Community Ecology of Fishes

Communities or assemblages?

Relationship between life history traits ⇒ population and community ecology

Complex life cycle ⇒ open populations ⇒ open communities

Assemblage / community attributes:

- **richness (S) = number of species**
- **evenness (E) = how equal individuals are distributed among species (relative abundance)**

	Assemblage 1	Assemblage 2
Species A	75	55
Species B	25	45

- **diversity (H') = combines richness and evenness**

Shannon-Wiener Index of Diversity

$$H' = -\sum_{i=1}^{s} p_i \ln p_i$$

p_i = the proportion of the each species
ln = natural log
s = the number of species in the community

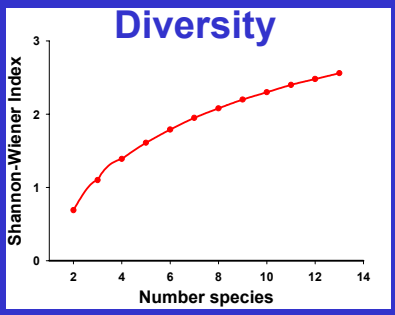
Shannon-Wiener Index of Diversity

- Rare species are weighted less in S-W index than abundant species
- Maximum diversity possible when communities are comprised of an equal number of individuals per species
- Evenness (J) = H'/H_{max}

  Evenness ranges between 0-1 (not zero)

Example

Community A				
Species	**Number**	**Proportion (p_i)**	**$\ln p_i$**	**$p_i \ln p_i$**
1	21	0.84	-0.17	-0.15
2	1	0.04	-3.22	-0.13
3	1	0.04	-3.22	-0.13
4	1	0.04	-3.22	-0.13
5	1	0.04	-3.22	-0.13
Total	25	1.0		-0.66
		H' =	**0.66**	



If # species = 200 and Evenness = 1, S-W index = 5.30
If # species = 2,000 and Evenness = 1, S-W index = 7.60
If # species = 20,000 and Evenness = 1, S-W index = 9.90

Assemblage / community attributes:

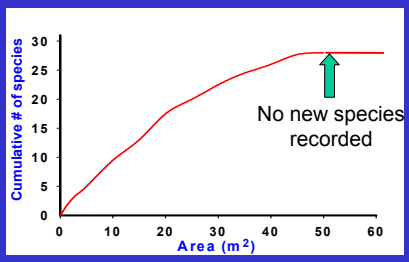
- species composition (proportion of individuals of particular species)

- maintenance of diversity (i.e. species coexistence)

Species Richness & Area

Relationship between area and number of species…

As area increases, species richness increases



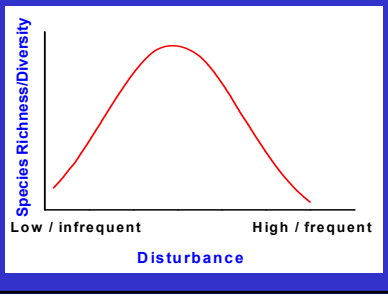
Species Richness & Habitat Heterogeneity

As habitat heterogeneity increases, species richness increases

Disturbance and Species Diversity

Disturbance = discrete killing, displacement, or damaging of individuals of a species that creates an opportunity for new individuals to become established

Two components: frequency and intensity



Community/Assemblage Structure

- Hypotheses for maintenance of species diversity

-- Equilibrium hypotheses
deterministic

-- Non-equilibrium hypotheses
stochastic

Equilibrium hypotheses

- Involves settlement and post-settlement processes
- Stresses biotic interactions
- Often based on competition, leading to community of low diversity dominated by the superior competitor
- Results are predictable in species composition

Niche Diversification Hypothesis

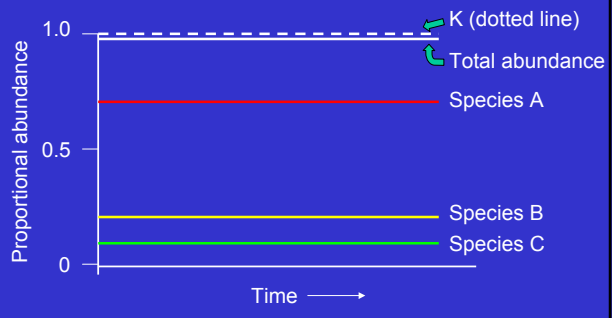
- Competition based (assumes resources are limiting
- Resource partitioning (each species is a superior competitor for particular resources)

Prediction:

