Lecture 13: Competition

I. Introduction

A. Objectives
1. Introduce concepts of ecological niche, resource axes, resource segregation
2. Summarize forms of and evidence for competition among fishes
3. Summarize role of competition in fish population and community dynamics

II. Definitions

A. Competition = interaction between individuals in which one or more of the participants suffers a net loss of fitness (eg, reduced survival, growth, reproduction)

- one competitor consumes resources that *would have been consumed* by the other
- interference competition (individuals interact directly)
- diffuse competition (individuals forfeit resources to multiple, often unidentified competitors)
- cumulative effects across individuals can limit population size

B. Ecological niche = the collection of conditions and resources used by an organism
- multi-dimensional (abiotic, biotic) range of conditions

1. fundamental niche
- entire usable range, in ideal setting, no predators or competitors
- limited by physiological, morphological, behavioral adaptations over short term
- observed range can be limited by representation in environment rather than by adaptations
- ecological niche models predict potential range of introduced fishes based on climate, physiography of native distribution

2. realized niche
- range actually utilized in a particular circumstance
- competition (or other factors) can constrain fundamental niche

C. Ecological resource axis = niche component along which resource use can be measured
- can be abiotic or biotic
- axes usually represent food, space, or time (currencies in optimization)
- can measure breadth or overlap of resource use along gradient of resource availability

III. Relations among resource availability, resource overlap, and competition

A. Resource availability versus overlap
- abundant resources → high selectivity (narrow niche breadth)
- abundant resources → high OR low overlap, depending on preferences
- scarce resources → high overlap

B. Resource overlap versus competition
- dangerous to infer competition from overlap alone (instead, treat as testable hypothesis)
- competition requires resource overlap AND resource scarcity
- resource superabundance versus crunch

C. Resource segregation

1. Selective segregation
   - observed segregation of resource is evolutionary result for fundamental niche
   - not a response to contemporary interactions with putative competitors
   - competition *may* have been involved ("the ghost of competition past")

2. Interactive segregation
   - realized niche varies in response to interactions with current competitor
   - evidenced by variation in resource use between allopatric and sympatric situations
   - suggested by complementary patterns of spatial distribution for very similar species

3. Patterns of segregation
   - common resource segregation among fishes: food > space > time
   - generalists more amenable to short-term shifts in resource use in response to competitor

III. Types of competition

A. Intraspecific competition

1. Individuals in same population likely to be most intense
   - intraspecific > interspecific competition
   - intraspecific segregation of resources common but not necessarily driven by competition
     eg, Roanoke logperch life stages

2. Scramble competition
   - individual's share of resources depends on amount available and population density
   - little variance in competitive ability among individuals
   - often applies to schooling fish w/out complex social structures or territoriality

3. Contest competition
   - dominance hierarchies (rankings) determine individual's share of resources
   - less density dependent
   - highest-ranking individuals get the most resources (well-studied in salmon and trout)

4. Competition for mates
   - evolutionarily, ultimate resource
   - resource "consumed" is fertilized gamete of potential mate
   - drives sexual selection, dimorphism (eg, size, colors, tubercles)

B. Interspecific competition

1. Competition for space
   - scarce resting positions for brook trout and brown trout (brown dominant)

2. Space – food interactions
   - co-occurring sunfish species (*Lepomis*) in Michigan ponds
   - all prefer vegetated areas and foods therein in absence of competitors
   - when stocked together, 2 species shifted resource use
   - all species suffered lower growth, but green sunfish suffered least (best adapted to vegetation)

3. Mechanisms that reduce competition
   - unlike predation, no adaptive advantage to any competitor

   a. predation can suppress prey densities below competitive levels

   b. complex spatial structure can enable individuals to minimize competitive interactions

IV. Role of competition in fish community organization

A. Environmental stability

1. Environmental flux, disturbance can suppress population densities below competitive levels
   - temporal flux in resource availability inhibits specialization
   - lakes vs rivers
   - deep ocean vs estuaries

2. Periodicity of competition
   - few ecosystems exhibit sufficient long-term environmental stability for sustained competition
   - competition tends to limit populations only periodically, during resource "crunch-times"
   - complicates demonstrations of competition

B. Interaction with other controls on populations and communities
   - generally not the only process responsible for community organization
   - interacts with predation, disease, environmental extremes, environmental flux