

Population Biology

- I. Why do we need to know population biology?
 - A. Much of fisheries management is directed toward a few, select populations with economic importance.
 - B. Populations respond to the abiotic and biotic environment
- II. Definition of population - group of species within a region that interbreed; have characteristics that individuals do not
 - A. Birth rate (b)
 - B. Death rate (d)
 - C. Gene pool
 - D. Density
 - E. Age / size structure
- III. How do we characterize populations?
 - A. Basic sampling to get size, condition, diets, individual growth rates.
 - B. Quantification of density
 1. Mark-recapture - Petersen estimate (the ratio of marked individuals in the population should reflect the ratio of marked individuals in a future sample)
 - a. Assume no mortality occurs between marking and recapturing
 - b. Assume no migration or emigration between marking and recapturing
 2. Catch-per-unit-effort (CPUE or CPE) - number caught per unit time or effort; often reflects true numbers in the field
 3. Depletion estimates
- IV. What is a stock?
 - A. Often considered the same as population
 - B. In reality, a management unit which may or may not be a population
- V. Modeling population change through time
 - A. Population change is probably not exponential – at some point, population growth must decline, essentially because an ecosystem has limited resources to sustain a population.
 - B. Logistic equation is $dN/dt = rN[(K-N)/K]$
 1. N is the population density; number of individuals
 2. dN/dt is the rate of change of population density (the *entire* population).
 3. r is the *per capita* change in population size; this means the rate of population increase relative to each individual in the population.
 4. K is the carrying capacity; do not mistake this for K in the von Bertalanffy. K is the maximum population size that at which population size will remain stable. If K is exceeded, the population size will decline.
 - a. K is influenced by the productivity of an ecosystem; eutrophic systems will likely have a greater K than oligotrophic ones.
 - b. At K, births = deaths. Population size is not changing.
 5. The function $[(K-N)/K]$ puts “the brakes” on population growth.
 6. Behavior of the logistic function
 - a. Small N - slow dN/dt BUT high r
 - b. Intermediate N - high dN/dt AND intermediate r
 - c. High N - low dN/dt AND low r
 - C. Population growth
 1. Per capita rate of change (r) = birth rate (b)- death rate (d)
 2. r declines with increasing population size because b declines and d increases; above K, r becomes negative

3. Negative r above K is a *compensatory* population mechanism. Increase in death rate and decline in birth rate above K makes population return to K . Similarly, a reduction in population size makes d decline and b increase, causing population size to increase toward K .
4. What does compensatory mechanisms mean for fishing? **Surplus production model**
 - a. Production = number of individuals or biomass accumulated per unit time.
 - b. Standing crop =
 - c. Increase in fishing effort leads to a decline in population size or catch per unit effort
 - d. At some intermediate level of fishing effort, total catch is maximized – this occurs at intermediate r and highest dN/dt . As fish produced are removed, the population compensates by producing more individuals (by reducing death rate and increasing birth rate).
 - e. A potential goal of management is to maintain fishing effort at this MSY (maximum sustainable yield).