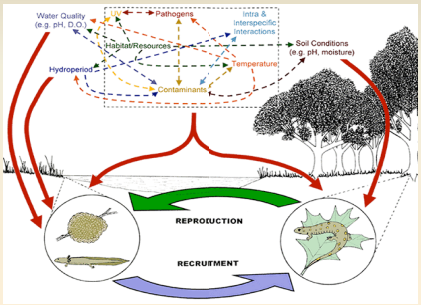
Amphibian community ecology



Lecture goal

To familiarize students with the abiotic and biotic factors that structure amphibian communities, patterns in species richness, and encourage discussion about community ecology

Required readings:

Wells pp. 694-696, 754-758, 768-778
Wellborn et al. 1996. *Annual Review of Ecology and Systematics* 27:337-363
Werner et al. 2007. *Oikos* 116:1697-1712

Supplemental readings:

Wells 729-740, 779-783

Lecture roadmap

Basics of community ecology

Amphibian community basics

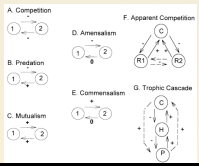
Anuran community ecology

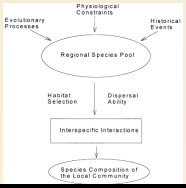
Salamander community ecology

Community ecology

What is a community: an assemblage of populations of species that live in an environment and interact with one another, forming together a distinctive living system with its own composition, structure, environmental relations, development, and function (Whittaker 1975)

Goal of community ecology: to understand the origin, maintenance, and consequences of biological diversity within local communities





Direct and indirect interactions among species within communities

Morin 1999. *Community Ecology*

Species composition of a local community at any time is a consequence of many factors interacting in a hierarchical fashion

Amphibian communities

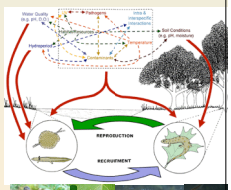
Biphasic life cycle results in different communities during different life stages

1. Aquatic community for larvae
2. Terrestrial community for juveniles and adults

Events that happen during the larval stage directly impact metamorph recruitment into the population

Numerous factors affect the structure and function of amphibians communities

1. Oviposition choice by adults
   - Habitat characteristics
   - Yearly environmental variation
   - Breeding phenology
2. Biotic interactions
   - Interspecific competition
   - Cannibalism
   - Predation (vertebrates, invertebrates)
   - Disease (mold, fungi, viruses)
3. Abiotic factors
   - Hydroperiod
   - Canopy cover
   - Water chemistry



Importance varies:
1. Across habitats
2. Over time
3. For different species

Oviposition site choice by adult anurans

What factors would influence you choice of an oviposition site?

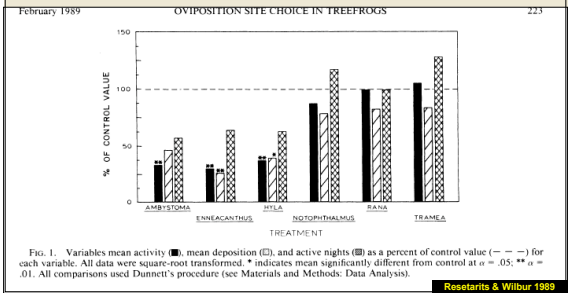


FIG. 1. Variables mean activity (■), mean deposition (□), and active nights (▨) as a percent of control value (— — —) for each variable. All data were square-root transformed. * indicates mean significantly different from control at $\alpha = .05$; ** $\alpha = .01$. All comparisons used Dunnett's procedure (see Materials and Methods: Data Analysis).

Resetarits & Wilbur 1989

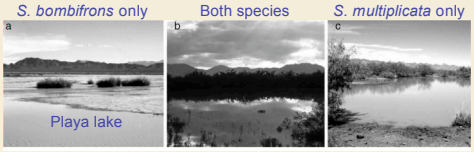
Competition in larval anuran communities

Spadefoot toad species can coexist across the landscape

Plains spadefoot (*Spea bombifrons*)

Mexican spadefoot (*Spea multiplicata*)

S. bombifrons only | Both species | *S. multiplicata* only



Abundant shrimp, Reduced detritus | Abundant shrimp, Abundant detritus | Reduced shrimp, Abundant detritus

Character displacement

Both species grow best on shrimp but when reared together,

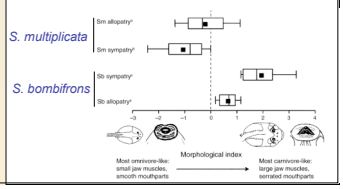
- *S. bombifrons* outcompetes *S. multiplicata* for shrimp and
- *S. multiplicata* outcompetes *S. bombifrons* for detritus

How do the species partition morphological space when together?

