EEB 122b SECOND MIDTERM

1.   You are interested in conducting an experiment with two competing species of plants. Below are the zero-growth isoclines for the two species.
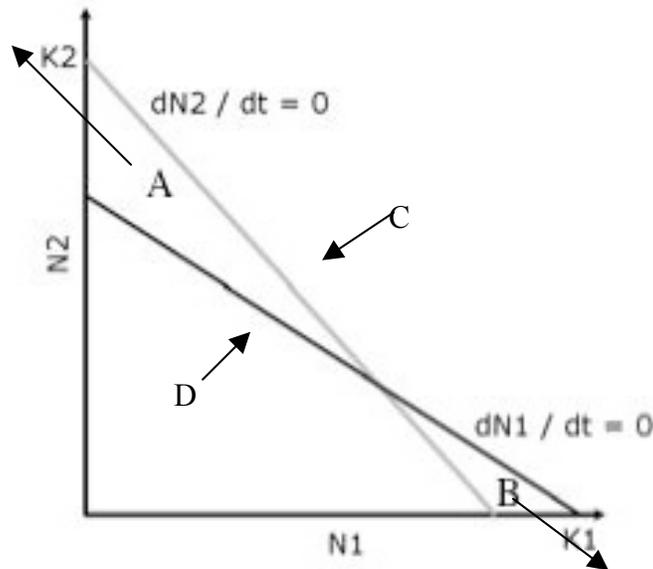
a) Draw the vectors that describe how N1 and N2 change at points A, B, C, and D on the graph above. (4 pts)

      (One point per correct arrow)

b) Is the competition coefficient for N1 ($\alpha_{1,2}$) greater than, equal to, or less than 1? (2 pts)

    >1

c) Is inter- or intraspecific competition stronger for species 1? (2 pts)

    Inter

d) If you planted many individuals of each of these species in a field together and observed the community over many generations, which of the two plant species (if either) would you expect to go extinct? (2 pts)

    The species that goes extinct will depend on the starting ratios of individuals. (But if you assume the two species are planted in equal quantities, species 1 will go extinct)

e) Why? (2 pts)

    This interaction is an unstable equilibrium that will have a different result depending on the starting conditions. (If you assume the starting condition is an equally large number of each then species 1 will go extinct because the competition coefficients are not equal)

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2. During a survey conducted in October 2003, separate populations of a threatened endemic rodent species were found in each of several habitat patches around Lake Naivasha, Kenya. Each year storms flood burrows in an average of 40% of the occupied patches, causing local population extinctions. Despite the high level of disturbance caused by the storms, a survey conducted in October 2007 revealed that the rodent species has persisted in this region of Kenya.

   a) Describe how the rodent species may be able to persist in this region, despite frequent destruction of much of its habitat. (4 pts)

   There are high enough reproductive rates in the occupied patches and enough dispersal from patches that the destroyed habitat can be recolonized regularly

   b) Do these habitat patches constitute a metapopulation? (1 pt)
   yes

   c) Why or why not? (2 pts)

   There is regular gene flow between all the patches via dispersal

   d) What two major patch characteristics account for the colonization and extinction rates of local populations? (2 pts)

   Below is the life table of the rodent population found in one of the patches.

x	p_x	l_x	m_x	$l_x m_x$
0	0.1	1	0	0
1	0.8	0.1	4	0.4
2	0.5	0.08	4	0.32

   e) Calculate R_0 by filling in the missing values in the table. (2 pts)

   R_0 = __0.72___

   f) Is the population a sink or a source? (1 pt)
   Sink

   g) Why? (2 pts)
$R_0<1$, so the population is decreasing due to insufficient reproduction and survival rates to maintain the population

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3. Imagine a lake community consisting of algae, zooplankton (which eat the algae), and detritivores (or decomposers, which eat all dead material in the lake).