-- total number of individuals and species limited by resources

-- assemblage-wide carrying capacity

Niche Diversification Hypothesis



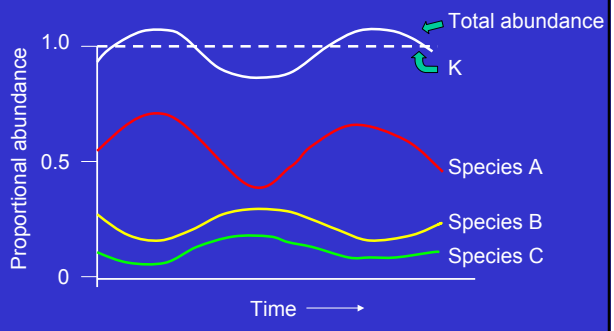
Predation Hypothesis

- Compensatory mortality (predators feed on most abundant species)
- Predators "switch" to feed on most abundant species, disproportionately reducing that species
- Induces competition for refuge from predation
- Regulate populations of prey species separately (density dependence)
- Allows persistence of inferior competitors

Prediction:

-- differences in recruitment of species diminishes over time as numbers converge

Predation Hypothesis (Compensatory mortality)



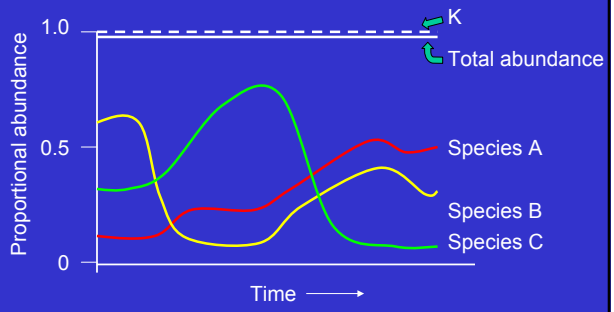
Non-equilibrium hypotheses

- Various processes can be involved: competition, predation, disturbance, limited recruitment
- Relative and total abundance fluctuates unpredictably
- Species composition is unpredictable

Lottery Hypothesis

- Competition based (resource limitation)
- Assumes larval pool saturates resource (space)
- No resource partitioning
- Likelihood of creating and acquiring resource space due to random chance
  (deaths and larval settlement)
- Prediction:
  -- maximum total abundance across species
  -- relative abundance of species fluctuates unpredictably

Lottery Hypothesis



"Lottery Model and Storage Effect" Hypothesis

- relative recruitment success of species changes through time
- species persist through bad recruitment periods and "store" recruitment events in extended lifetime (age classes) of adults

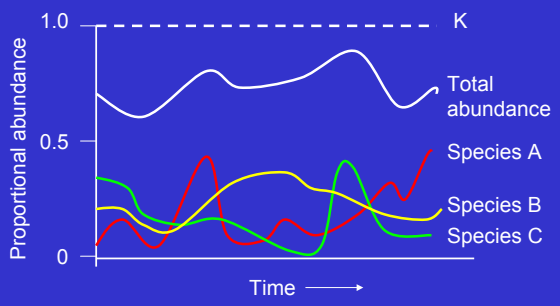
Similar pattern as Lottery Hypothesis figure, but different mechanism!

Recruitment Limitation Hypothesis (Doherty, Victor)

- Assumes high mortality of pelagic larvae limits number of recruits to benthic populations
- Larval supply limits recruitment below that which is required to saturate resources
- No competition so mortality is density-independent
- Prediction:

  -- total numbers and relative abundance fluctuates with variable larval supply

Recruitment Limitation Hypothesis

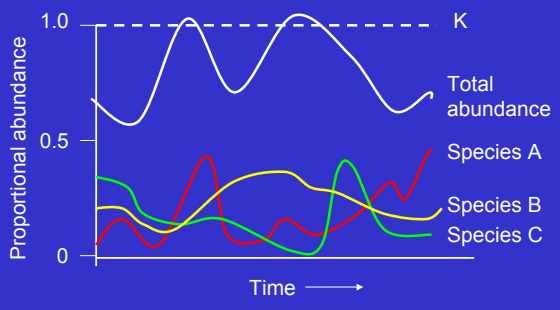


"Predation" Hypothesis (Hixon) = "Disturbance" Hypothesis (Chesson)

- predation reduces numbers below levels that saturate resources
- no competition ⇒ numbers fluctuate below K of habitat

Similar patterns as Recruitment Limitation Ho, but numbers fluctuate above and below K and it is a different mechanism!

Predation / Disturbance Hypothesis



Pluralistic Approach (Jones)

SETTLEMENT MODIFIED BY POST-SETTLEMENT PROCESSES?	POST-SETTLEMENT COMPETITION: STRONG	POST-SETTLEMENT COMPETITION: WEAK
YES	Niche Diversification	Predation, Disturbance
NO	Lottery	Recruitment Limitation