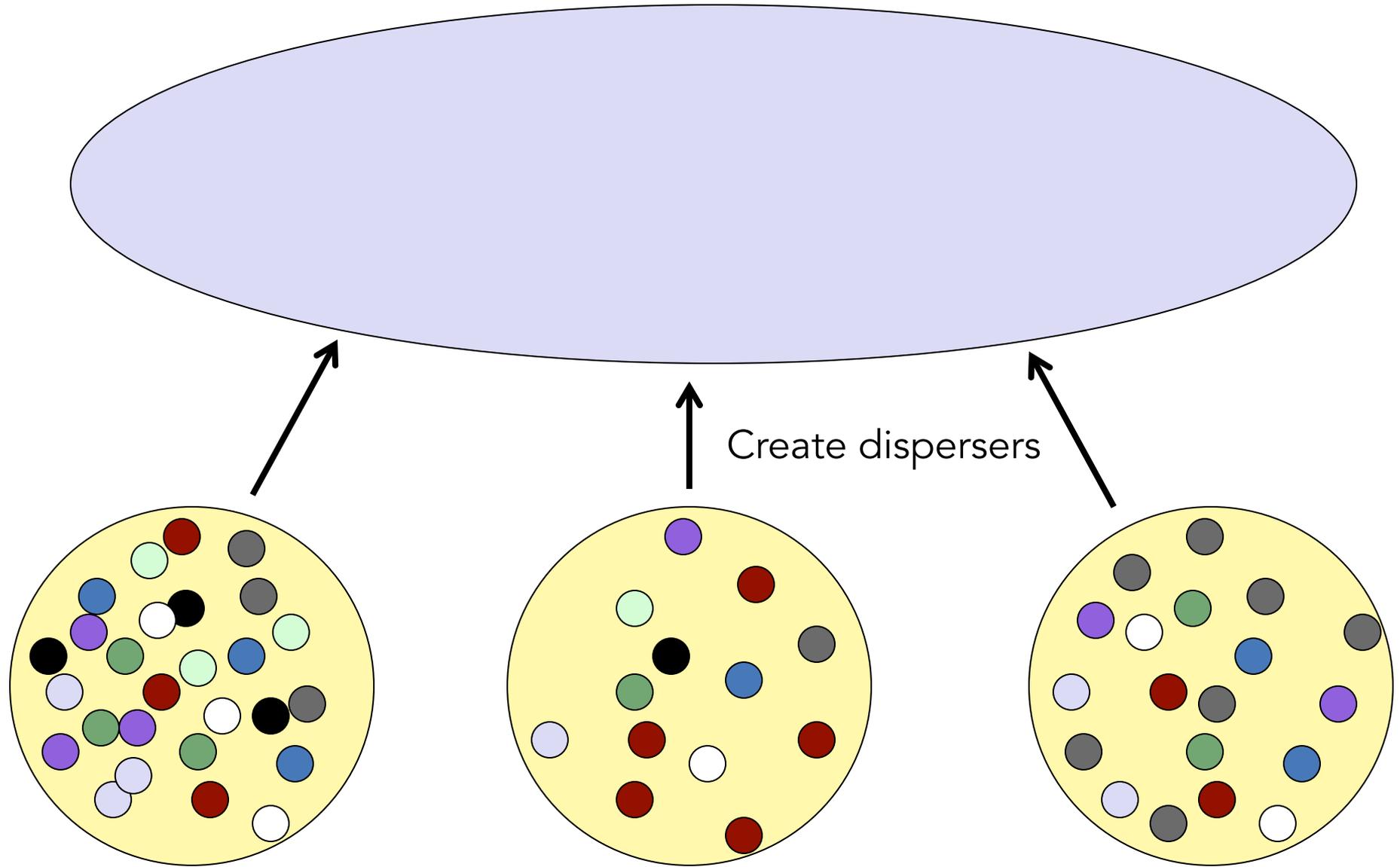
(beyond the fixed mainland pool)

Views of Wilson (1992) vs. Leibold et al. (2004)

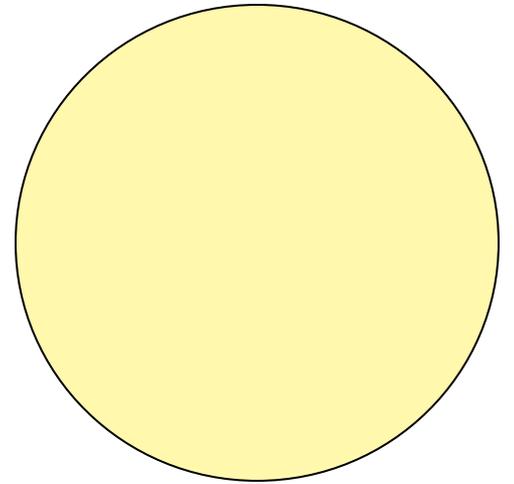
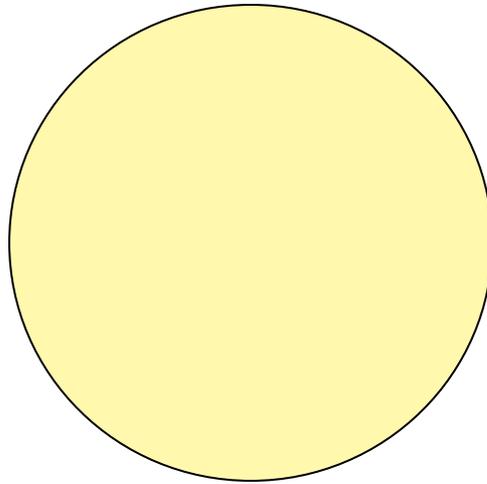
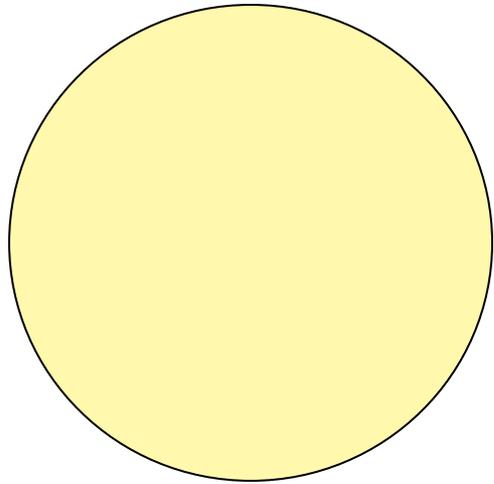
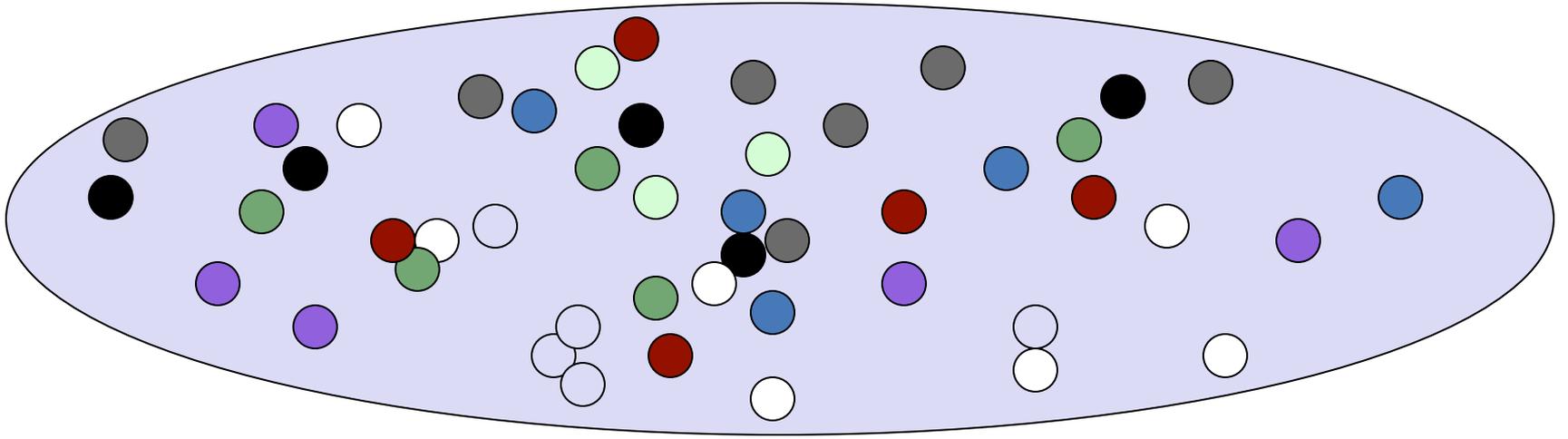
Wilson (1992)



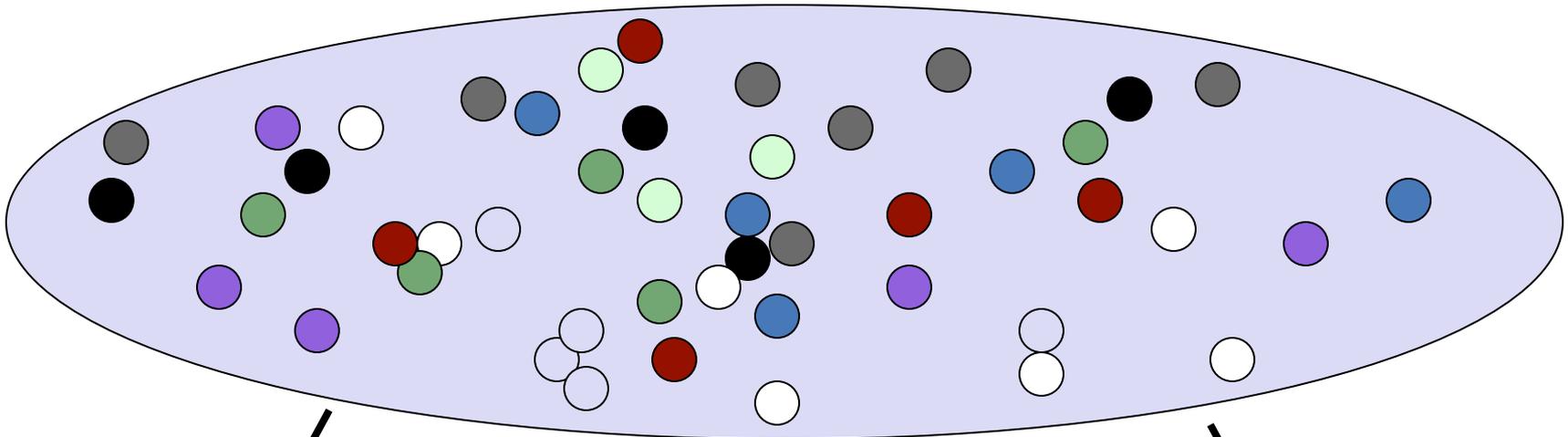
Wilson (1992)



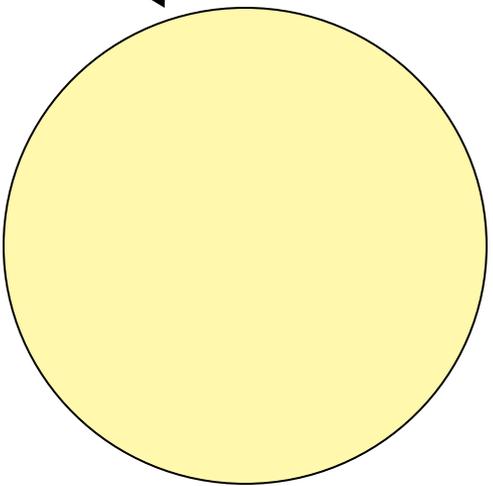
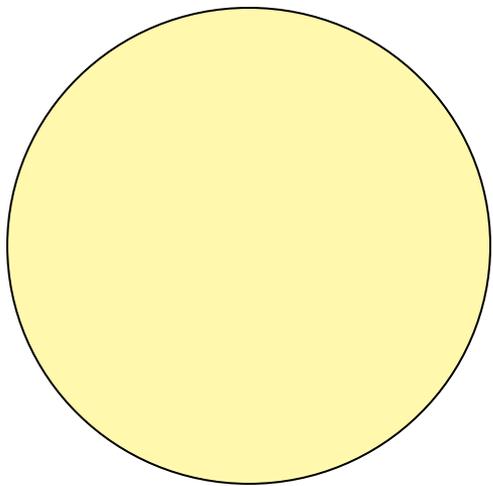
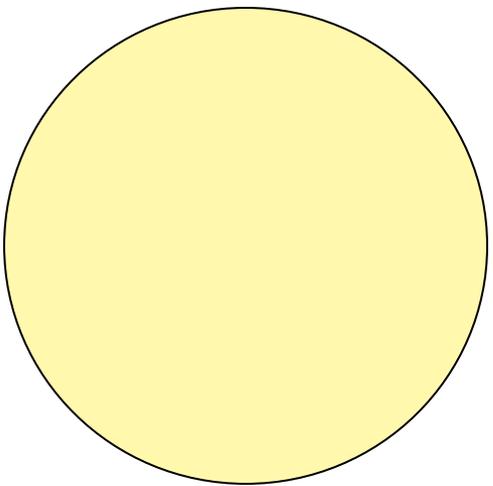
Wilson (1992)



