EEB2245: Evolutionary Biology

Spring 2009

Problem Set 2

1.) Which of these two populations will lose diversity faster due to genetic drift?

a.) A population with N = 2000, Ne = 300; a population with N = 10,000, Ne = 200.

b.) A population with N = 500, Ne = 459; a population with N = 678, Ne = 650.

c.) A population with N = 3000, Ne = 1430; a population with N = 1550, Ne =1430.

d.) A population with N = 100, Ne = 95; a population with N = 100, N = 90.

How many generations do you expect it to take to lose genetic diversity in each of the above populations?

2.) For a diploid species, assume one set of 100 populations, each with a constant size of 50 individuals, and another set of 100 populations, each with 100 individuals. Assume these are all ideal populations.

(a) If in each population the frequencies of alleles *A* and *a* are 0.4 and 0.6 respectively, what fraction of populations in each set are likely to become fixed for allele *A* versus *a*?

(b) Assume that a neutral mutation arises in each population. Calculate the probability that it will become fixed in a population of each size. In what number of populations do you expect it to become fixed?

(c) If a fixation occurs, how many generations do you expect it to take? (Modified from Futuyma, 2005)

3.) A small population of wolves consists of 25 males and 75 females. At a particular major histocompatibility locus (MHC), the *A* allele has a frequency of 63% and the *B* allele has a frequency of 37%.

(a) What is the probability that the *A* locus will become fixed in the population, assuming genetic drift is the only evolutionary factor acting on the population. What is the probability that the *B* locus will become fixed?

(b) What is the effective population size?

(c) How many generations do you predict will pass before there is a loss of genetic diversity?

4.) A particular population of 350 water snakes lives on an island off the coast of Lake Erie. At a particular locus involved in determining color patterning, this population has a frequency of 0.54 for the *B* allele and 0.46 for the *b* allele. Assume that this is an ideal population (none of the genetic drift assumptions are violated, N = Ne).

(a) What is the probability that the *B* allele will become fixed in the population? What about the *b* allele?

(b) How many generations do you predict will pass before there is a loss of genetic diversity?

5.) Imagine that 10 water snakes migrate from the mainland and join the island population. 3 of these snakes have a *BB* genotype, 6 have a *Bb* genotype, and 1 has a *bb* genotype. Imagine that the allele frequencies of the migrants are representative of those of the mainland population.

(a) What is the migration rate?

(b) What are the new allele frequencies?

(c) What do you expect the allele frequencies to be in the next generation?

(d) Do you expect these two populations to diverge, why or why not? If not, what do you expect the equilibrium frequencies of the island population to be?

(e) What do you expect the allele frequencies to be in the next generation if the migration rate is 0.4? What about 0.6?

(f) What would the migration rate be if 20 water snakes migrated from the mainland? What about 50 migrants?

6.) What is the population size and the effective population size for a population of water snakes with the following sex-ratios, assuming constant population size and non-overlapping generations.

(a) 45 males and 55 females

(b) 10 males and 90 females

(c) 50 males and 50 females

How many generations do you expect it to take to lose genetic diversity in the above populations?