    a) Draw a food web that explains the interactions among these three trophic levels. (2 pts)
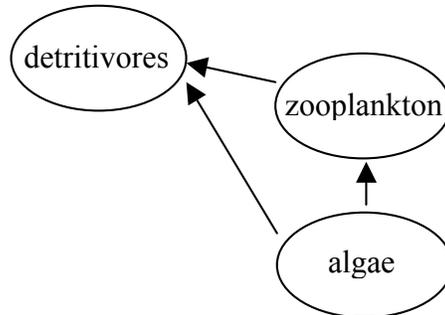
    b) What would you expect to happen to this system if you added a large amount of phosphorous to the lake? (2 pts)
    The algae would increase in density first, followed by an increase in density of the zooplankton and detritivores.

    c) Why? (2 pts)
    The algae would have more resources, therefore would grow and reproduce more. This would provide more food for the zooplankton and detritivores, which would grow and reproduce more in response.

    d) Is the response seen in part (b) top-down or bottom-up control? (2 pts)
    Bottom-up control.

    e) What would you expect to happen to this system if you added fish (which eat zooplankton) to the lake? (2 pts)
    You would see a decrease in zooplankton density first, followed by an increase in algal density. Detritivore density would likely remain constant.

    f) Why? (2 pts)
    Zooplankton density would decrease due to predation by the fish. This would release the algae from herbivory by the zooplankton, allowing them to increase in density. The detritivore density would remain the same because they eat anything dead, therefore could feed on fish and algal remains even though they have fewer zooplankton remains to eat.

    g) Is the response seen in part (d) top-down or bottom-up control? (2 pts)
    Top-down control.

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4.   Marginal value theorem.

Milligrams of worms collected

9
8
7
6
5
4
3
2
1

a   b   c

Travel time   Time   Foraging time

f
e
d
y*
y
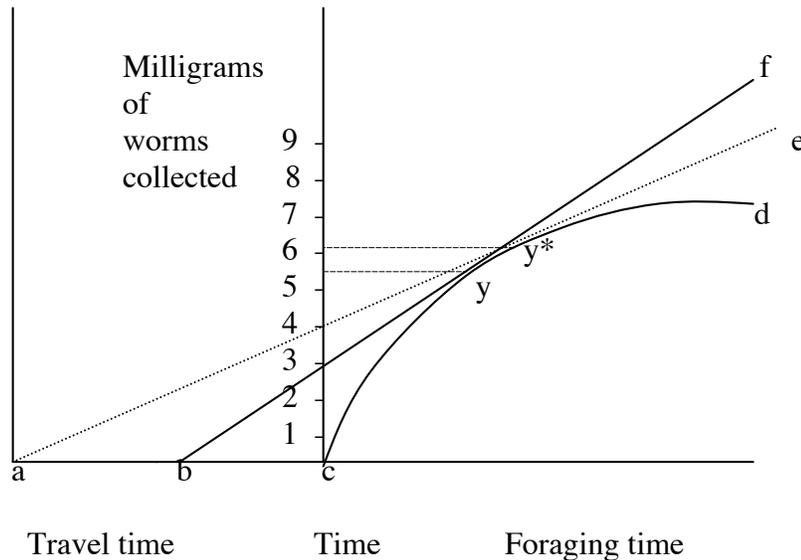
The graph above represents foraging time for two American robins collecting worms for their broods. The robins can start either from a nest at point a or from a nest at point b. Line a-e is tangent to curve c-d at point y*, and line b-f is tangent to curve c-d at point y.

   a) What does curve c-d represent? (3 pts)

   the number of worms a robin accumulates as a function of foraging time.

   b)   About how many milligrams of worms should the robin starting from the nest at
        point b collect if it is foraging optimally? (2 pts)

   between 5 and 6 milligrams of worms

   c)   Do robins that travel longer distances collect a greater or smaller weight of worms
        than robins that travel shorter distances? (2 pts)

   greater

   d)   Why might this be? (3 pts)

   they are trying to maximize their payoff/time. Since they are spending longer getting to
   the patch of worms, they should collect a greater weight of worms to maximize their net
   rate of gain.

