But populations and species do not exist in a vacuum...

Species interactions...

Community Ecology

A) Five fundamental types of species interactions:

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<th>Effect on species</th>
<th>A</th>
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B) Concept of the Niche

1) Best known definition of niche is Hutchinson (e.g., 1957)
   a) role organism plays in environment
   b) role can be determined by measuring all of an organism’s activities and requirements

2) Examples

   - Substratum friability (low - high)
   - Wave exposure (low - high)
   - Percent cover (macroalgae - high)

3) By extension... niche defined as an N-dimensional hyperspace (encompasses all effects and requirements of a species)

B) Concept of the Niche

3) Two types of niche

   a) fundamental: niche space determined by physical factors and resource requirements. Manifest in the absence of other organisms.

   b) realized: niche space determined by combined physical and biological factors. Realized in presence of other organisms

fundamental niche always bigger (or at least as large) - biological interactions can (usually do) limit realized niche
**C) Competition**

**Defined:**
The common use of a resource that is in **limited** supply.

1) Within and between species
   a) Intraspecific - among individuals of the same species
      source of density dependence discussed last time
   b) Interspecific - among individuals of two or more species

2) Two types of competition
   a) Interference - direct competition
      i) e.g., aggression
      ii) e.g., territoriality (fishes, birds, limpets)
   b) Exploitation -
      i) Compete through a resource (R)
      ii) e.g., sessile spp. -- space

3) Competitive exclusion principle
   The more similar organisms are, the more likely they are to compete.
   a) Species occupying the same niche cannot coexist.
   b) The greater the niche overlap, the greater the likelihood of competitive exclusion, leading to local extinction of one species.
   c) Leads to “resource partitioning”

4) Resource partitioning
   - e.g.,
     - seed / plankton size
     - elevation
     - height on tree / alga
   - e.g.,
     - adaptation
     - species “packing”
C) Competition

5) Manifested in patterns
   a) non-overlapping spatial (or temporal) distribution

   ![Diagram showing resource gradient with number of individuals changing across different resource levels and patterns for barnacles, mussels, and black & yellow rockfish.]

   ![Diagram illustrating negative (inverse) relationship in abundance with gradient in density and patchy / clumped distributions.]

   ![Diagram showing competitive release with change in distribution or some other response such as growth when separate and together.]

C) Competition

6) Competitive release
   a) Change in distribution (or some other response such as growth) when separate and together

   ![Diagram illustrating competitive symmetry with relative competitive strength, dominant, subordinate.]

C) Competition

7) Competitive symmetry
   a) Relative competitive strength
   b) superior, inferior (or) dominant, subordinate

   ![Diagram showing A = B, A > B, A < B with arrows indicating direction of competitive interaction.]

Could examine observationally or experimentally, which preferred?

How would you assess this??
C) Competition
7) Effects on measured variables
   a) Individual responses:
      • Behavioral (feeding rates, foraging distribution)
      • Physiological (growth rate, reproductive rate)
      • Morphological (body size, biomass)
   b) Population responses:
      • Abundance (density)
      • Distribution (zonation)
      • Demographic rates (population growth)

D) Predation
Consumption of one organism (prey) by another (predator),
which by definition, occurs between organisms on
different trophic levels (vs. competition: within same
trophic level)
1) diagrammatically:

D) Predation
2) Effects on prey (direct and indirect):
   "Direct effects": direct losses (removal of individuals)
   - death of individuals
   - mortality rate of population
   "Indirect effects": influence of predator on variable
   other than death or mortality

D) Predation
3) Effects on prey (individual and population):
   Population responses:
   • abundance, density
   • distribution (habitat use)
   • structure (e.g., size, age, sex ratio, genetic, spatial)
   • dynamics and persistence (regulation)
D) Predation

4) Complex interactions (with other processes)
such as competition:
   e.g., predator that specializes on barnacles and is restricted to
   the mid and lower intertidal

With predators
- Barnacles
- Mussels

Without predators

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D) Predation

4) More complex predation interactions:

Apparent competition
A and B are prey
and C is a common predator.
Presence of both prey increases overall predation rates, leading to negative indirect effect on one another.

Trophic cascade
A is primary producer,
B is an herbivore, and C is a predator.
Effect of species on adjacent trophic level has net positive indirect effect on next trophic level.

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Trophic cascades

Strong "top-down" effects that produce downward rippling effects through a food chain.
Higher trophic level predators *indirectly* affect plant biomass via their impacts on herbivore populations.

Strong "bottom-up" effects that produce upward rippling effects through a food chain.
Lower trophic level producers *indirectly* affect predator biomass via their impacts on herbivore populations.
Oksanen/Fretwell Model:
Productivity and Food Chain Length

- Depending on productivity of community, food chains can have fewer or more than three trophic levels.
- As primary productivity increases, trophic levels will be sequentially added.
- Food chains that have an odd number of trophic levels should be filled with lush vegetation, because herbivores are kept in check by predators.
- Food chains that have an even number of trophic levels should have low plant abundance because plants are herbivore limited.
**E) Mutualism / commensalism**

1) Occurs within or between trophic levels, more often between trophic levels

a) mutualisms: e.g., pollinators
   - obligate - required for each others existence - pollinators
   - facultative - not required - cleaner fish and parasitized hosts

b) commensalisms: e.g., facilitation

\[ A = B \]

\[ A < B \]

How would you assess this??

**E) Community metrics**

1) Species richness: number of species in a community

2) Species composition: identity of species that constitute a community

3) Species diversity: species richness and relative abundance

Shannon-Weiner index of diversity:

\[ H' = -\sum p_i \ln p_i \]

Where \( p_i \) is the proportion of individuals in the community that are species \( i \)

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**E) Community metrics**

4) Illustration of diversity

Evenness: measure of the relative similarity of species abundance in a community

\[ E = H'/\ln S \]

where, \( S \) is species richness

Which community is more even?

Pre-proposals due Tues July 7!

1) Hand in printed copy at the beginning of class
2) Email electronic copy to Cynthia: cghays@ucdavis.edu by 5pm

Come prepared for exam review – mock exam on website by 1pm on Mon