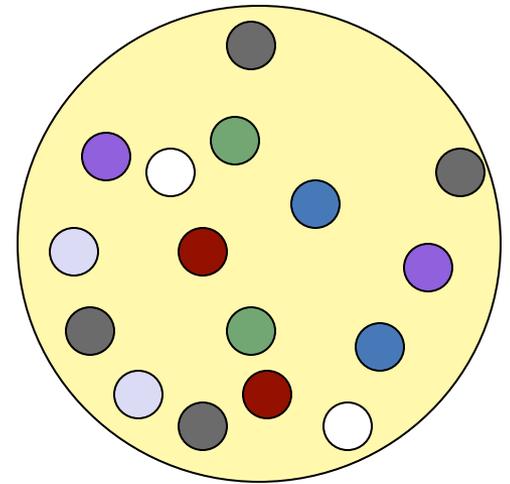
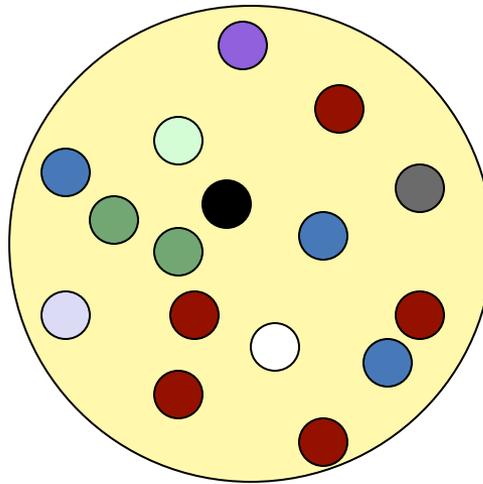
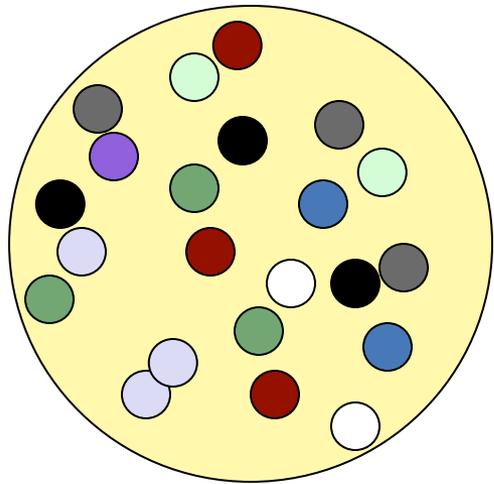
Wilson (1992)

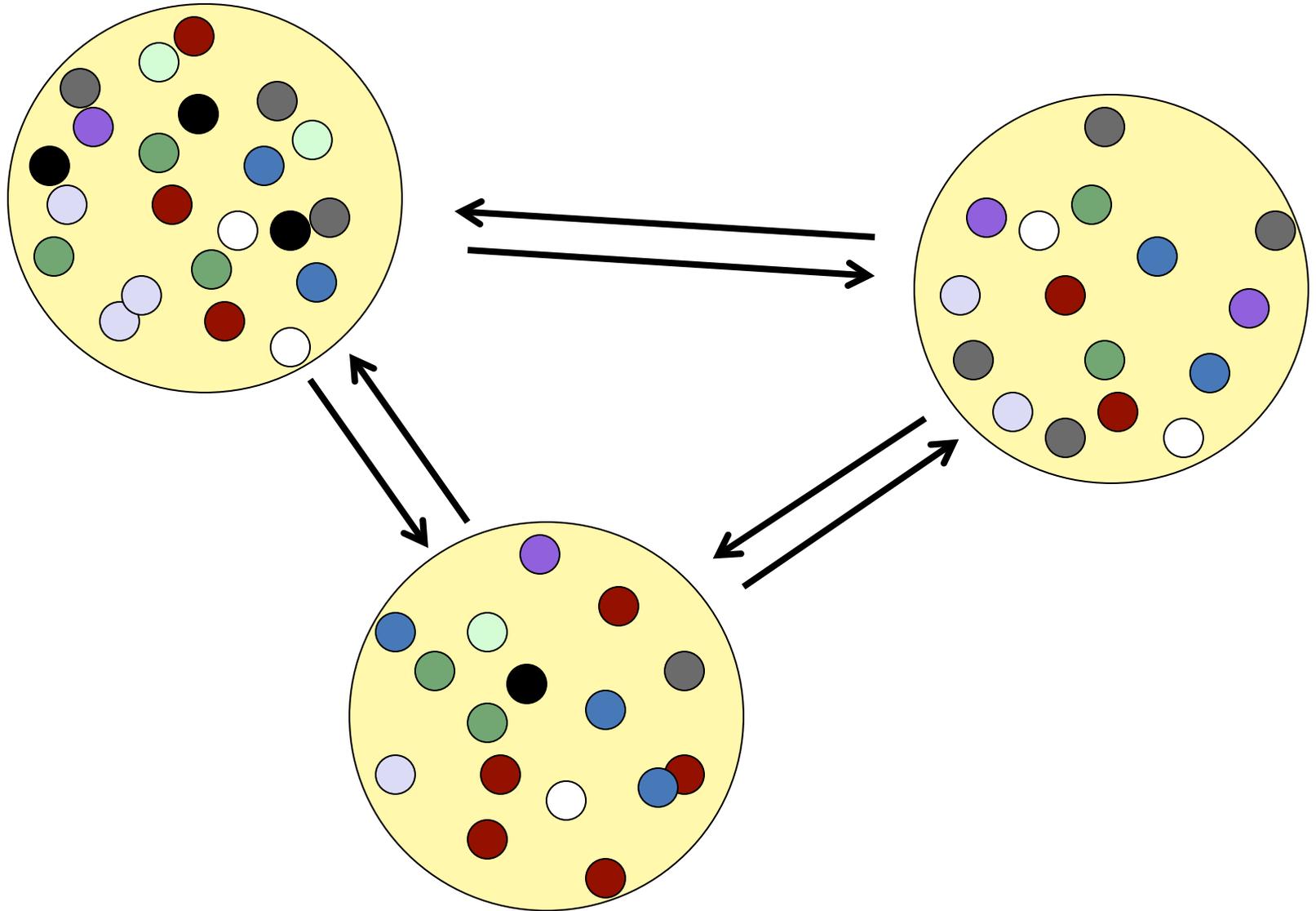


Mix and colonize patches

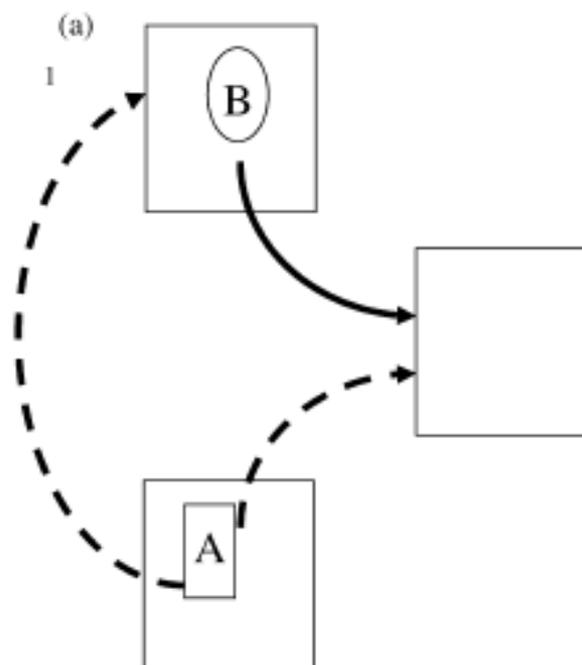


Wilson (1992)

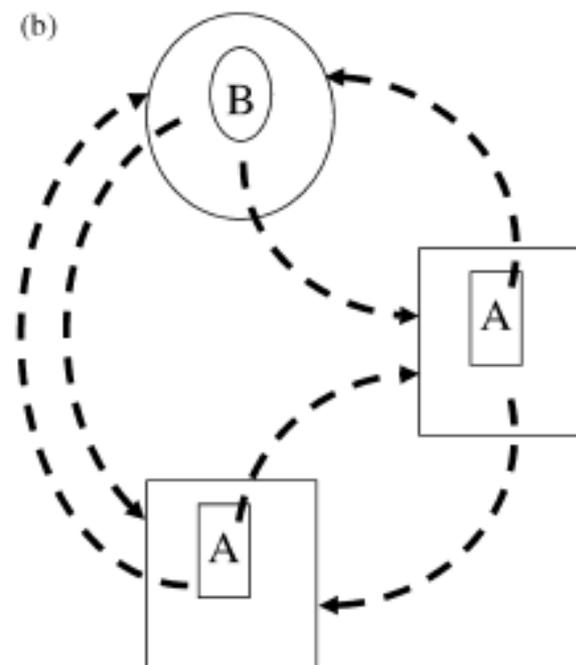




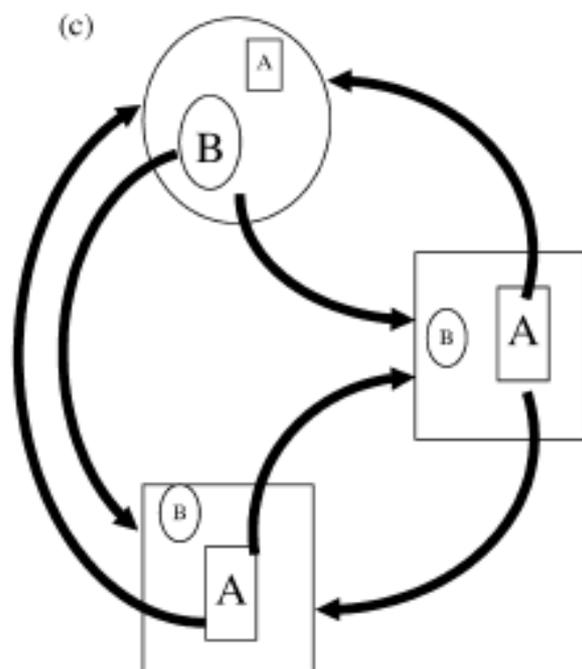
Patch  
dynamics



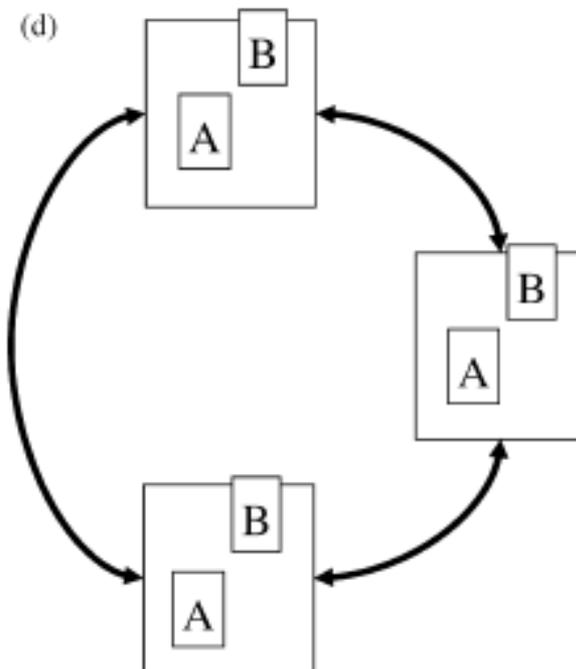
Species  
sorting



Mass  
effect

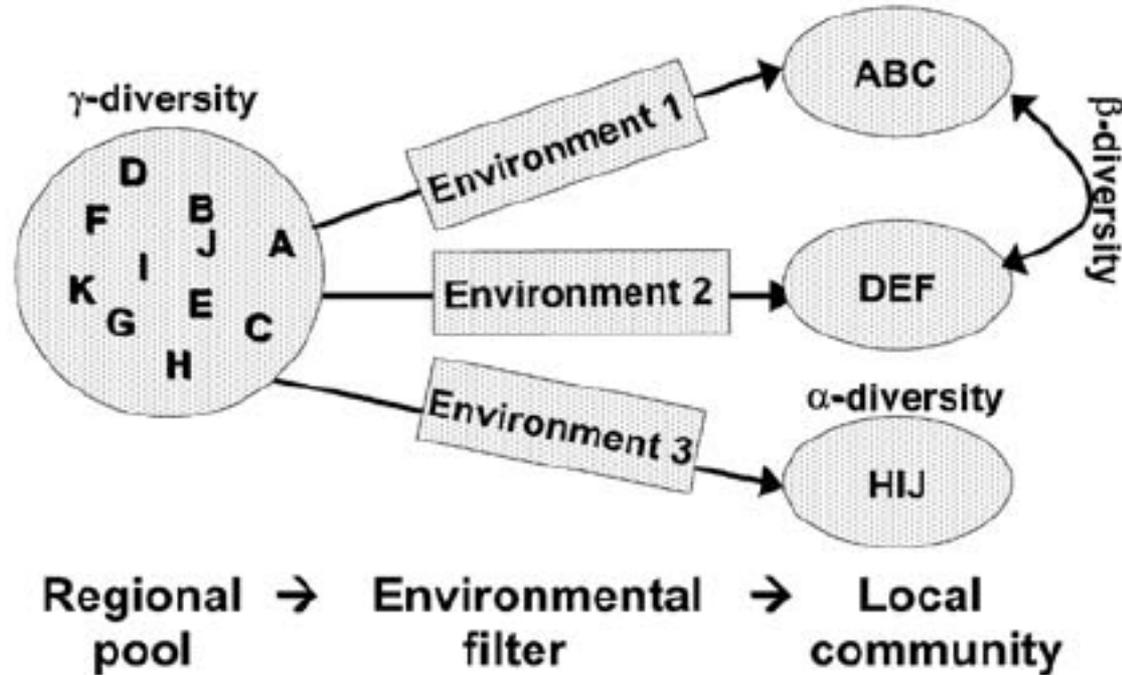


Neutral



Comparing patterns at local (within a "patch") and regional (sum across patches) scales

