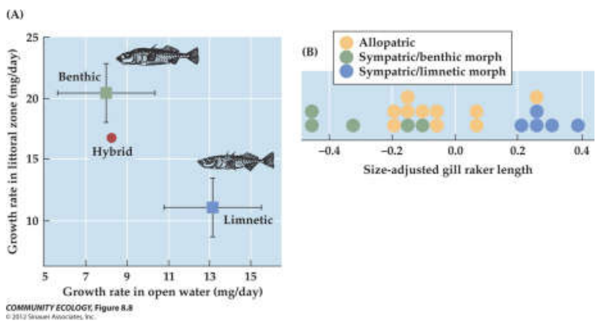
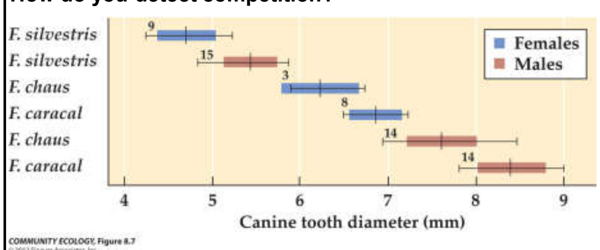


If you look for competition in closely related species…

- No competition:
  - Ecological scale explanations: e.g. niche shift
  - Evolutionary scale explanations: e.g. character displacement
  - Phylogenetic explanations: historical differences
- There is competition
  - Strength of competitive interactions
  - Niche conservatism
  - History of species interactions

How do you detect competition?



- Niche shift or contraction in sympatry
- Morphological patterns consistent with character displacement
- Pattern or process?
- Hypothesis tests?

How do you detect competition?

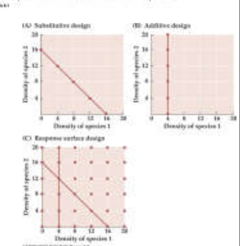
- Experimental evidence is limited to a few systems that are logistically simple enough.
- Experimental designs
  - **Additive**
  - **Substitutive**
  - **Response Surface**

TABLE 8.1 Minimal (2-species) response surface design[a]

	Treatment 1	2	3	4	5
Population of species A	N	2N	N	0	0
Population of species B	0	0	N	2N	N
Intraspecific effects: Treatment 1 vs. treatment 2; treatment 4 vs. treatment 5					
Interspecific effects: Treatment 3 vs. treatment 1; treatment 3 vs. treatment 5					

Source: After Underwood 1986, Community Ecology Pattern and Process, pp. 240–268.

[a] A response surface (or addition series) design is used to compare the magnitudes of intraspecific vs. interspecific effects. All treatments should be replicated.



Experimental Considerations

- Manipulating density or setting up mesocosm or cage experiments requires some careful considerations.
- **Internal** – strength in the cause-effect relationship between dependent variable(s) and independent variables.
- **External** – strength of the link between your conclusions and the question or hypothesis you're asking about the natural population. How generalisable are your conclusions?

Threats to Validity

- **Question** – does concentration of nutrient "x" control productivity?
- **Field Experiments**
  - – Measure nutrient x and plant size in various environments
  - – Measure nutrient x and number of new leaves produced
  - – Measure nutrient x and increase in plant biomass in various environments
- **Lab Experiments**
  - – Measure growth in pots with different levels of x

Mesocosm Experiments

- Advantages - disadvantages

Ecology, 85(1), 2004, pp. 134–149

ASYMMETRIC COMPETITION, HABITAT SELECTION, AND NICHE OVERLAP IN JUVENILE SALMONIDS

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115 treatments – response surface design with multiple density treatments for each species.

Measured habitat use (pool vs. riffle)

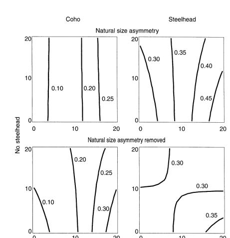

FIG. 4. The isoleg response surfaces showing the predicted proportions of coho and steelhead in the secondary riffle habitat as a function of the species' densities under the two competitive scenarios. See Tables 2 and 3 for the ANCOVA results and parameter values that produce the graphs.

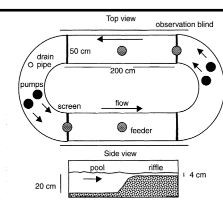

FIG. 1. Schematic diagram of the two oval flow tanks used for the habitat selection trials. Each tank had two identical stream channels.

- Energetics of predation
  - Predator and prey strategies
  - Evolutionary arms race
  - Predator selectivity indices, E and Chession's index based on Energy gain per prey, encounter rate, probability of pursuit and handling time
- Optimal foraging
  - Assumptions and predictions
  - Maximization of net energy gain per prey item
  - Specialist vs. generalist consumers
  - Zero rule and switching behavior
  - Prey profitability given an array of options
  - Evidence and giving up density
  - Research example – Eubanks and Denno paper (Big eyed bugs)
- Ideal free distribution
  - Assumptions and predictions
- Prey responses to consumers
- Consumer effects on prey assemblages – reduce competitive exclusion, increase diversity
  - Consumers driving apparent competition and trophic cascades
  - Noncomsumptive effects
  - Habitat shifts
  - Morphological shifts
  - Life history shifts
- Types of competition, definitions
- Review of intraspecific models, modification to interspecific
- Significance of coexistence, three outcomes of similar species coexistence
- Ecological (short term) responses
  - Niche shift, specialization (barnacle example)

$$E = \frac{(r_i - p_i)}{(r_i + p_i)}$$

$$a_i = \frac{d_i/N_i}{\sum_{j=1}^{k}\left(d_j/N_j\right)}$$

$$\frac{E_n}{T} = \frac{\sum_i^k \lambda_i E_i P_i}{1 + \sum_i^k \lambda_i h_i P_i}$$

- Interspecific models
  - Modified Lotka-Volterra, competition coefficients
  - Lotka-Volterra isocline graphical models
  - Predictions (3 basic outcomes), assumptions, problems and limitations
  - Tilman vs. Grimes debate on importance of competition
  - Grimes triangle
  - Tilman R* model based on optimal foraging, Liebig's law and resource allocation trade-offs (R* also called resource ratio hypothesis)
  - Zero net population growth (ZNPG) isoclines
  - Use, application and prediction of graphical R* models
  - multiple species and resource coexistence and interactions with R*
  - Calculating niche overlap
- Niche packing, competitive release, evolution of generalists vs. specialists
- Species responses to competition
  - Ecological (niche shift), evolutionary (character displacement, "Ghost of competition past"), or phylogenetic explanation for reduced competition
  - Character displacement mechanisms and example (Anole)
  - Niche shift example (sunfish)
  - Stickleback example (Pritchard and Schluter paper)
  - Phylogenetic signal and niche conservatism
- Difficulties in testing for competition
  - Observing patterns vs. testing hypotheses
- Competition experimental design, additive, substitutive, response surface
- Internal vs. external validty
- Field vs. mesocosm experiments

$$\frac{dN_1}{dt} = r_1 N_1\left(\frac{K_1 - N_1 - a_{12}N_2}{K_1}\right)$$

$$\alpha = e^{-d^2/4w^2}$$