FW364 Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Midterm I Exam

February 15, 2012 Section: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Be sure to read questions carefully. Always give the best answer.**

**Pay attention to units in the questions and in your answers. Show your work.**

1. (4 pts.) Which of the following is a measure of the **net production** of a plant population?

 a. photosynthesis

 b. respiration

 **c. photosynthesis minus respiration**

 d. photosynthesis plus respiration

2. (4 pts.) Given the units of a stock in the global hydrologic cycle, which of the following represents the best example of a **flow** **into** the stock of water in the world’s oceans?

 a. evaporation (m3/yr)

 b. precipitation (m/yr)

 **c. precipitation (m3/yr)**

 d. evaporation (m/yr)

3. (4 pts.) Environmental stochasticity affects:

 a. only small populations

 b. only large populations

 **c. all populations, regardless of size**

 d. only populations that reproduce seasonally

4. (4 pts.) What is the tripling time of a population that is growing geometrically? Show

 derivation assuming discrete growth.



5. (4 pts.) If we wanted to determine the **residence time** of water in Lake Michigan at steady state, and we knew the total of all river and groundwater flowing into the lake annually, what other information would we need?

 a. the volume of precipitation falling onto the lake annually and the surface area of the lake

 b. the volume of water evaporating from the lake annually and the surface area of the lake

 c. the surface area of the lake and the volume of the lake

 **d. the volume of precipitation falling onto the lake annually and the volume of the lake**

6. (6 pts.) The equation: Nt = N0λt is an example of which type of model? (choose between each pair, circle the right choice):

static or **dynamic**

**deterministic** or stochastic

7. (4 pts.) Which of the following best describes demographic stochasticity?

 a. small populations with different probabilities of birth and death grow at different rates

 b. population growth is a function of fractional birth and death rates

 **c. small populations with the same probabilities of birth and death grow at different rates**

 d. small populations with the same probabilities of birth and death grow at the same rate

8. (4 pts.) The two figures below are risk curves. Label each figure as either an extinction risk curve or explosion risk curve. Give an example of the type of organism (does not have to be a specific species) that each curve might be useful for managing.

9. (6 pts.) To derive our equations for population growth, a main assumption about the birth rate

 of the population was made.

 (a) What was this main assumption?

 **The main assumption was that the per capita birth rate was linear: B = b’N**

 (b) Use a graph to illustrate the assumption (make sure to label axes).



10. (8 pts.) Create a complete diagram that illustrates the **cycling** of carbon in a closed ecosystem comprised of the following four stocks: plant carbon, herbivore carbon, detrital carbon and CO2. Label the diagram with words that describe each flow process.



11. (4 pts.) Which of the following is the correct formula for determining the ratio of herbivore carbon to plant carbon (SH/SP)?

 a. (TH•FP)/(TP•FH)

 **b. (TH•FH)/(TP•FP)**

 c. (TP•FH)/(TH•FP)

 d. (TP•FP)/(TH•FH)

12. (4 pts.) Imagine two wildlife biologists (Liz and Mike) forecasting the population dynamics of migratory geese. Liz defines her study population as all birds inhabiting North America, while Mike defines his study population as all birds inhabiting Ingham County. What additional processes (parameters) does Mike need in his population-forecasting model that

 Liz probably doesn't need?

 **Immigration and emigration**

13. (4 pts.) The following is a **partial** table of results from **200** replications of a stochastic model that was used to forecast next year's population size. Note that 95 individuals was the minimum forecasted.

|  |  |  |  |
| --- | --- | --- | --- |
| Population size | # of trials | **Cumulative** | **Prob to decline to Nc** |
|  95 |  5 | *5* | *0.025* |
|  96 |  5 | *10* | *0.050* |
|  97 |  10 | *20* | *0.100* |
|  98 |  10 | *30* | *0.150* |
|  99 |  15 | *45* | *0.225* |
|  100 |  15 | *60* | **0.300** |
|  101 |  20 | *80* | *0.400* |
|  102 |  25 | *105* | *0.525* |

 What is the probability of population size being **100 or fewer** individuals next year?

