Fish Management (Zool 466)
Lecture 8

Fish Growth

I. What is growth? Can be defined in many ways.
   - A. Increase in energy content (calories)
   - B. Increase in length
   - C. Increase in mass

II. Growth is important for may reasons
   - A. Growth affects yield (i.e., biomass); commercial harvest
   - B. Growth affects body size (i.e., length and girth); recreational anglers
   - C. Body size and growth rates may affect risk to predators
   - D. Size affects reproduction
     - 1. Maturation timing
     - 2. Fecundity (number of eggs produced)

III. Quantifying growth
   - A. Short term – growth in length in the short term is approximately linear; hence, simple techniques may be used to quantify it
     - 1. Absolute increase in length
     - 2. Relative rate of increase in length
     - 3. Instantaneous rate of increase in weight (exponential)
   - B. Long term –growth in length and weight across life stages or during entire life is non-linear
     - 1. Timeline
       - a. Early life - characterized by rapid growth
       - b. Late life - slowing growth
     - 2. Do fish ever stop growing?
       - a. Fish are indeterminate growers
         - (1) growth never completely stops
         - (2) no innate pattern to growth
   - C. What affects growth?
     - 1. Temperature - affects assimilation, metabolism, and consumption
     - 2. Consumption - maintenance ration is generally 1-3%
     - 3. Genes
     - 4. Competitors/predators
     - 5. Daylight - seasonal production

IV. Length
   - A. Typical pattern
     - 1. Rapid, exponential growth phase followed by asymptotic growth
     - 2. Length increment (and growth rates) decline in non-linear fashion
   - B. Length change through time may be modeled in may ways - most recognized, von Bertalanffy equation
     - 1. Parameters
       - a. l_t = length at year t
       - b. $L_{infinity}$ = theoretical asymptotic length
       - c. t_0 = time when length = 0
       - d. K = growth rate

2. Estimating parameters
    a. Collect complete age and growth data for population, if possible
    b. Use computer to derive parameters using iterative approaches
    c. By hand - Walford plot
        (1) plot l_t against l_{t+1}; get K and $L_{infinity}$
        (2) t_0 is derived by plugging the derived parameters back into the original equation

V. Weight
  A. Typical pattern
    1. Early, slow growth
    2. Intermediate, rapid growth
    3. Late, slow growth
  B. Two models work well
    1. Gompertz - lots of parameters involved to get weight at any time t
        a. G = Instantaneous rate of growth at t = 0
        b. g = instantaneous rate of decline of G
        c. w_0 = weight at time 0
    2. von Bertalanffy - modified from length model
        a. Same parameters as before, but for mass
        b. Need to add “3"; this is a scaling parameter because mass(or volume) should theoretically increase as the cube of length

VI. Relationship between length and weight
  A. Exponential; again, length increases at much slower rate than mass
  B. $W = aL^b$; a and b are constants; W is mass; L is length
  C. b theoretically should be 3 (if fish were spheres); b ranges 2.8 - 3.4
  D. This relationship can be made a linear one if plotted on a log scale; convenient for parameter estimation using simple linear regression