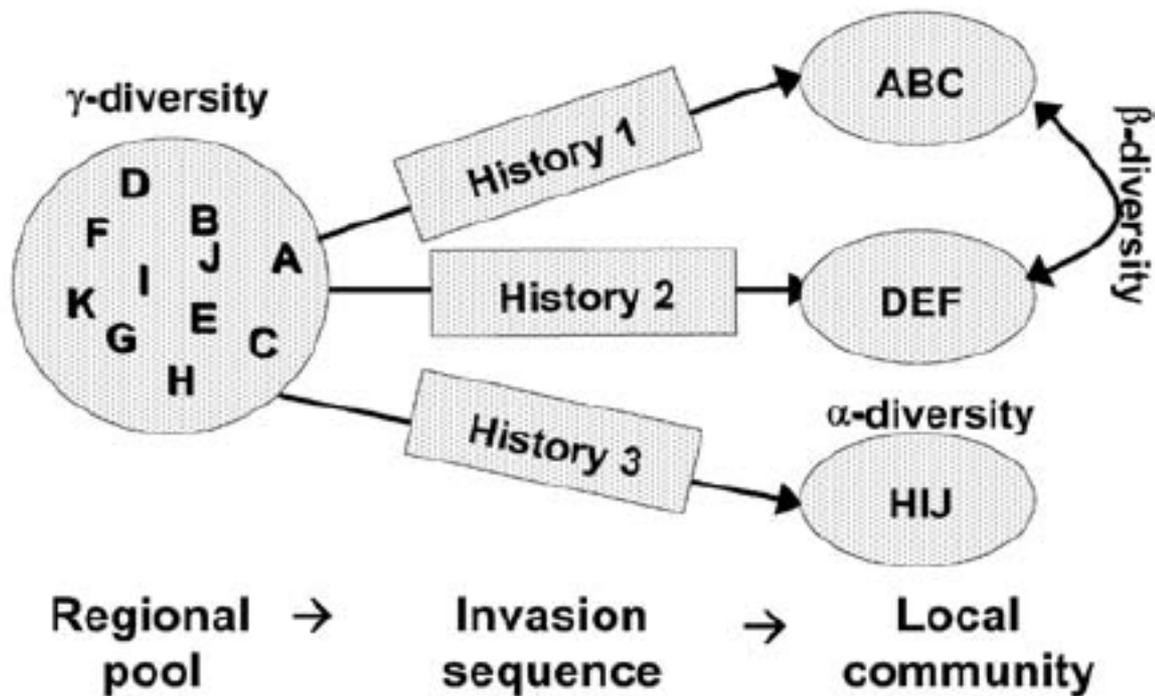
## A. Single stable equilibrium: environments differ



i.e., Species sorting

Note: high dispersal among environments (patches) can create mass effects, elevating local  $\alpha$ -diversity, but decreasing  $\beta$ -diversity.

## B. Multiple stable equilibria: histories differ



REVIEW

Jonathan M. Chase

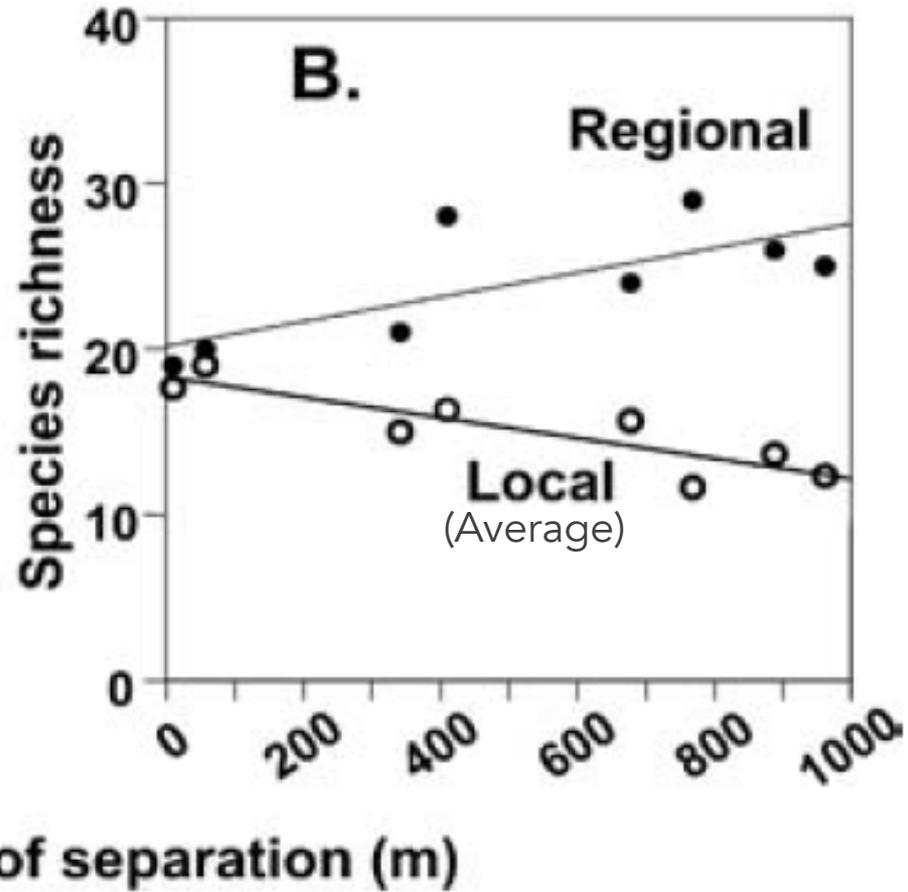
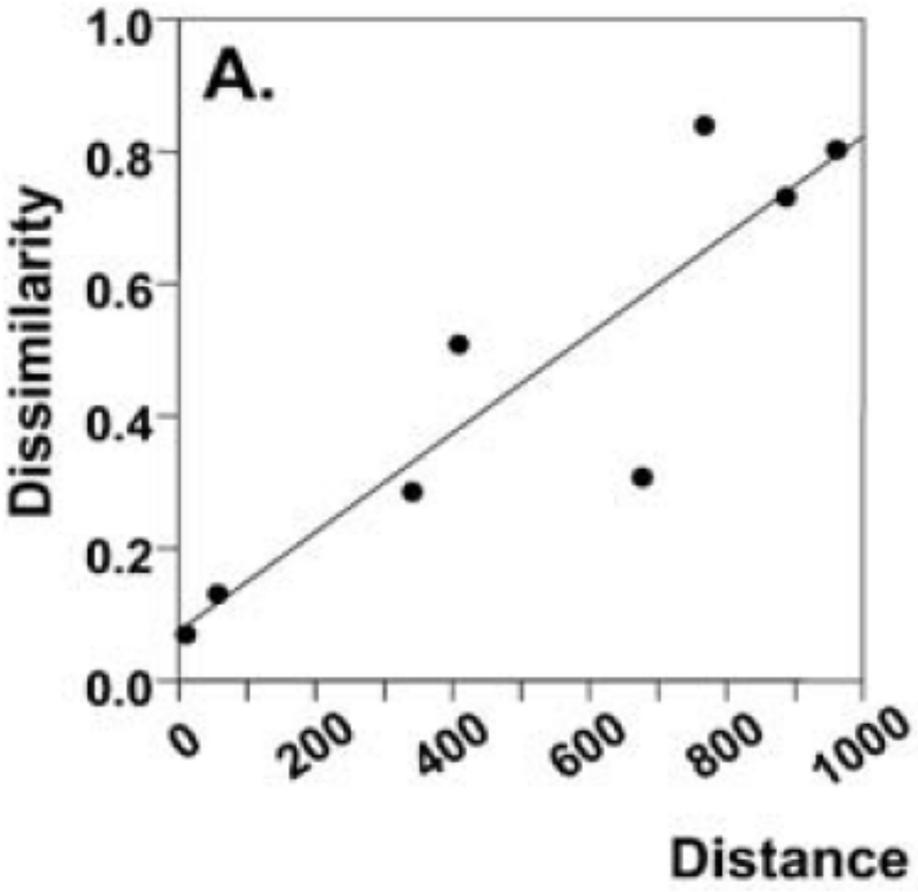
**Community assembly: when should history matter?**



Data: Species presence/absence in 72 ponds (over 3 years)

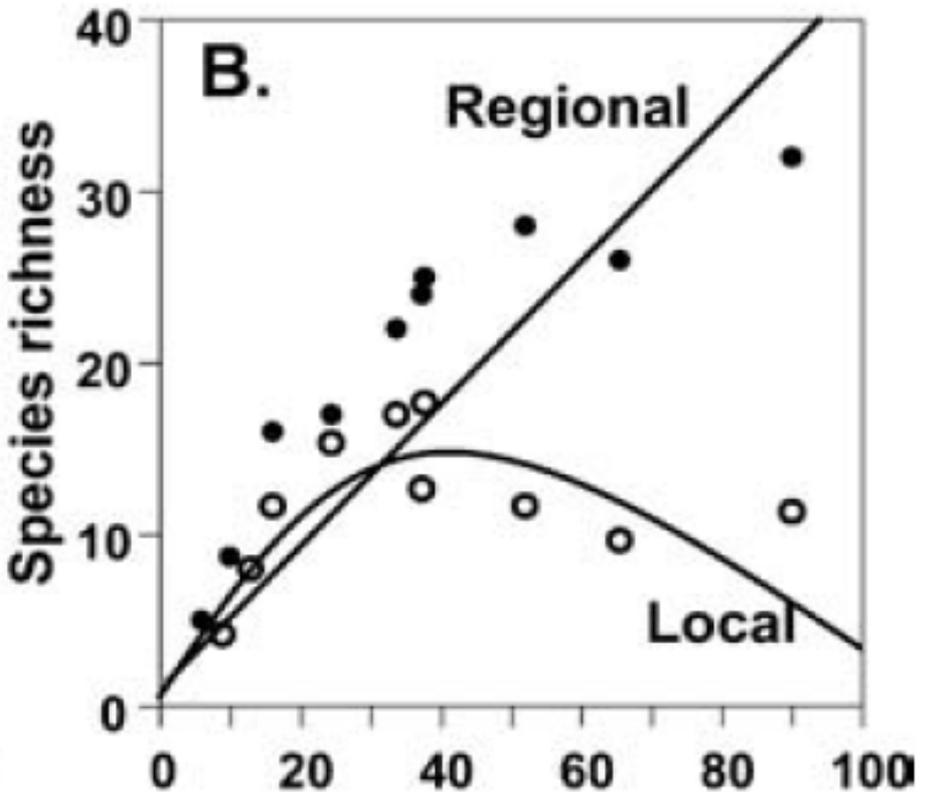
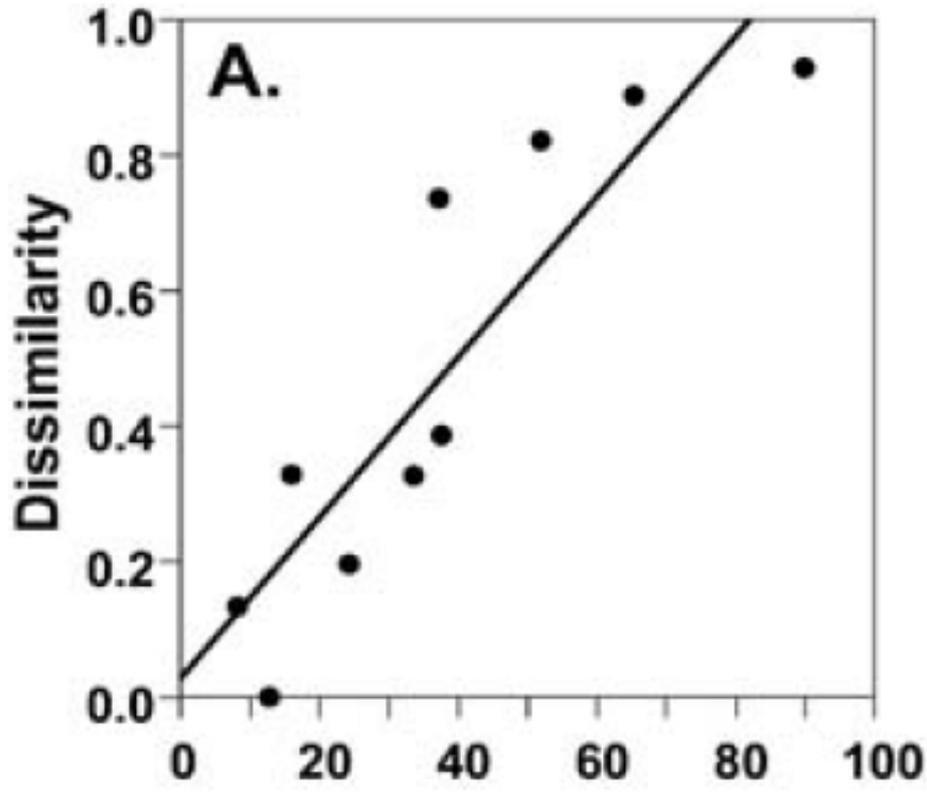
## Habitat connectivity

- Prediction 1: more connected communities are more similar in community composition than less connected communities
- Prediction 2: more connected communities have higher local, but lower regional species richness than less connected communities



