1. (6 pts)
a. Can all characteristics of organisms be explained by natural selection? Explain your answer in a sentence (3 pts)

b. Name two non-selectionist mechanisms of biological evolution (3 pts).

a. No, before building an adaptive story, one must consider the possibility that characteristics could also be fixed or prevalent in a population because of other evolutionary mechanisms/forces.

b. Genetic drift and mutation.

2. (4 pts)
When age structured population dynamics are modeled using a Leslie matrix, is any manner of biological evolution assumed over generations? (2 pts) If yes, list which population parameters (e.g., l_x, m_x, R_0) evolve; if no, give one intransient population parameter that you could modify to include evolution in the model (2 pts).

No, evolution is not assumed or built into the stage/age structured population model. To include evolution, one could have a model of where either l_x, m_x or P_x change over generation, or all of them, for that matter.

3. (7 pts)
Differentiate between demographic stochasticity and environmentally driven fluctuations in population size (3 pts). Which population is more likely to experience demographic stochasticity: a small, isolated population of beetles in your backyard, or a large population of the same insect in Zilker Park (2 pts)? Which of these two populations is more likely fluctuate due to environmental stochasticity, and why (2 pts)?

Demographic stochasticity: Population size fluctuations due to intrinsic random events (such as stochastic outcomes of birth/death events, or genetic drift) in small, isolated populations. Environmental stochasticity on the other hand, acts extrinsically, and often in a density independent manner.

The backyard population is more likely to exhibit demographic stochasticity. Environmental fluctuations are likely to affect both populations similarly if they are occur in both areas, and are have truly density independent impacts.

4. (8 pts)
Do you expect reproductive and mortality rates to evolve independently (4pts)? Explain using the concept of reproductive value (4pts).

They do not. Empirical evidence and much of theory indicates that an increase in reproductive output at a particular life stage results in increased mortality and/ or reduced fecundity at a later stage.

One way to understand or model this tradeoff is by considering the reproductive values, which combines all future mortality and fecundity estimates to give an age-specific expectation of future reproductive output.

5. (3 pts)
Assuming linear relationships between population density (N), birth rates and death rate, derive the equation for carrying capacity (K) of a population. (Hint: Draw a diagram of the relationship between birth rate, death rate and N. K is the value of N at which $b_N = d_N$). *Show all your work for full credit.*

Step1: Write out the equations for birth and death rates as straight lines
Step2: Set them equal
Step 3: Rearrange to get K on LHS or RHS

6. (8 pts)
State and explain briefly one ecological (4 pts) and one evolutionary (4 pts) hypothesis to explain the observed population cycles of microtine rodents and their predators.

Ecological: Sunspot, Time Lags, Stress, P-P oscillation, etc. (see pp. 193-196)
Evolutionary: Genetic control

7. (6 pts)
Using Fisher's theory of optimal sex ratio evolution, make your prediction of the optimal sex ratio in the following kinds of species':

(a) Where cost of producing males is same as the cost of producing females (2 pts)-
1:1

(b) Where cost of producing males is twice as much as producing females (2 pts)-
1 male: 2 female

(c) Where cost of producing males is half as much as producing females (2 pts)-
2 male: 1 female

8. (8 pts)
Think of your favorite bird species in which the males act stupid and have exaggerated external traits (such as long tail- think of peacocks, or the grackles on campus). What is your best explanation for such undignified behavior and traits (2 pts)? Briefly explain your theory in terms of how the evolutionary mechanism would act (4 pts). Name one factor that could set an upper limit on the directional evolution of the trait (2 pts).

Sexual selection;

e.g., Heritable variation in tail length _ Females favor longer tails _ males with longer tails have higher fitness _ Mean value of trait increases

Mechanism setting upper limit on trait value could be: Opposing selective force such as predation OR there being an upper limit to female preference for trait value OR an inherent biological constraint on the amount of trait expression.

9. (4 points) What is the optimal reproductive strategy for an iteroparous organism in a population that is decreasing? Why?

The best reproductive tactic for an iteroparous organism in a decreasing population is to postpone current reproduction and invest soma thereby increasing its future offspring, which are worth more because they enter into a smaller population, and gain a greater relative contribution to the gene pool.

