History and meaning of the word “Ecology”

A. Definition
1. Oikos, ology - the study of the house - the place we live

B. Etymology = study of the origin and development of a word
1. Earliest - Haeckel (1869) - comprehensive science of relationship of organism and environment
2. Elton (1927) - scientific natural history
3. Andrewartha (1961) - scientific study of the distribution and abundance of organisms
4. Krebs (1985) - scientific study of the interactions that determine the distribution and abundance of organisms

Note that all talk about “scientific” Why???

Definitions (levels of ecological organization)

A. Individual (can be difficult to define! Generally, a biological organism that...)
B. Population (a collection of individuals in an area, of the same species, that...)
C. Species (characterized by...)
D. Community
E. Ecosystem

Basic Population Biology - Unlimited Growth = Malthusian Growth or exponential growth

Population at time t = \( N_t \)

Where \( t \) = time \( t \) and \( t+1 \) = sometime after that

Assumptions:
1) Emigration = immigration, then

where \( b \) and \( d \) are instantaneous estimates
2) Generations overlap
3) Resources are unlimited

The instantaneous per capita rate of growth \((r)\) equal the birth - death rate:

\[ r = b - d \]
Exponential Growth - calculation

\[ N_t = N_0e^{rt} \]

- \( N_0 \) = population at time 0
- \( r \) = per capita rate of growth (\( b - d \))
- \( t \) = time
- \( e \) = base of the natural log (\( \approx 2.72 \))

Essentially same formula as compounded interest

Exponential Growth - an Understanding of Rates

Rate of growth of population = \( \frac{\Delta N}{\Delta t} \)

Using calculus we can derive a function for the instantaneous rate of growth of populations. The rate of change of the population is equal to growth rate \( r \) times the population:

\[ \frac{dn}{dt} = rN \]

Exponential Growth - why is growth unlimited?

The assumption is that the per capita growth rate \( (r) \) is unrelated to population size \( (N) \). This means:

1) Birth rates are unaffected by population size, and
2) Death rates are unaffected by population size

Does this make sense?

\[ \text{remember } r = b - d \]
Limited Growth

Assumptions:
1) Resources become limited as populations increase
2) Thus, per capita rate of growth must decrease with increasing population

Limited Growth – density dependence

Exponential rate of population growth
\[
\frac{dn}{dt} = rN
\]

Logistic (limited) rate of population growth
\[
\frac{dn}{dt} = rN \frac{(K-N)}{K}
\]

K = carrying capacity

Key consequence of density dependence:

Population regulation: when population fluctuations are bounded so as not to increase indefinitely or decrease to extinction
Population Structure:

Contrary to assumptions of Logistic Growth, not all individuals in a population are the same!

**Structure**: relative abundance of individual traits among individuals in a population:

All of these influence per-capita rate of mortality (D) and reproduction (B)
Size Matters: Bigger Fish Produce Far More Larvae

- Approx. 11-fold increase
- Approx. 7-fold increase

What does this mean for larval output of over-fished populations?

Age matters: older females produce higher quality larvae with a higher likelihood to survive


Moreover: Different aged fish spawn at different times

“Bipartite” life cycle of benthic marine organisms with pelagic larvae

Larvae
- Pelagic Environment
- Reproduce
- Settle
- Pelagic Environment
- Survive, grow, develop, disperse

Juvenile
- Pelagic Environment
- Survive, grow, mature

Benthic Environment
- Juvenile, settle
- Adult, reproduce
"Closed" Populations

Little or no exchange among populations

Production  Supply

“Open” Populations

Significant exchange among populations

Production  Supply

Supply  Production

Life History Traits  (individual, heritable, species-wide)

Population Attributes

Community Attributes