## Primary productivity

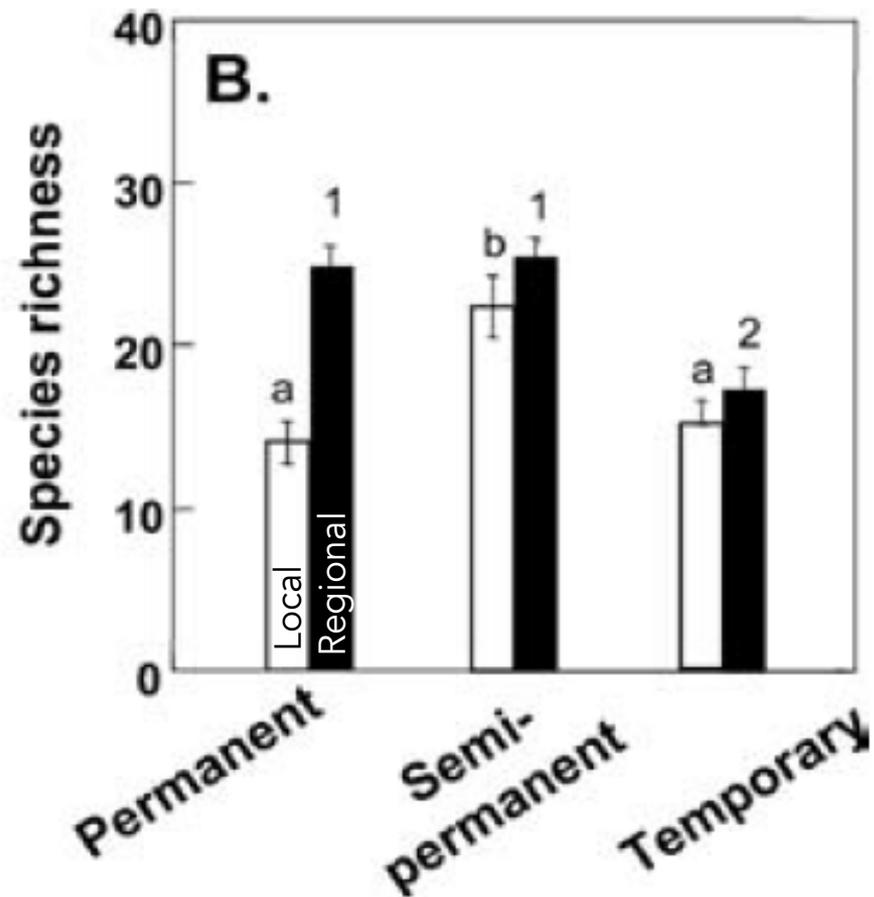
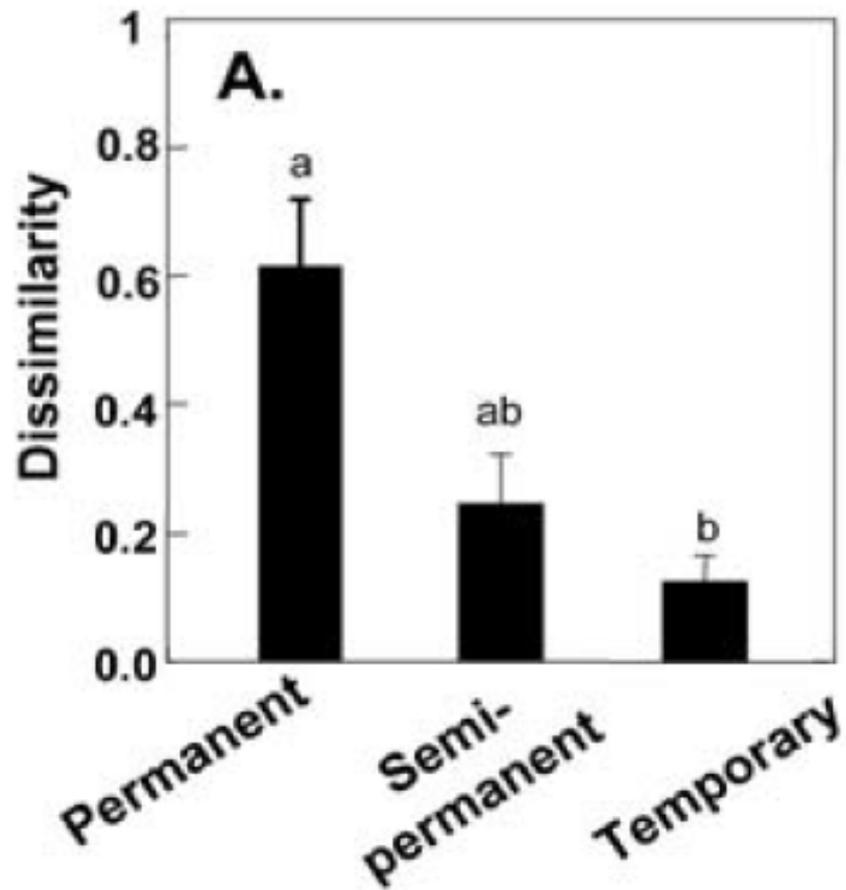
- Prediction 1: less productive regions are more similar in community composition than more productive regions
- Prediction 2: the shape of the productivity-diversity relationship depends on spatial scale



Primary productivity (mg cm<sup>-2</sup> d<sup>-1</sup>)

## Disturbance

- Prediction 1: more disturbed regions are more similar in community composition than less disturbed regions
- Prediction 2: the relationship between disturbance and diversity depends on spatial scale



A different view on "metacommunities":  
Linkages across different types of systems

# Subsidies: Unidirectional flow of energy or nutrients



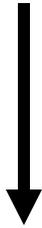
© QT Luong / terragalleria.com

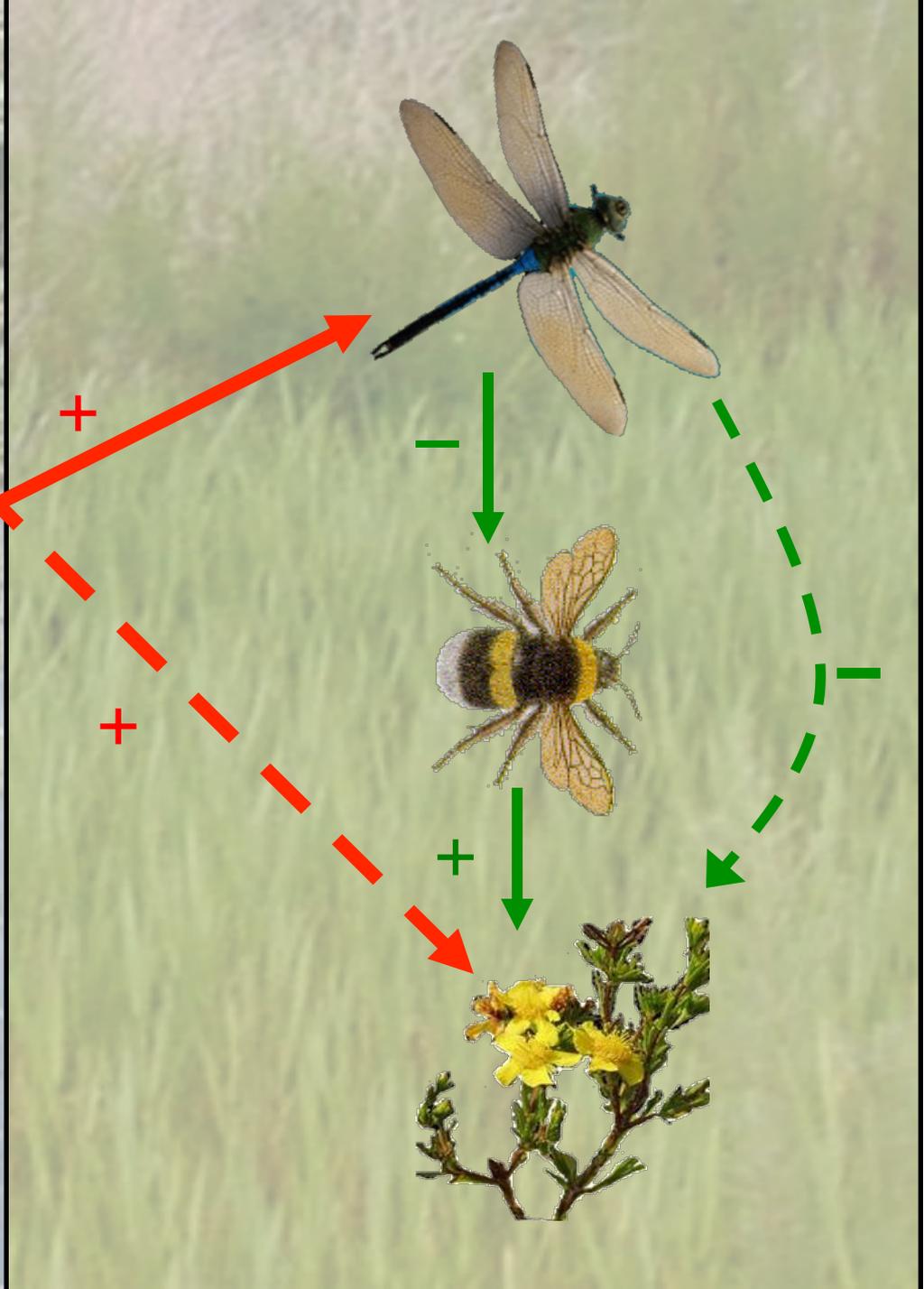
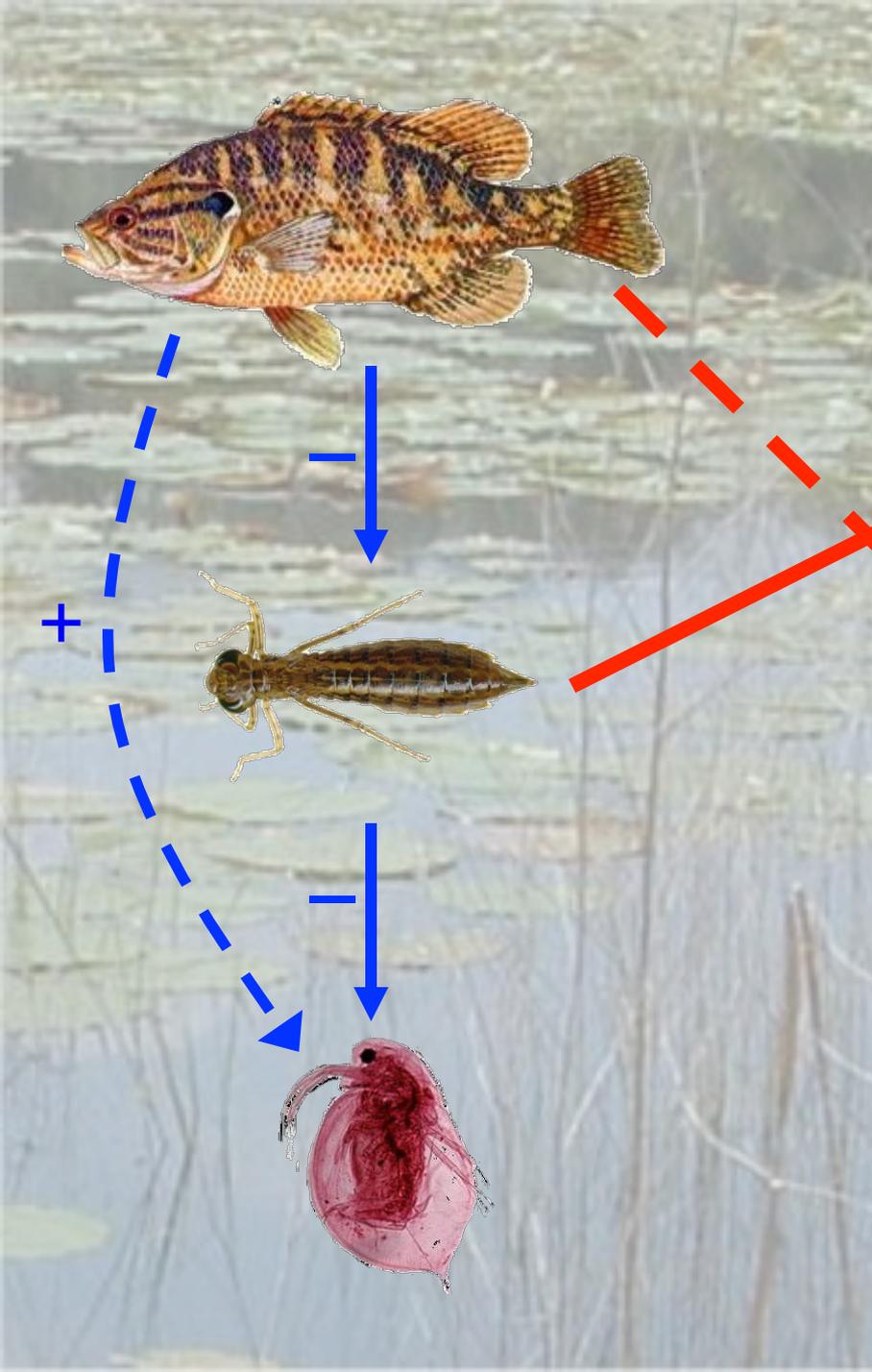


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Connectivity via life histories

# Organisms with Complex Life Histories





## LETTERS

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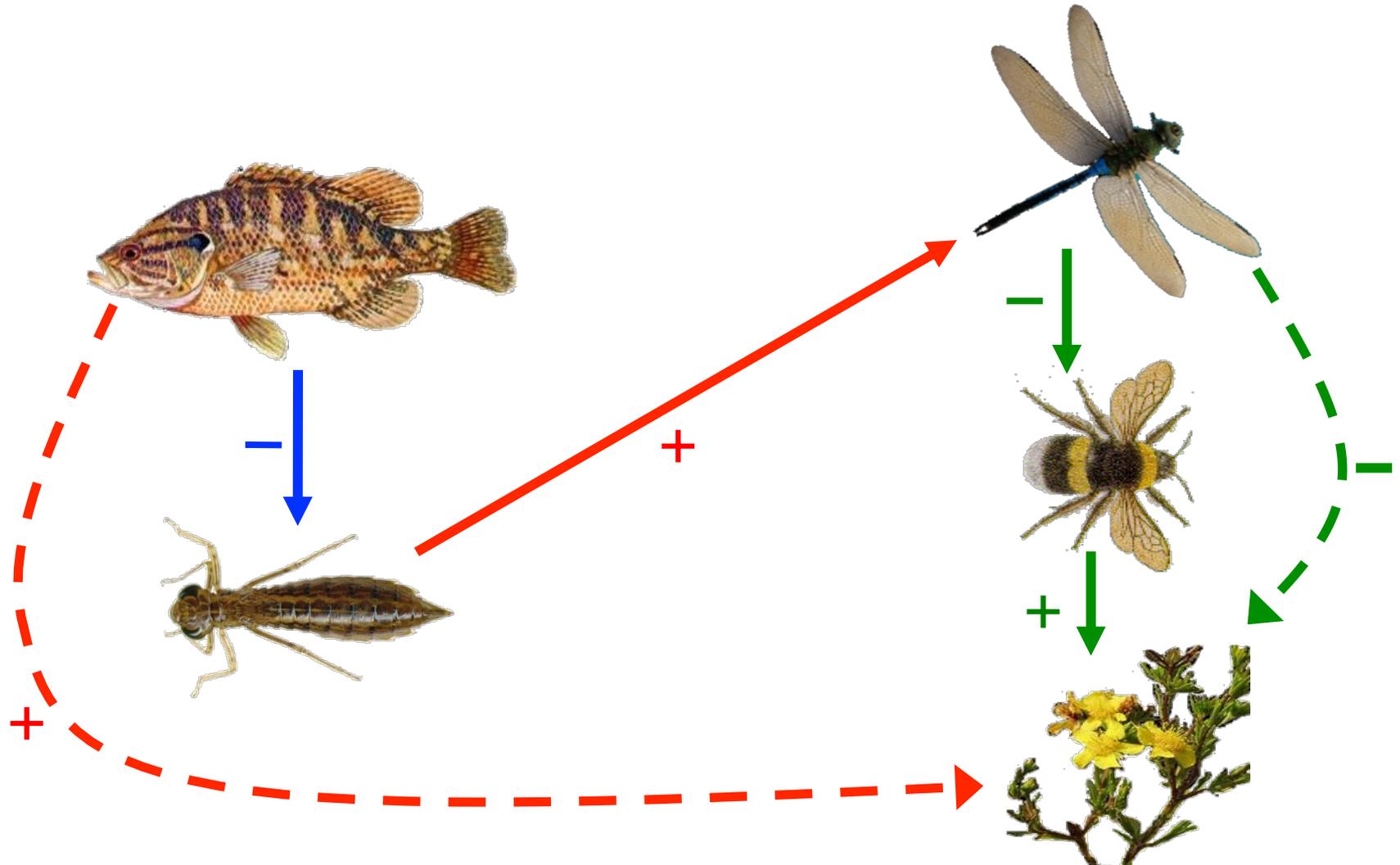
# Trophic cascades across ecosystems