Tadpoles must consider:

Resource types
Resource levels
Competitive ability

Character displacement in the expression of resource polyphenism



Priority effects

Some species overlap very little during development

Spring peepers breed early and usually metamorphose before gray tree frogs breed

Can one species still impact the other?

Different numbers of spring peepers were added early in the experiment
Same number of gray tree frogs were added late in the experiment

Interpretation - How does this occur?

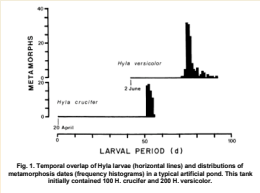
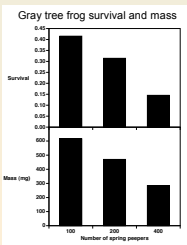


Fig. 1. Temporal overlap of Hyla larvae (horizontal lines) and distributions of metamorphosis dates (frequency histograms) in a typical artificial pond. This tank initially contained 100 H. crucifer and 200 H. versicolor.

Gray tree frog survival and mass

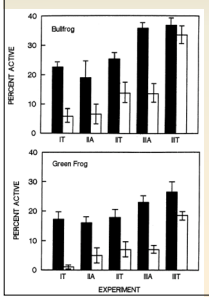


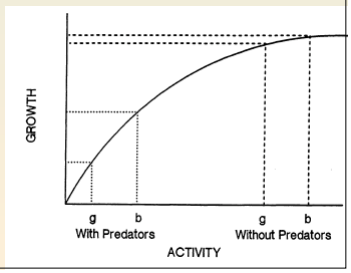
Asymmetric competition

Bullfrogs and green frogs are frequent competitors

Bullfrogs are more active than green frogs even in the presence of predators

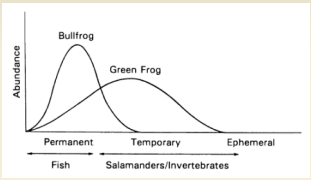
Bullfrogs out compete green frogs





Interactions between competition and predation

If bullfrogs are superior competitors,
why aren't they found in across a broader range of habitats?



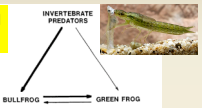
To answer this question we need to address:

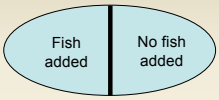
1. Composition of the predator community
2. Hydroperiod
3. Traits of each species

Interactions between competition and predation

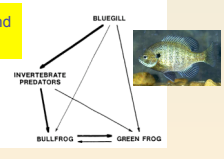
Let's put it together and figure out the answer

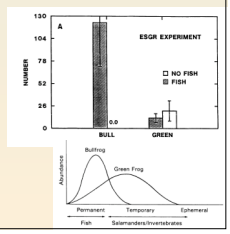
Temporary pond food web





Permanent pond food web





Werner and McPeek 1994

Interactions between competition and predation

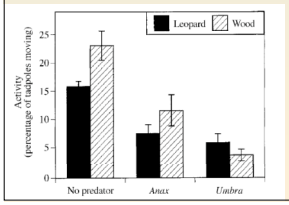
Larval anurans often encounter competitors and predators simultaneously

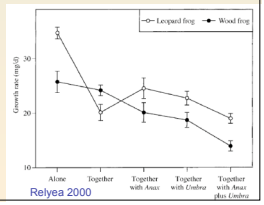
Species differ in competitive ability and responses to predators

Can predation alter the outcome of competition?

