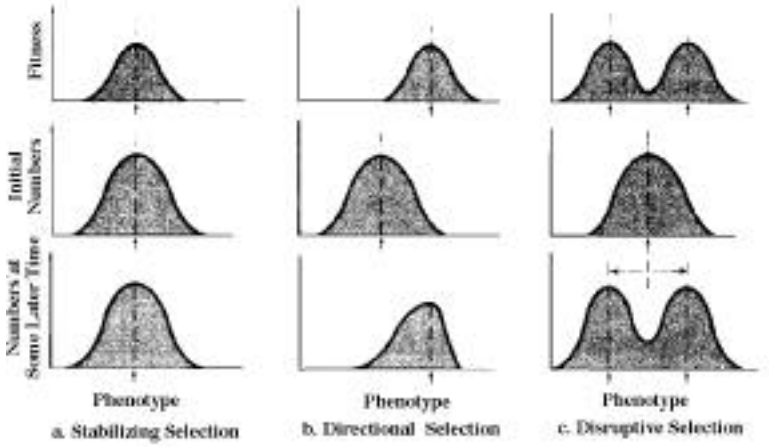
**Zoology 357 - Evolutionary Ecology - First Exam** _____

1. (6 points) List three types of natural selection and show how the population changes over time (graph the initial phenotype frequency distribution and the distribution after selection has occurred).

stabilizing directional disruptive




2. (7 pts) Define the following population parameters: $R_0$, r, λ. List the critical values of each parameter and what these values tell you about the population? How are r and λ mathematically related?

$R_0$ = net reproductive rate (or net replacement rate) = the average # of offspring produced by an individual. If $R_0 > 1$, then increasing population.... (2pts)
r = intrinsic rate of natural increase = the instantaneous rate of change in population size (per individual). If $r > 0$, then increasing population...(2pts)
λ = the finite rate of increase = rate of increase per individual per unit time (a discrete measurement). If $\lambda > 1$ then, increasing population... (2pts)

$r = \ln \lambda$ $\lambda = e^r$ (1pt)

3. (9 points) Complete the following life table (2pts). Can you tell if this population is increasing, decreasing, or stable? How (3pts)? Define (in words) each parameter given in the table (4pts).

| x | $l_x$ | $m_x$ | $P_x$ |
|---|---|---|---|
| 0 | 1.0 | 0 | 0.8 |
| 1 | 0.8 | 0.2 | 0.75 |
| 2 | 0.6 | 0.8 | 0.67 |
| 3 | 0.4 | 0.6 | 0 |

x = age class
$l_x$ = survivorship (probability of surviving from birth to age x)
$m_x$ = fecundity (average # of offspring produced by an average organism of age x)
$P_x$ = age-specific mortality/survivorship (probability of surviving from age x to x+1) = $\mathbf{l_{x+1} / l_x}$
Decreasing, because $R_0$ = 0.88 (Ro < 1).

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

Putting more effort into current reproduction is advantageous, because offspring will represent a larger proportion of the gene pool.

5. (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 nest predation hypothesis. Discuss this hypothesis (4pts), potential problems with the hypothesis (2pts), and give a brief description of how you would test the hypothesis (2pts).

Proposes that tropical birds have smaller clutch sizes because predation pressure is higher in the tropics than in temperate areas. With smaller clutch sizes, tropical birds reduce the chance of detection by predators since fewer foraging trips are required to feed a smaller clutch. One concern with this hypothesis is that it has not been empirically tested and thus suffers from the problem of multiple causality. Additionally, having fewer eggs to escape predation is a strategy that should be expected to occur in temperate areas also. Comparative studies may help test this hypothesis:

1.) compare birds with protected vs. vulnerable nests along a latitudinal gradient - protected nests should have less latitudinal change than vulnerable nests
2.) compare island and mainland clutch sizes – mainland birds should have smaller clutch size because of higher # of predators on mainlands vs. islands.

* You could empirically test this hypothesis with predator removal/addition experiments, although there may be a substantial lag time before natural selection acts to change clutch size (who knows what the evolutionary time scale is).

6. (9 points) Label each of the following parts of the logistic equation (describe in words what each part of the equation means) (5 pts):

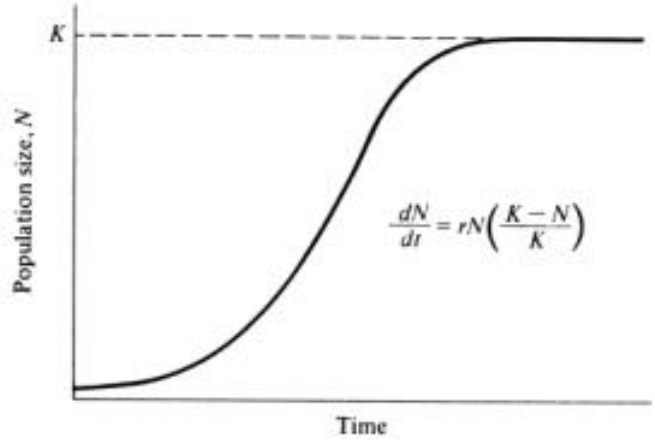
dN / dt = r N * (K - N/ K)

change in population size over time (population growth rate)