Tiffany M. Knight<sup>1,2</sup>, Michael W. McCoy<sup>1</sup>, Jonathan M. Chase<sup>2</sup>, Krista A. McCoy<sup>1</sup> & Robert D. Holt<sup>1</sup>



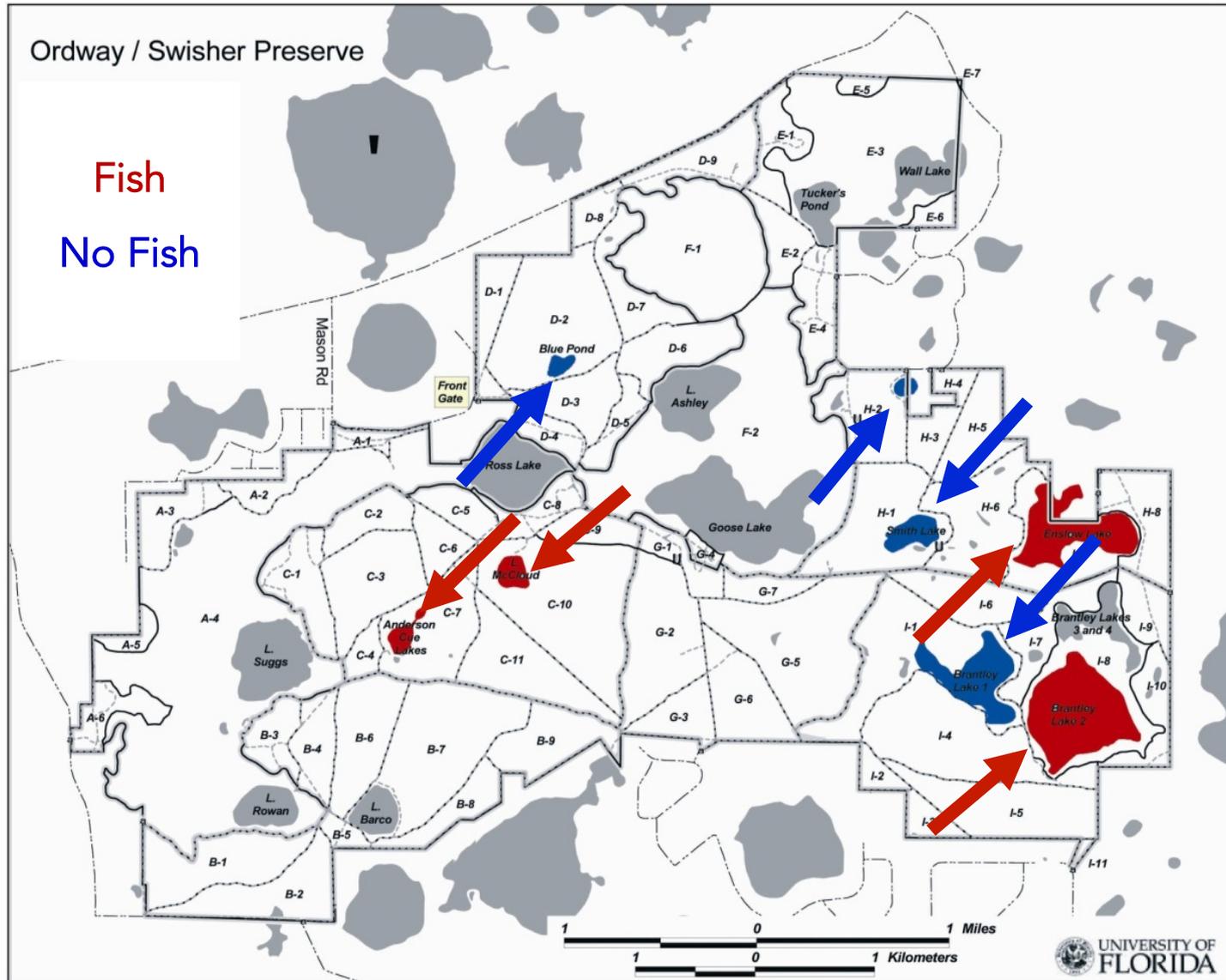
# Goal

Determine if fish affect terrestrial plant reproduction



# Study Site

8 ponds within the Ordway Nature Preserve



# Approach

## 1. Quantify Abundance

- Larval dragonflies
- Adult dragonflies
- Pollinators

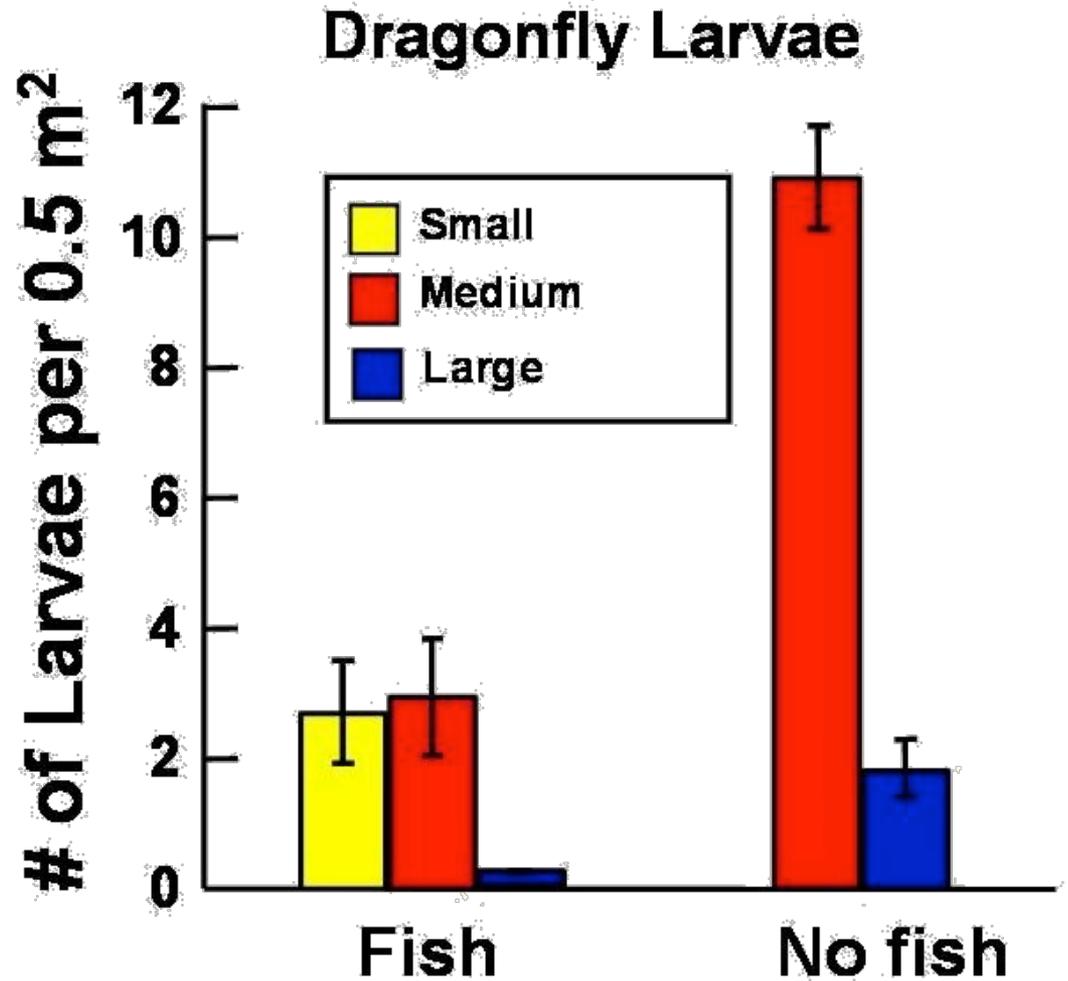
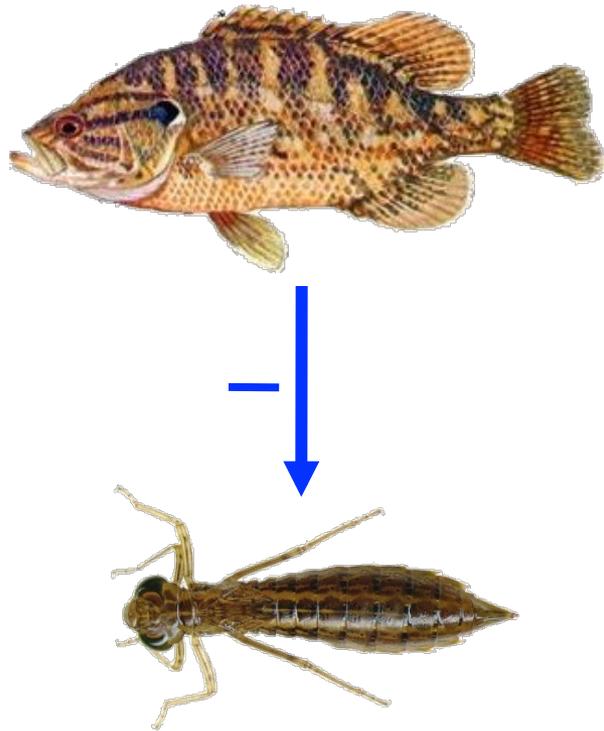


## 2. Pollinator Effectiveness

- Pollen supplementation experiment
- Transplant experiment

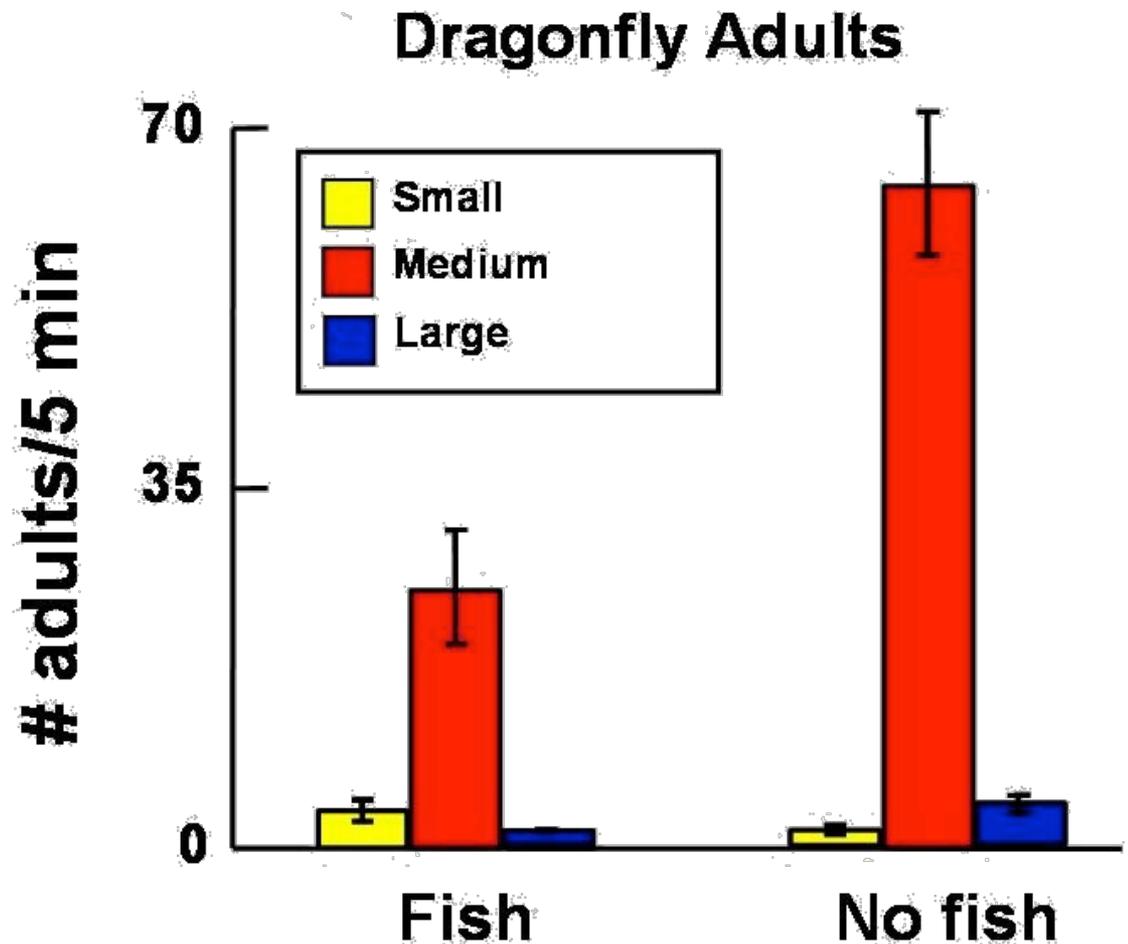
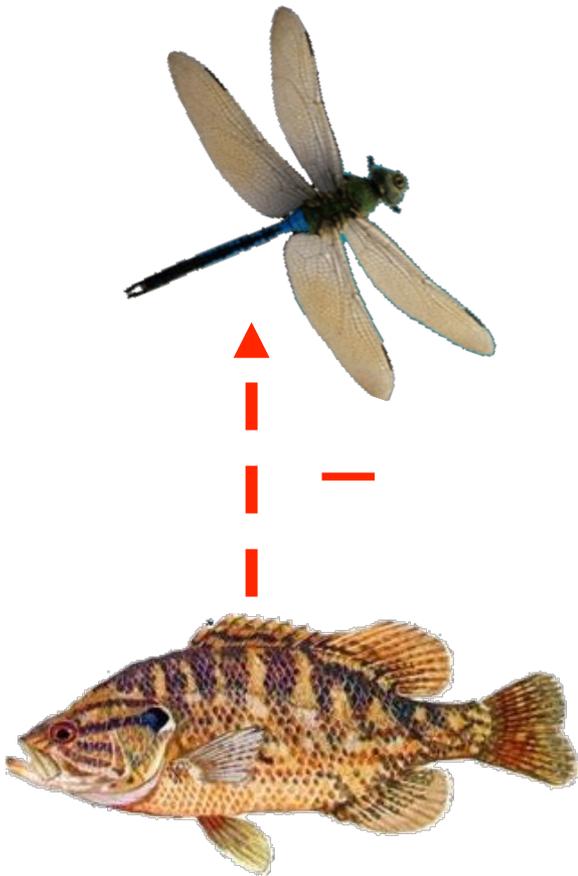
# Results