10. (8 points) Both within and among species, birds exhibit a latitudinal gradient in clutch size. One hypothesis that has been proposed to explain this trend is the hazards of migration hypothesis. Discuss this hypothesis and give a brief description of how you would test the hypothesis.

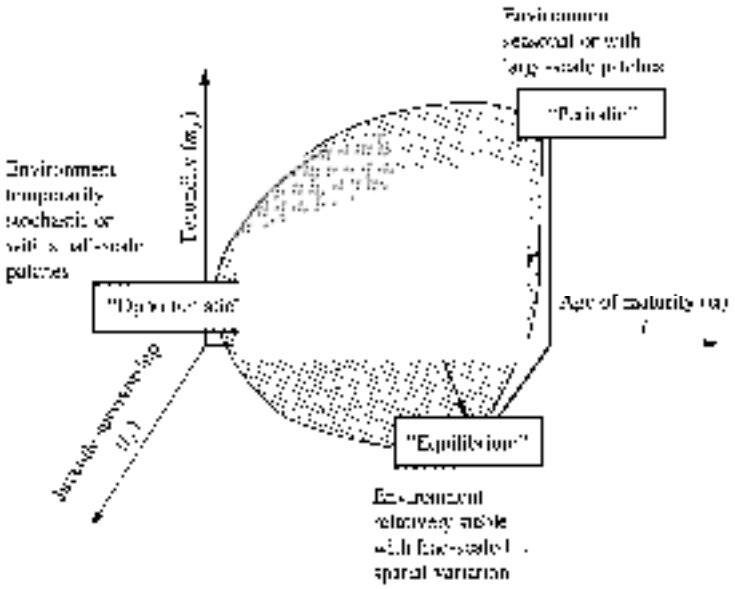
The hazards of migration hypothesis asserts that birds nesting at high latitudes have low residual reproductive values because they must face agents of mortality (France, Eleanora's falcons). Optimal reproductive tactics dictate that animals with low expectation of future offspring should invest more in current reproduction, hence these birds have larger clutches now because they might not survive to reproduce next year.

11. (6 points) Why is intensive male parental care uncommon, and why do a few animals exhibit it? Which ones do?

Sperm are small and inexpensive to make so males can afford to scatter them around the landscape. Because males have a much smaller initial investment than females, they have much less to gain from parental care than females do. Moreover, in species with internal fertilization, males face the problem of "uncertainty of paternity" (cuckoldry), thus favoring little or no parental care as it would be fruitless to raise offspring of another male. In jacanas, reversed sexual dimorphism allows females to defend rich territories with a polyandry threshold such that a female can attract more than one male. However, this male mates with the female and she stays nearby until eggs are laid so that the male is certain of his paternity.

In organisms with external fertilization such as most fish and frogs, males can be assured that their offspring are theirs, thus favoring evolution of male parental care.

12. (6 points) Draw Winemiller's triangular life history surface and label the axes and intercepts.



See page 187.

13. (6 points) What is the best evidence that natural populations are regulated?

In most populations that have been studied, % change in population density varies inversely with population density — small populations are likely to increase, whereas large populations usually decrease (humans are the single exception).

14. (6 points) Explain the distinction between density dependent selection and density independent selection.

Under density dependent selection, per capita effects are a function of density, whereas in density independent selection, per capita effects do not vary with changes in density such that the same proportions of individuals are affected.

16. (2 points each, for a total of 14) Define each of the following:

Isogamy

When gametes are the same size

Disruptive Selection

When a plot of fitness versus phenotype is bimodal or multimodal so that two or more phenotypes enjoy highest fitness.

Ultimate factor

The strategic, or evolutionary, basis of a biological phenomenon, such as long-term predictable winter mortality favoring migratory behavior in temperate zone birds

Nidifugous

“Nest fugitives” birds that hatch precocial chicks which leave the nest immediately after hatching

Philopatry

“Love of place” Birds and salmon return to the same place they were hatched and raised to breed after a long migration elsewhere

Polyandry

When a female maintains simultaneous pair bonds with two or more males, such as in jacanas

Inclusive Fitness

This refers to the fitness an individual gains from assisting its close relatives, thereby enabling them to pass on shared genes that are identical by descent (W. D. Hamilton)