Wood frogs outcompete leopard frogs - activity

Wood frogs respond more strongly to predators





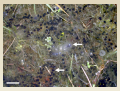
Relyea 2000

Interactions between competition and pathogens

Pathogens are often overlooked in community ecology

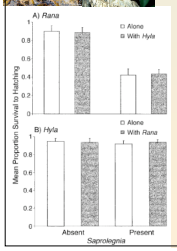
Species differ in susceptibility to pathogens

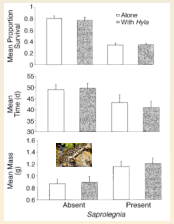
Can pathogens alter the outcome of competition?

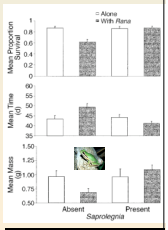


Saprolegnia ferax attacks eggs

Rana is more susceptible than *Hyla*







Kiesecker & Blaustein 1999

Keystone predation

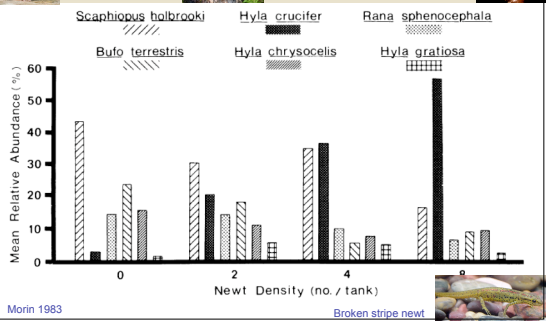
A species that has a disproportionate effect on its environment relative to its abundance

Are there keystone predators that structure larval anuran communities?

Results

Decreased in abundance

Increased in abundance



Morin 1983

Broken stripe newt

Synergy between predation and hydroperiod

Species interactions play out along abiotic gradients

Variation in pond hydroperiod can affect species performance and success

Results

For ponds that never dried:
Bufo dominated when newts were present
Scaphiopus dominated without newts

For ponds that dried quickly:
Only *Bufo* and *Scaphiopus* metamorphosed when newts were present, *Bufo* still dominated
Scaphiopus was the only species to metamorphose without newts

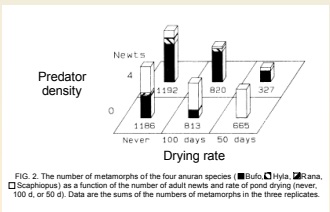
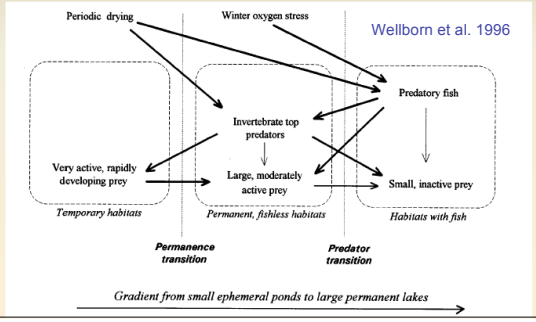


FIG. 2. The number of metamorphs of the four anuran species (■Bufo, ◘Hyla, ◪Rana, ☐Scaphiopus) as a function of the number of adult newts and rate of pond drying (never, 100 d, or 50 d). Data are the sums of the numbers of metamorphs in the three replicates.

Wilbur 1987

General concepts in larval anuran communities

Mechanisms generating community structure



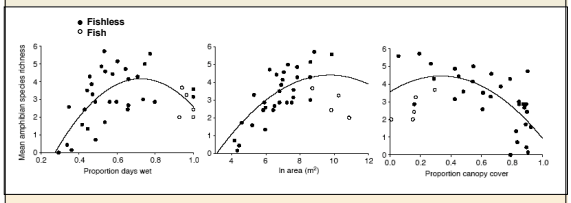
Wellborn et al. 1996

General patterns in larval anuran communities

Data from 37 ponds and wetlands in Michigan

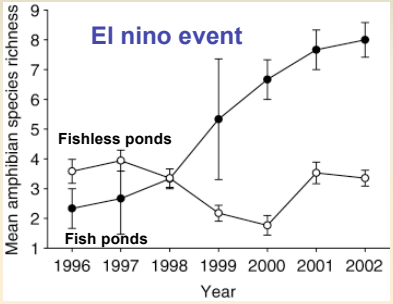
Examined species richness over 7 years

Humpshape relationship due to fish



Werner et al. 2007

General patterns in larval anuran communities



Werner et al. 2007