   e)   Which robin collects more milligrams of worms per minute: the one starting at point
        a, or the one starting at point b? (2 pts)

   Point b

5.   The distribution of species around the globe is not even. In general, most of the world's diversity is found in the tropics. As you move away from the equator, the diversity of plants, fish, reptiles, amphibians, insects, and mammals declines.

 a)   Many hypotheses proposed to explain the latitudinal biodiversity gradient focus on the availability of abiotic factors such as sunlight and water. How does amount of available sunlight affect levels of biodiversity? (2 pts)

ANSWER: Primary productivity is higher in areas with more sunlight. The more energy available for photosynthesis, the more plant species, which leads to greater diversity of all species.
Alternate explanation: Increased solar radiation leads to increased rates of molecular evolution, leads to increased population divergence, leads to increased rates of speciation.

 b)   Another theory proposes that the variability of a climate has more of an impact on biodiversity than average climatic conditions. How does a stable climate promote increased biodiversity? (2 pts)

ANSWER: Natural selection can lead to the evolution of many highly specialized organisms in constant climates, with no danger of the population being wiped out by a freak climatic event. Also, there is no need to put energy into adapting to withstand multiple sets of environmental conditions.

 c)   Give an example of how human-induced global climate change is changing the patterns of biological diversity on the planet. (2 pts)

ANSWER: Increasing climate variability might lead to lower species diversity because see (b). Also, it will take longer for species to adapt to the changing climate than it will for the climate to change. May lead to many species migrations and extinctions.

 d)   From the economic view, what is biodiversity worth? (3 pts)

ANSWER: The marginal value of totally planetary ecosystem services is about $33.3 trillion/year. But, the role of biodiversity in providing these services is not included. If species are ecologically redundant, we could get these services with many fewer species.

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6. A population of foxes has been feeding preferentially upon the abundant squirrel population in a particular area where both squirrels and rats are available as potential prey. After one rough winter, the squirrel population declines steadily due to a lack of acorns.

a) Draw a graph of the proportion of rats in the foxes' diet versus the proportion of rats available. Label the pre- and post-rough winter conditions on the graph. (4 pts)
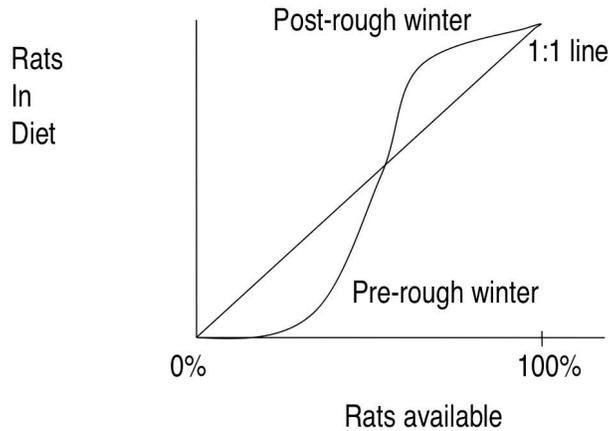
b) Would you expect the foxes to switch to eating rats as the proportion of squirrels in the community decreases? (2 pts)
Yes

c) Why or why not? (2 pts)
Predators prefer profitable prey. The foxes do prefer to eat squirrels but when the preferred prey becomes rare it is more efficient to switch to the more common prey.

Consider this graph of two species, A and B. One species eats the other. The growth of both species is well-described by the Lotka-Volterra predator-prey model.
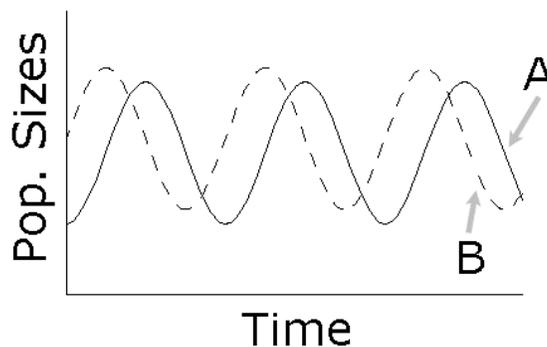
d) Which species, A or B, is the predator? (1 pt)
Species A

e) How can you tell? (3 pts)
In L-V predator-prey curves the predator curve always lags behind the prey curve.

