Competition
Limiting resources

Lecture outline
- Competition as a potentially important density-dependent factor
- Intraspecific competition in animals and plants
- The niche and competition
  - Gause’s principle
  - Hutchinson’s n-dimensional hypervolume
- Competition and math—Lotka-Volterra equations
- Evidence for interspecific competition in the field

Competition
- Only occurs when …
- Intraspecific vs. Interspecific competition
- Types of competition:
  - Exploitative vs.
  - Interference

Potential outcomes
- Types of interspecific interactions

<table>
<thead>
<tr>
<th>Type of interaction</th>
<th>Species 1</th>
<th>Species 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mutualism</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Commensalism</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Amensalism</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Parasitism</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Predation</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Competition</td>
<td>-</td>
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</tr>
</tbody>
</table>

How would you test for competition?

Effects of intraspecific competition on animals

Fig. 13.6
Protelesia marginata on Spartina
Effects of intraspecific competition on plants

- Picture yourself as a pine tree through time…
- What happens?

Self-thinning

![Graph showing the effect of density on final dry weight](image)

Consultation Initial density vs. Final density for various initial densities.

M. sativa planted at high density initially.

The niche

- Incorporates many ideas over the years
- *Niche consists of…*
- Some interpretations:
  - E.P. Odum (1959):
    - Address vs. profession
    - Resource vs. impact niche

Linking niches and competition

- Gause’s or competitive exclusion principle
- Do we ever see this principle in action?

*n*-dimensional hypervolume

- Hutchinson (1957)
Effects of competition on the niche

Bluegill + Green sunfish

What about the reverse?

- Are there interactions that expand the hypervolume?

Bruno et al. (2003)

An example of the reverse

Callaway and King (1996)

A reminder...

- Another form:

\[ \frac{dN}{dT} = rN \left( \frac{K - N}{K} \right) \]

As the ratio \( N \) increases, population growth slows.

Lotka-Volterra competition outcomes

- Four possibilities:
  - Species 1 wins, species 2 goes extinct/excluded
  - Species 2 wins, species 1 goes extinct/excluded
  - It depends
  - Coexistence
  - A reality check

Alfred Lotka Vito Volterra

Competition theory

- Lotka-Volterra model
  - Species 1: \( \frac{dN_1}{dt} = r_1N_1\left( \frac{(K_1-N_1-\alpha N_2)}{K_1} \right) \)
  - Species 2: \( \frac{dN_2}{dt} = r_2N_2\left( \frac{(K_2-N_2-\beta N_1)}{K_2} \right) \)

- If \( \alpha N_2 \) or \( \beta N_1 \) = 0, then population shows ? population growth

Callaway and King (1996)

Lotka-Volterra competition outcomes

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Evidence for interspecific competition in the field

- Two older meta-analyses:
  - Connell (1983): 40% of studies; 50% of species
  - Schoener (1984): 90% of studies; 76% of species

Diversity and the coevolution of competitors, or the ghost of competition past

James Brown et al.

- 20 ha study site
- 24 plots
- Each plot is 50 m x 50 m

Competition in the field

- Control
- Removal

Any other reasons to do long-term studies of rodents?

- Michener et al. (2009)
- Yates et al. (2002)