Larval dragonfly abundance greater at ponds without fish



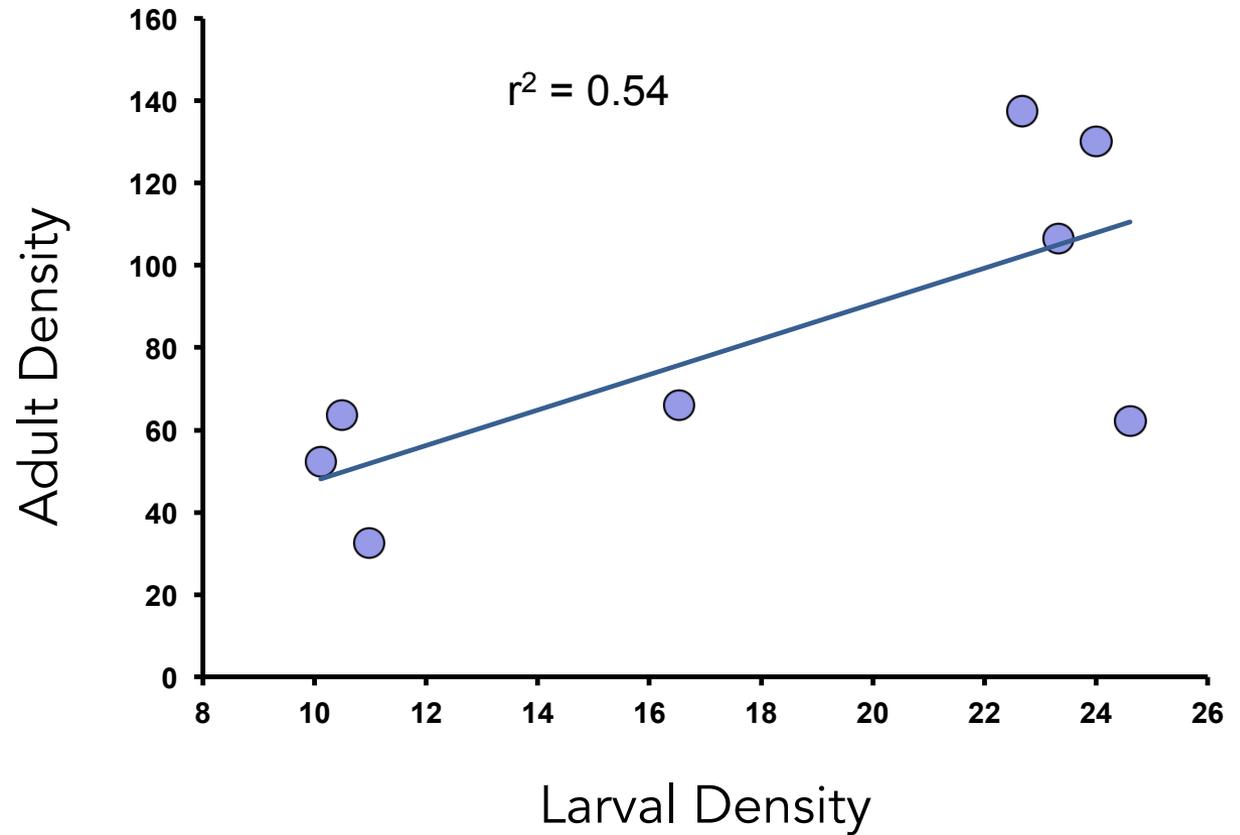
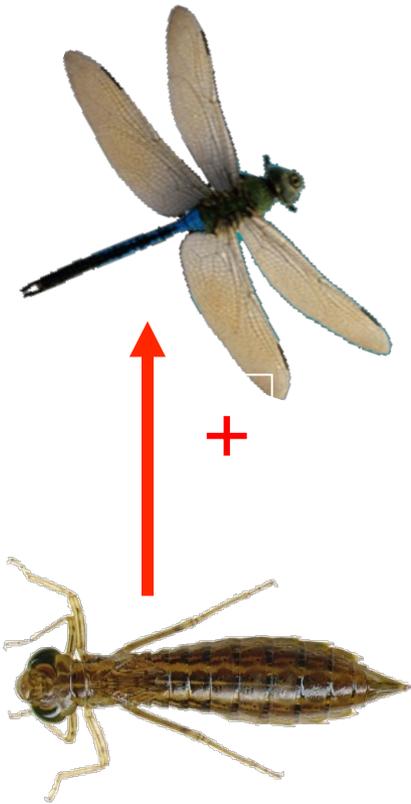
# Results

Adult dragonfly abundance greater near ponds without fish



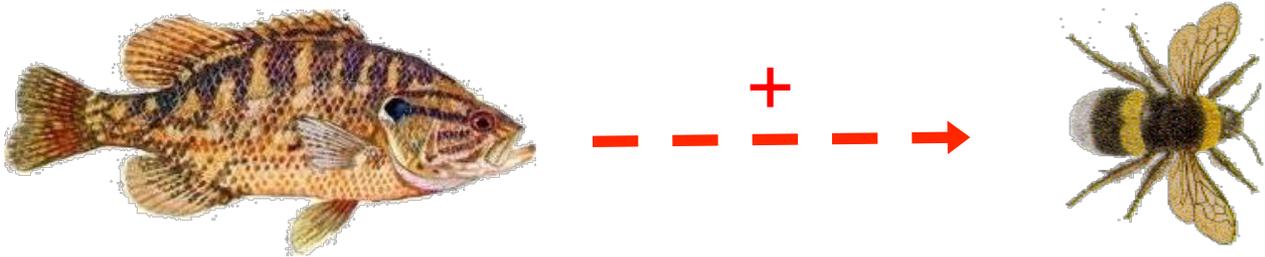
# Results

Larval dragonfly abundance correlated with adult abundance

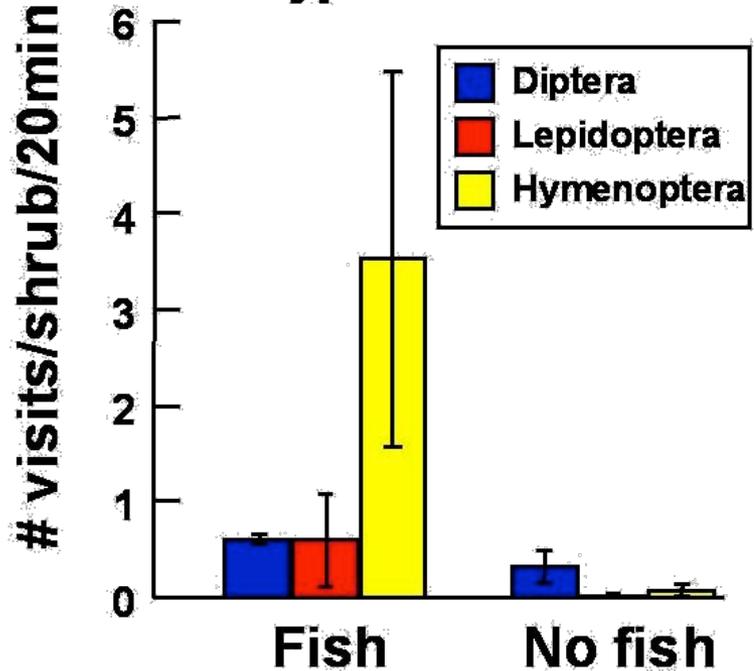


# Results

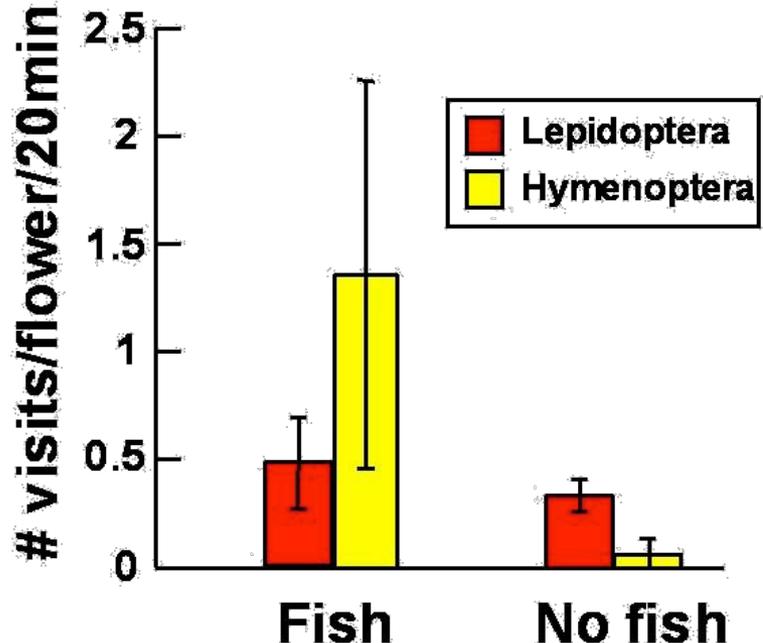
Pollinator abundance greater near ponds with fish