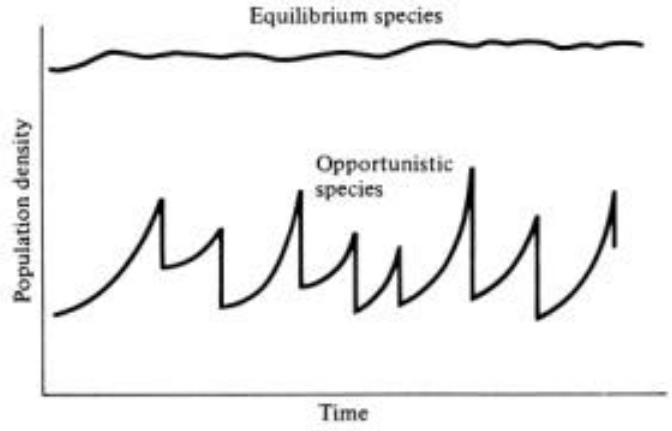
intrinsic growth rate at N close to 0 multiplied by population size

density-dependent reduction in growth rate

Draw a graph describing the behavior of this equation (label all parts of the graph) (4pts).




7. (6 points) Graph and describe the population growth trajectories of an equilibrium, opportunistic, and fugitive species. (4pts)




Identify whether the species is r-selected/ K-selected (2pts).

Equilibrium species____K-selected_

Opportunistic species__r-selected

9. (6 points) Why is intensive male parental care uncommon, and why do a few animals exhibit it? Which ones do?

In species with internal fertilization, males can be cuckolded. Uncertainty of paternity, coupled with the fact that sperm are cheap to make, do not favor male investment. Females, however, enjoy certainty of maternity and have a higher investment in each progeny, favoring female parental care.

In species with external fertilization, **such as some fish and all frogs,** the female deposits her eggs and a male can be certain that he fertilized the eggs, favoring intensive male parental care. Male parental care has also evolved in jacanas because of reversed sexual dimorphism and female defense of territories.

10. (6 points) Explain Fisher's theory of the sex ratio. Why is the sex ratio at birth in humans biased towards sons?

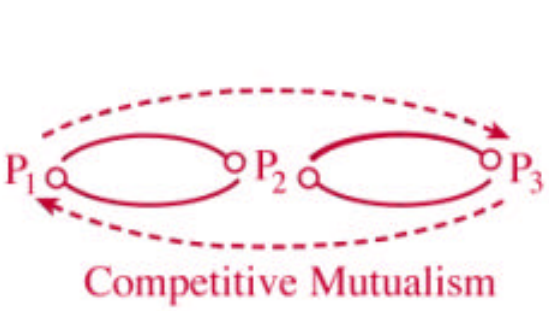
Fisher postulated that parents should allocate equal investment in sons and daughters because half the genes in the next generation must come from males and half from females, no matter what the sex ratio in the previous generation.
Sex ratio at birth in humans is biased towards more sons because males suffer higher mortality during the period of parental care than females, so in order to equalize investment in sons and daughters, parents must over-invest in sons early which is compensated for by an over-investment in daughters during the latter part of the period of parental care.

11. (8 points) What is Hamilton's rule (describe in words, include the critical equation, and make sure to indicate what each variable stands for)?

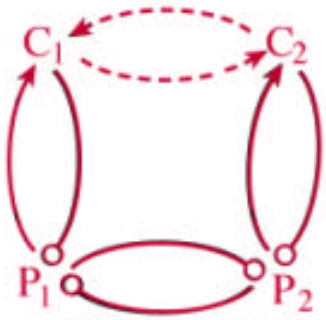
Hamilton's rule of kin selection asserts that benefits to kin must outweigh the costs paid by a donor. Mathematically it is $rbn > c$, where $r$ is the coefficient of relatedness (proportion of shared genes that are identical by descent), $b$ is the benefit to each kin, $n$ is the number of kin benefited, and $c$ is the cost to the pseudo-altruistic donor.

12. (8 points) Define competitive mutualism and facilitation. Using solid arrows to depict direct effects and dashed ones for indirect effects, diagram each interaction.

Competitive mutualism is an indirect mutualism that occurs when two species share a common competitor and when competition with this third species is stronger than it is between the first two species. Facilitation is an indirect mutualism involving four species, two consumers and two prey species which compete with each other via interference competition. Because each consumer species eats only one of the prey species, the indirect effect of each consumer on the other consumer is beneficial.



Competitive Mutualism



Facilitation

13. (14 points total, 2 points each) Define each of the following:

Anisogamy Gametes that are not equal, the situation whereby one gamete (male) is small and mobile and cheap to produce, whereas the other gamete (female) is larger to provision early development and therefore less mobile and more expensive to make — results in a fundamental asymmetry between the sexes that is the basis of sexual selection

Epigamic Selection Selection above the level of gametes, intersexual sexual selection leading to the conflict of interests between the sexes

Lek A traditional breeding ground where a group of males aggregate and posture themselves to attract females.

Nidicolous "Nest loving" refers to animals such as many birds whose young stay in the nest during parental care.

Polygyny threshold The minimal difference in quality between two male territories that is just sufficient to favor bigamous matings by females

Protandry Sex change during ontogeny in which an animal is first a male, and then changes sex to become a female later in life

Reciprocal Altruism A situation in which two unrelated individuals cooperate because the gains to the recipient are greater than the costs to the donor, and which is reciprocated at some later time resulting in an overall gain to both parties