7. In the Hawk-Dove game of competition over resources, let B be the fitness benefit of the resource and let P be the fitness cost that a winning hawk inflicts on a losing hawk.

    a) If hawks and doves coexist at equilibrium, what is the relationship of B to P? (2 pts)
B<P

    b) If the stable equilibrium for hawks and doves is 75% hawks, 25% doves, draw a graph of the fitness of hawks and doves as a function of the frequency of hawks. Label your plotted curves (6 pts).
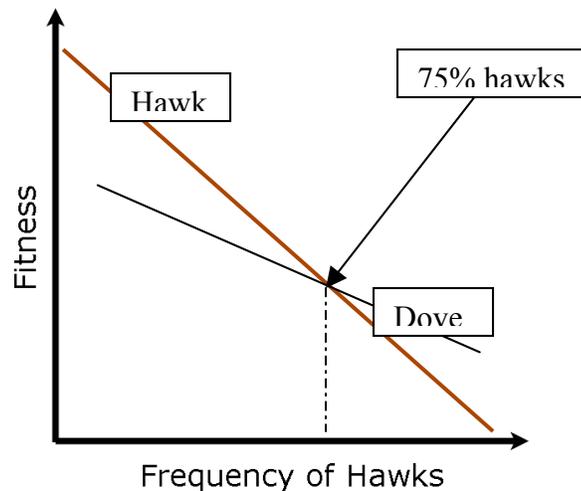
Now imagine a new variant arises, chickenhawk, which plays the following strategy: against hawks, it acts like a dove; against doves, it acts like a hawk. Consider the evolution of a population of hawks, doves, and a few chickenhawks.

    c) Would the chickenhawk strategy replace hawks? Why? (2 pts)
Yes because they don't incur cost from fighting with hawks but always beat doves, ½(B-P)+B<B since B<P
    d) Would it replace doves? Why? (2 pts)
Yes because they always beat doves so they receive more resources, B/2 (dove)<B (chickenhawk)

Your name: _____

8. Foregoing one's own reproduction to help raise another's offspring, as in birds that help at the nest, can be explained several ways.

a) Give a group selection explanation for helping behavior (3 pts)

Birds help other individuals raise young in order to add strength and numbers to the group. A larger group may be better able to survive or defend themselves against predators, etc.

(Other explanations are possible as long as the benefit is to the group as a unit.)

b) State one reason why group selection is implausible. (3 pts)

Group selection is not an evolutionarily stable strategy (ESS) because selfish mutants can easily invade the population and increase in number.
OR
The correlation between traits and reproductive success is often much weaker for groups than for individuals.
OR
Variation in reproductive success among individuals is often greater than variation in reproductive success among groups. The potential strength of individual selection is therefore normally much greater than the potential strength of group selection.
Etc.
(See other explanations from Lecture 37)

c) An alternative to group selection is kin selection. How might kin selection explain helpers at the nest? (3 pts)

An individual's genes also exist in its relatives. A bird may therefore be able to pass more copies of its genes into the next generation by helping to raise the offspring of its relatives. Helping behavior will be selected if the caused increase in the number of its genes in the next generation through the offspring of its relatives is greater than the resulting decrease through its own offspring.
(otherwise stated, if b*r>c)

d) In the Pied Kingfisher in Kenya and the Scrub Jay in Florida, what ecological constraint helps to explain the evolution of helping behavior, and how does it do so? (3 pts)

Safe nesting sites are severely limited. Mating is better than helping, but if a bird is not able to gain access to one of the limited nesting sites, it is beneficial to help because the helper is in a position to inherit the nest burrow for its own reproduction later.