*Hypericum fasciculatum*



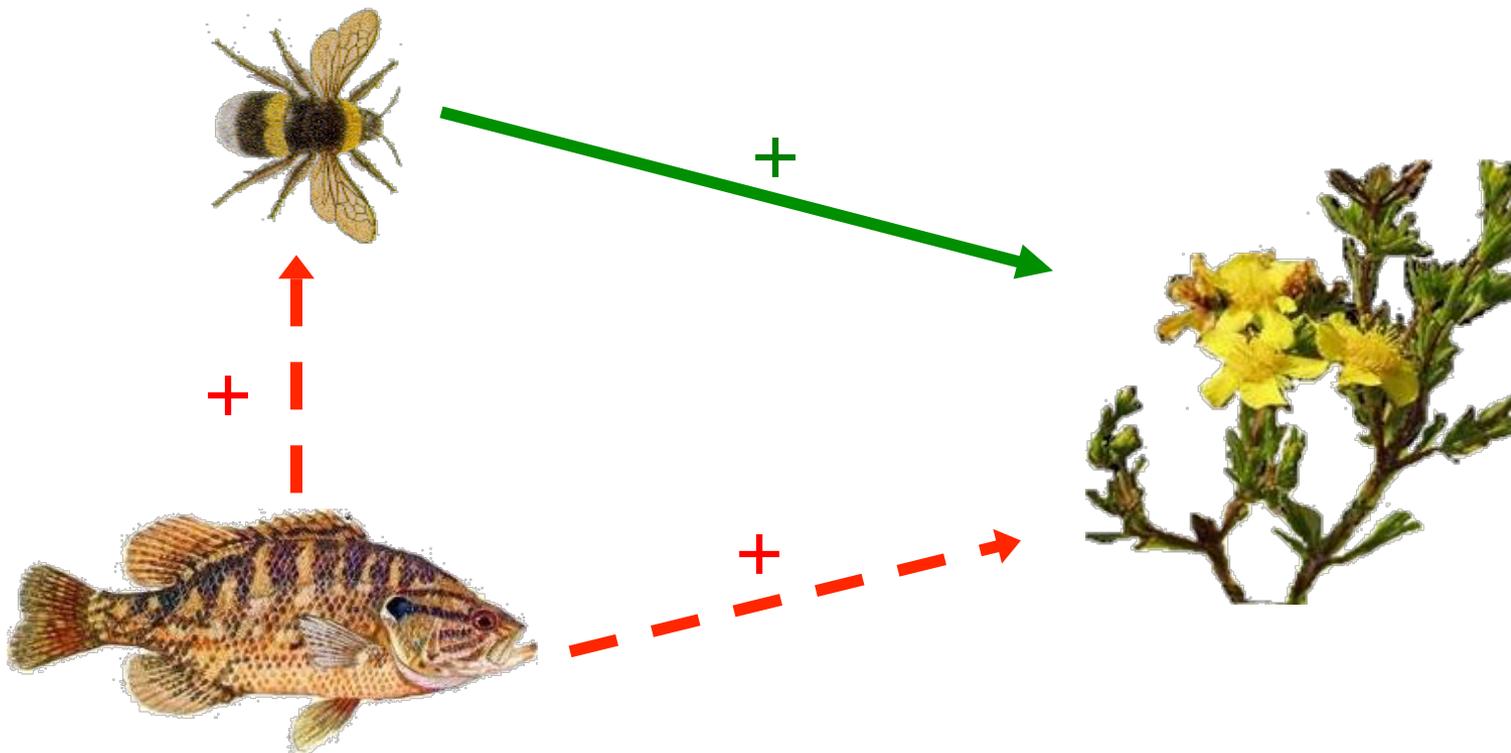
*Sagittaria latifolia*



# Pollinator Effectiveness

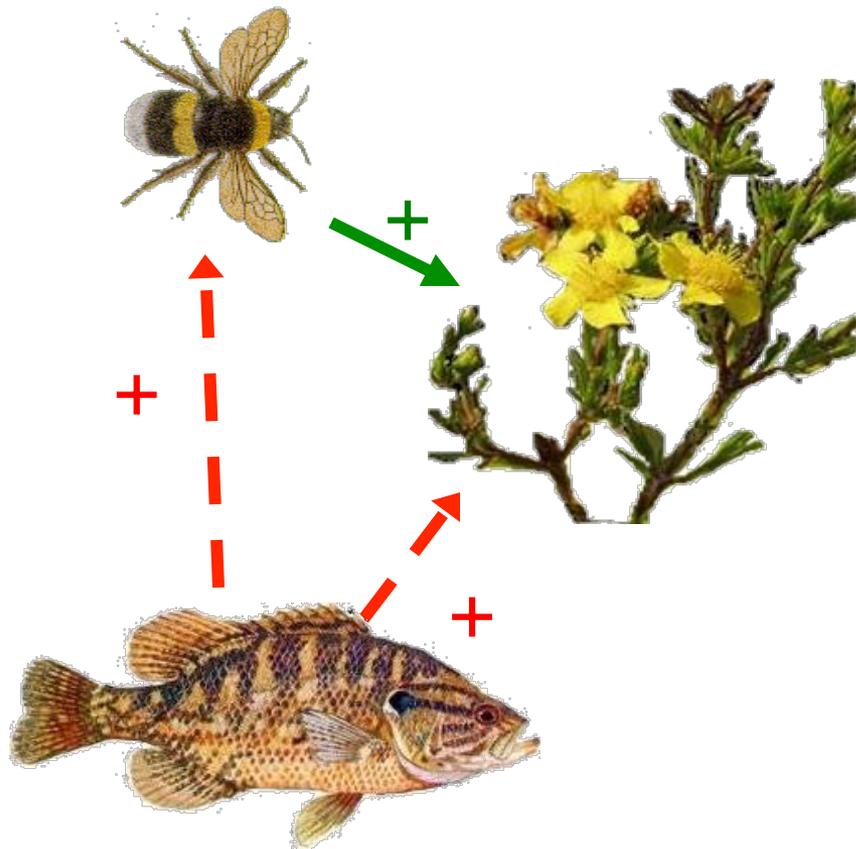
# Pollen Supplementation Experiment

- 10 *Hypericum fasciculatum* shrubs at each pond
  - 2 branches of similar size and numbers of flowers
- randomly assigned 1 to the pollen supplement treatment
  - quantified fraction of flowers that set seed

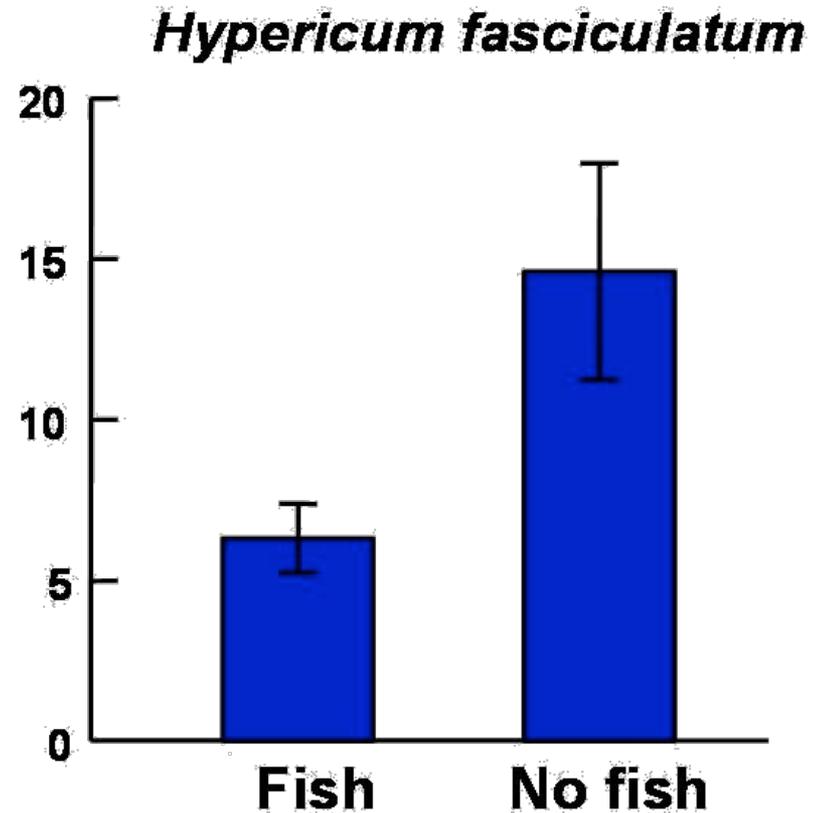


# Results

*H. Fasciculatum* near ponds with fish were less pollen limited

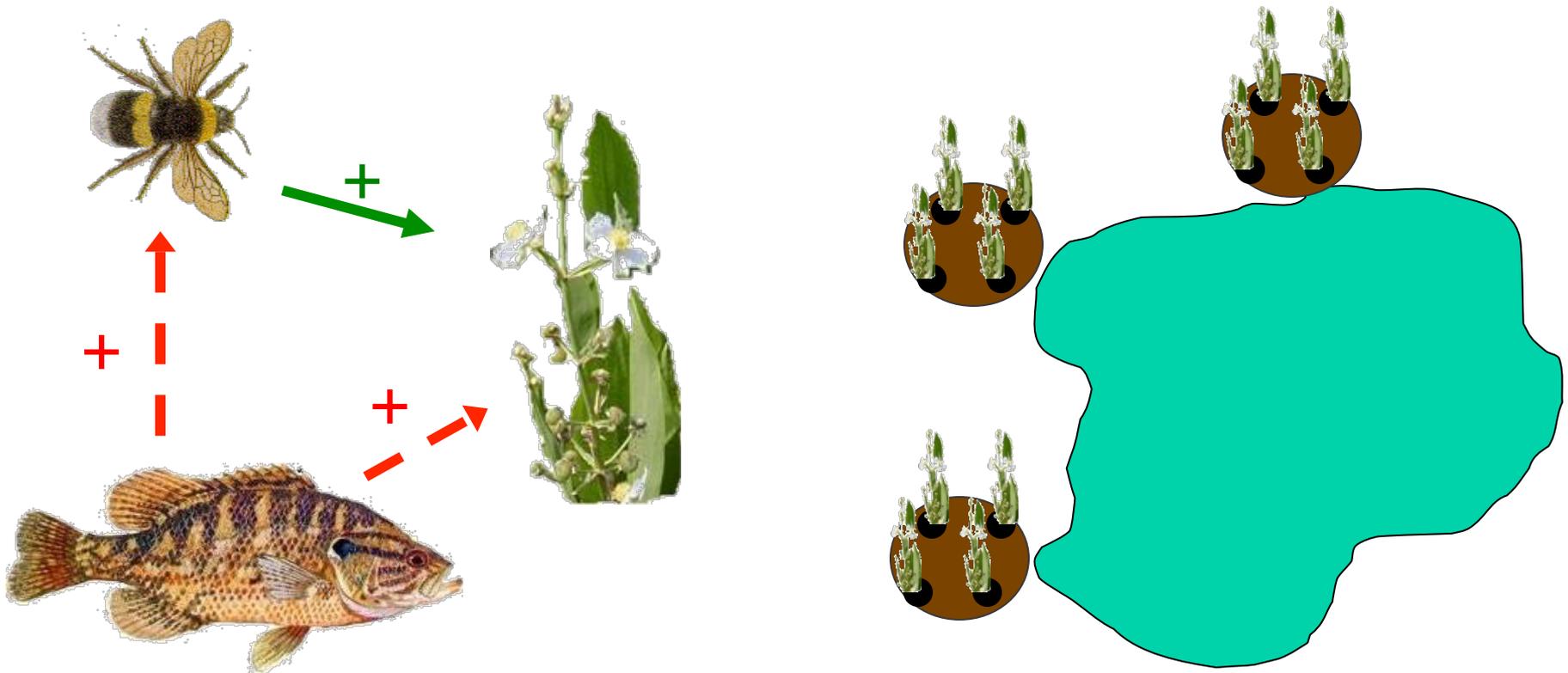


Magnitude of pollen limitation



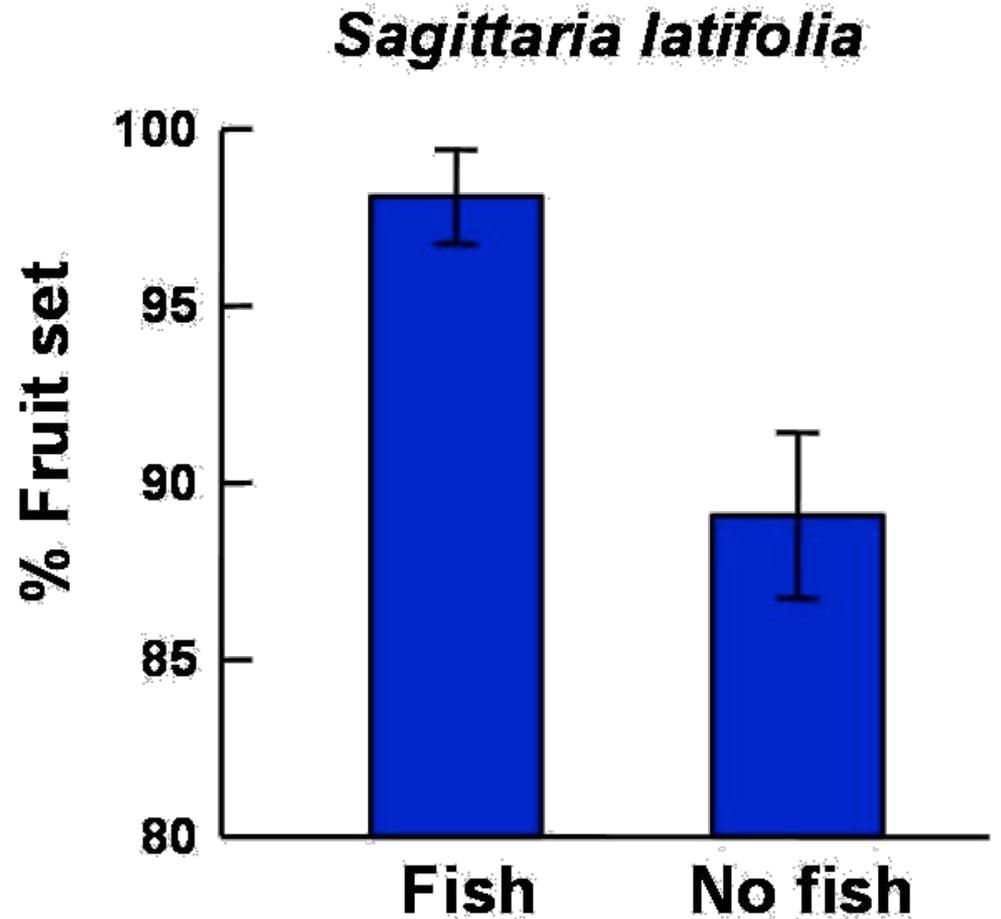
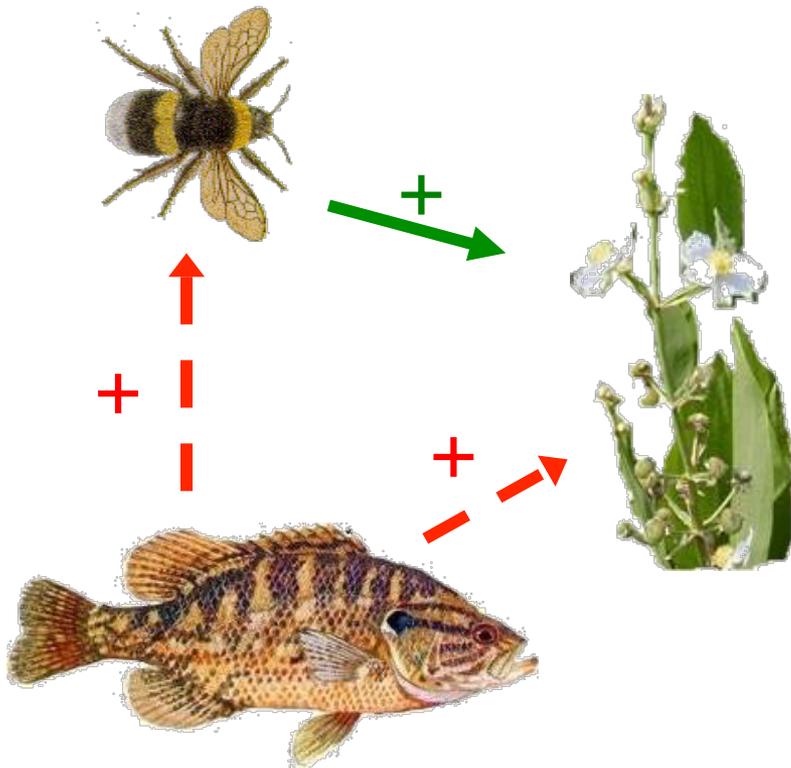
# Transplant Experiment

