ECOL 3500 – EXAM #3 STUDY GUIDE
CHAPTER 11 NOTES

- Human Global Population
  - current population = **7.07 x 10^9 → will reach 9 x 10^9 by 2040**, at which point the world should approach a stationary growth rate (i.e., when $r = 0$, when birth & death rates are equivalent)
  - Asia approaching stationary… Europe & NA decreasing… Africa & SA increasing
  - growth rate = (birth rate) – (death rate)
  - U.S. population = **1/3 of a billion**
  - world population = **6.7 billion**
- 2 Models of Population Growth
  - **exponential growth** = young individuals added to population **CONTINUOUSLY**
  - **geometric growth** = young individuals added to population at one particular time of year or some other **DISCRETE INTERVAL** (usually a response to season)
- Exponential (Continuous) Population Growth
  - results in a continuously accelerating curve of increase (or a continuously decelerating curve of decrease)
  - to calculate rate of individuals added to population: $dN/dt = r N$
    - exponential growth rate (r) expresses population increase on a "per individual basis"
    - rate of increase (dN/dt) varies in direct proportion to N
    - continuous time equation
- Discrete Time (Geometric) Population Growth
  - e.g., European rabbits in Australia & California quail
    - using discrete time approach allows you to estimate r w/: $N_t = N_0 \lambda^t$, where λ = change of #s over one time interval
    - using logarithmic scale: straight line, since r is constant… if slope "wiggles," then r is NOT constant
  - results in seasonal patterns of population increase & decrease
  - to calculate instantaneous discrete time growth: $N_{(t+1)} = N_t \lambda$
    - $N_{(t+1)}$ = # of individuals after 1 time unit
    - N_t = initial population size
    - λ = ratio of population at any time compared to 1 time unit earlier, such that $\lambda = N_{(t+1)} / N_t$

– to calculate population growth over many time intervals: $N_t = N_0 \lambda^t$
  - ○ N_t = new population size
  - ○ N_0 = initial population size
  - ○ λ = discrete time growth rate
    - ▪ NOTE: λ = 1.50 for a population w/ a discrete time growth rate of 50%
  - ○ t = appropriate # of time intervals

- Relating Exponential & Discrete Time Growth
  - – $\lambda = e^r$
  - – $\ln \lambda = \log_e \lambda = r$
  - – estimate r by calculating λ
  - – DECREASING population when:
    - ○ discrete time growth rate: $\lambda < 1$
    - ○ exponential growth rate: $r < 0$
  - – STATIONARY population when:
    - ○ discrete time growth rate: $\lambda = 1$
    - ○ exponential growth rate: $r = 0$
  - – INCREASING population when:
    - ○ discrete time growth rate: $\lambda > 1$
    - ○ exponential growth rate: $r > 0$
  - – λ & r are constants
  - – λ cannot be less than 0
- Life Tables
  - – S_x = age-specific survival
    - ○ e.g., if first-year survival (S_x) is 0.5, then only 50% of individuals from that year will survive to the next year
  - – B_x = (age-specific fecundity) x (iteroparity)
  - – L_x = survivalship
- Crucial Population Vocabulary
  - – **stable age distribution** = proportion of individuals in each age class DOES NOT change through generations
    - ○ $\lambda > 0$

– **stationary population** = # of total individuals NEITHER increases nor decreases through generations

- $\boldsymbol{\lambda = 1}$
- a stationary population is a special case of a population w/ a stable age distribution

• Static Life Table: Nall Mountain Sheep

– **Olaus Maurie** collected skulls from Nall mountain sheep in Colorado

– studied teeth in jaw bone to make STATIC LIFE TABLE

- static instead of a cohort b/c he took all organisms at one time instead of individually

– made assumption that each age class behaved the same way

• Shapes of Survivorship Curves

– **curve I**: good survival during early years

- e.g., big mammals & humans
- mortality increases w/ age due to senescence

– **curve II**: normal / average survival

- mortality rate is independent of age

– **curve III**: high mortality during early years, then survive for a very long time

- e.g., turtles (?)
- mortality is high among juveniles then decreases

• Intrinsic Rate of Change / Increase

– r_m = **Malthusian parameter** or **intrinsic rate of change / increase** = EXPONENTIAL rate of increase (r) assumed by a population w/ a STABLE AGE DISTRIBUTION

- r_a = an approximated value of r_m

– R_0 = **net reproductive rate** across all age classes = $\Sigma l_x b_x$, where l_x = how long it takes for female to reproduce & b_x = how many babies (just female babies)

- expected total # of offspring of an individual over course of her life span
- $R_0 = 1$ represents her replacement rate
- $R_0 < 1$ represents a declining population
- $R_0 > 1$ represents an increasing population

– T = **generation time** = $\Sigma x l_x b_x / \Sigma l_x b_x$ = average time at which an individual gives birth to its offspring