 **(5 + 5 + 10 + 10 + 15 + 15)/200 = 60/200 = 0.30 (30%)**

14. (5 pts.) Your bathtub has a volume of 400 liters. If you adjust the faucet to deliver 1.666 liters per minute, plug the drain at 7PM and forget about it, what time will it be when the bathroom floor starts getting wet?

 **The time it takes for the bathtub to completely fill is the residence time (T)**

 **T = S/F**

 **S = 400 L**

 **F = 1.666 L/min**

 **T = 400 L/(1.666 L/min) = 240 min = 4 hours**

 **It will be 11 PM (4 hours after 7 PM) when the floor starts getting wet**

15. (8 pts.) The average trout consumes 10g of carbon per day, assimilates 60% of what it consumes and incorporates 30% of what it assimilates. If there are 100 trout in the population, what are the **gross and net** production rates of this **population**?

 **gross production is assimilation rate**

 **net production is incorporation rate**

 **Each trout assimilates 10 gC/day x 0.60 = 6 gC/day**

 **Gross production of the trout population is: 6 gC/trout/day x 100 trout = 600 gC/day**

 **Each trout incorporates 10 gC/day x 0.60 x 0.30 = 1.8 gC/day**

 **Net production of the trout population is: 1.8 gC/trout/day x 100 trout = 180 gC/day**

16. (8 pts.) Lake Wymea has a surface area of 200,000 m2 and a water residence time of 200 days. If the total volume of the lake is 480,000 m3 at steady-state, and groundwater plus river flow into the lake is 75 m3/hr, what is the rate of precipitation onto the lake surface in **m/day**?

 **T = S/F, so F = S/T, where S = 480,000m3 and T = 200days**

 **F = 480,000m3/200days = 2400m3/day = total input (Fi)**

**total input is the sum of runoff volume (75 m3/hr = 1800m3/day) and precipitation volume (P)**

 **Fi = 2400m3/day = 1800m3/day + P**

 **P = 2400m3/day - 1800m3/day = 600 m3/day**

**The volume input of precipitation is equal to the precipitation rate (p, m/day) multiplied by the lake's surface area (SA):**

 **P = p \* SA,**

 **p = P/SA =  = 0.003m/day**

17. (6 pts.) Write an equation that forecasts population size next year (Nt+1) as a function of: population size this year (Nt), a constant per capita birth rate (b'), a constant per capita death rate (d'), a constant **number** harvested per year (H) and a constant **number** of immigrants per year (I).

 **Nt+1 = Nt(1 + b' - d') - H + I**

18. (8 pts.) A salmon population has a per capita death rate from natural causes of 4% per year, a per capita death rate from harvesting of 6% per year, and a per capita birth rate of 8% per year. Assuming the population is closed, how many salmon will there be in 100 years if current population size is 100,000 fish?

 **Nt = N0λt, where N0 = 100,000 and t = 100 years**

 **λ = 1 + birth rate - death rate - harvest rate**

 **λ = 1 + 0.08 - 0.04 - 0.06 = 0.98 (so the population will decline)**

 **Nt = 100,000(0.98100) = 13,262 salmon**

19. (5 pts.) A population of elk **at steady-state** has a per capita birth rate of 0.15 and a per capita emigration rate of 0.05. If there is no immigration into this population, what is the per capita death rate? What is λ?

 **λ = 1, since population is at steady state**

 **λ = 1 + birth rate - emigration rate - death rate**

 **death rate = 1 + birth rate - emigration rate - λ**

 **death rate = 1 + 0.15 - 0.05 - 1 = 0.10**

Bonus Questions:

BQ1. (1 pt.) What is the equation that describes **continuous** growth of a population between any

 two time periods (i.e., between a starting time and any time in the future)?

 **Nt = N0 *e*rt**

BQ2. (1 pt.) A population of *Paramecium* (a genus of protozoa) grows continuously and has an

 **instantaneous** population growth rate of 0.55 per day. What is the doubling time for

 *Paramecium*?

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