- To control for variation in plant quality ...
  - 3 mesocosms
  - 4 potted *S. latifolia* per mesocosm

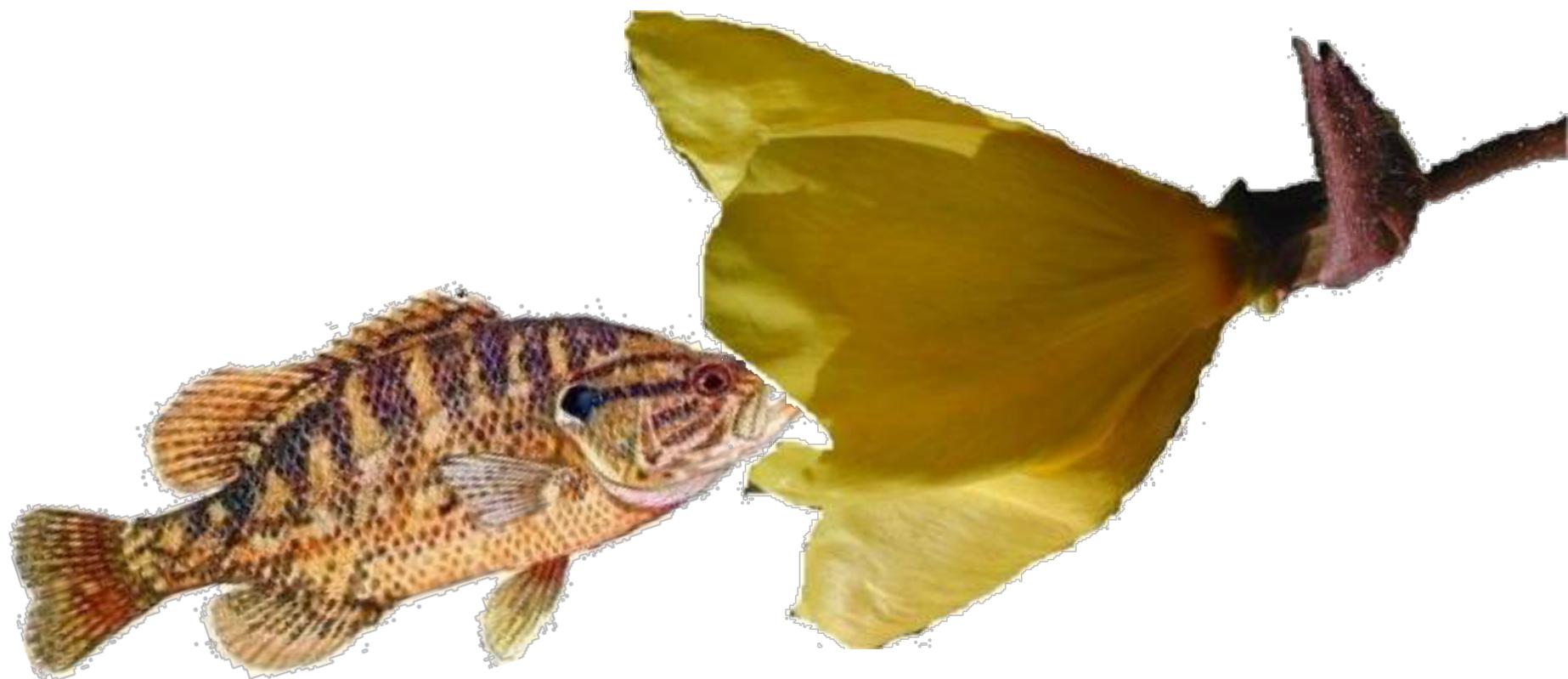


# Results

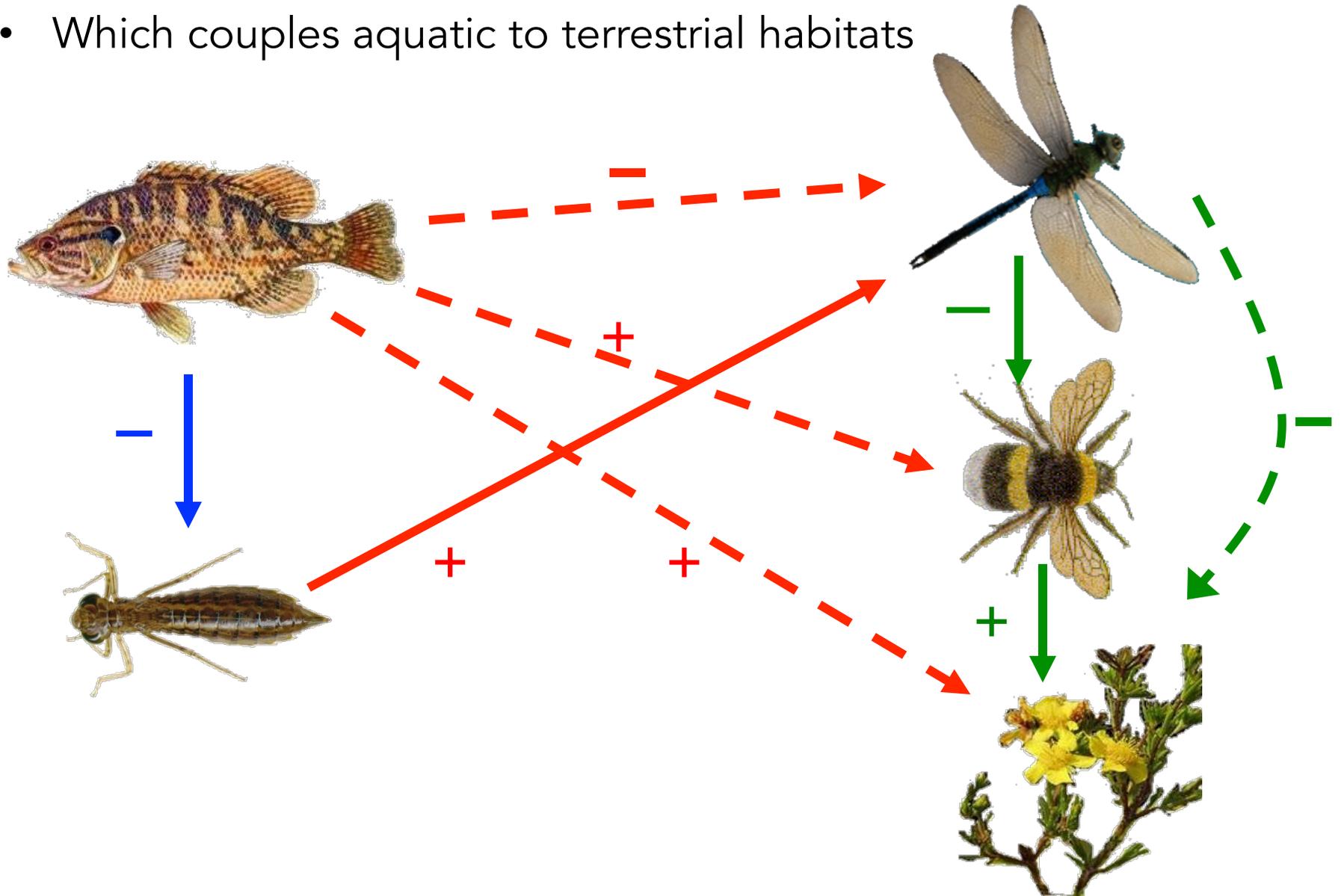
*S. latifolia* near ponds with fish have higher fruit set



# Conclusion

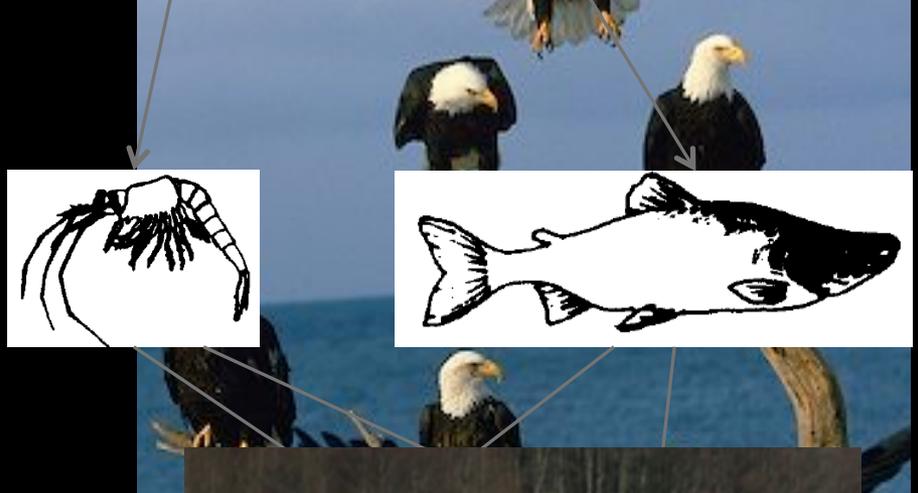
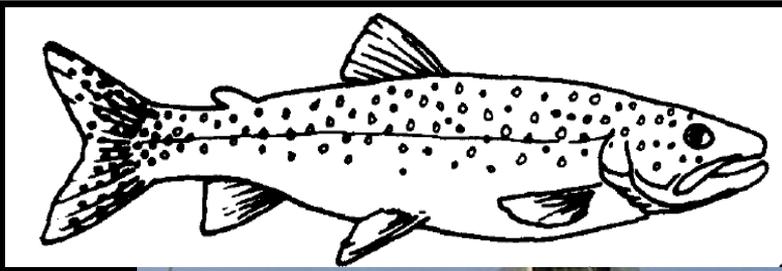
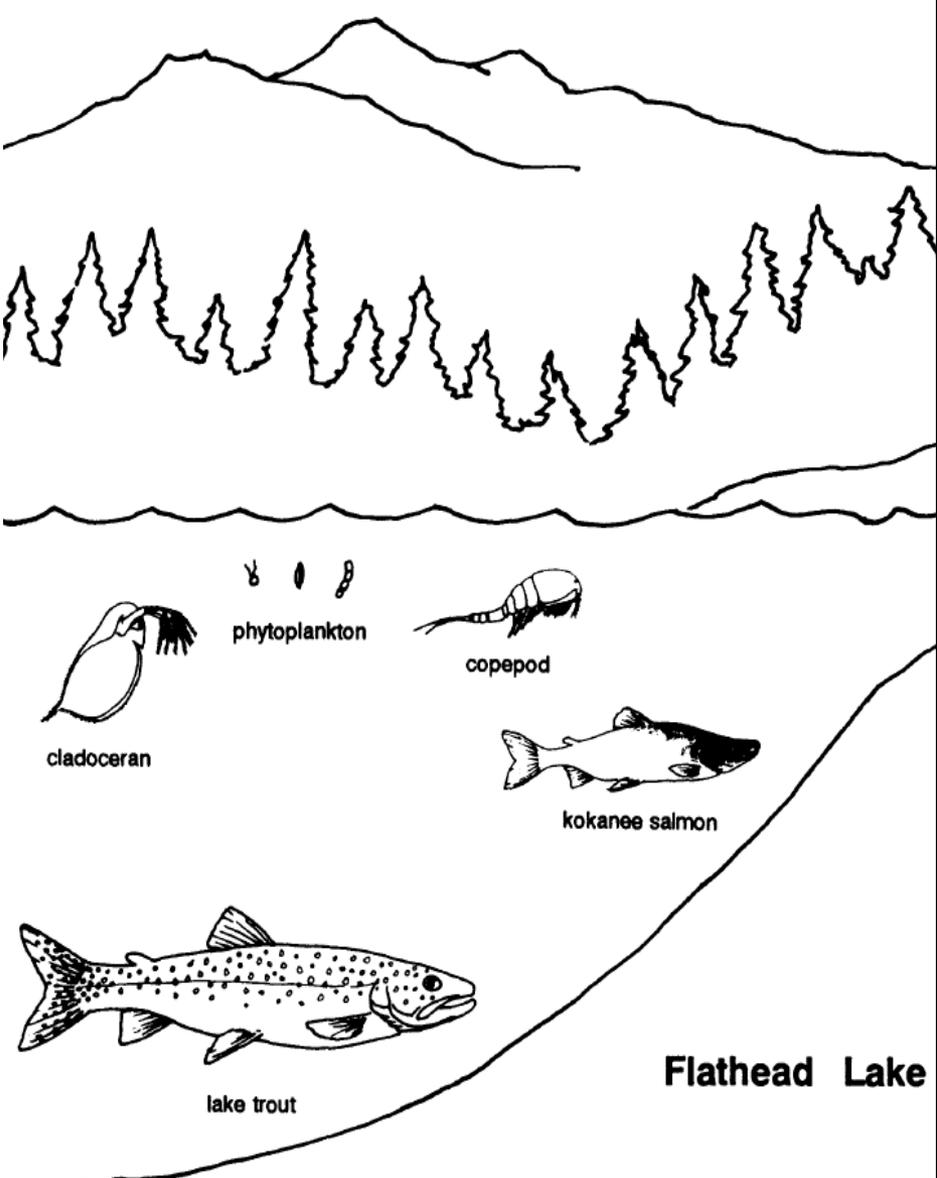


- Fish indirectly facilitate plant reproduction
- Mediated by dragonfly life history
- Which couples aquatic to terrestrial habitats



# Implications

1. Linkages between aquatic and terrestrial systems.
2. Cross-ecosystem linkages should be common because complex life histories (and habitat shifts) are ubiquitous in nature.
3. Anthropogenic alterations to one ecosystem can have unforeseen and far-ranging consequences for adjacent ecosystems.



Enjoy the pathogens; and Thanksgiving!