BIO 434 Assignment 3

1. What is the effective size of an otherwise ideal diploid population in which the distribution of successful gametes per individual has a mean of two and a variance of 4?

Because the mean number of successful gametes is two (in a diploid population), the population size is not changing. So the appropriate formula is

$$N_e = \frac{4N-2}{V+2}$$

We don't know N, but we know the variance in reproductive success, so the best answer is

$$N_e = \frac{4N-2}{6} = \frac{2N-1}{3}$$

2. A population of cats has 4 males and 30 females.

a. A neutral allele in this population has frequency 0.45. What is the probability that this allele is ultimately lost from the population?

The probability of loss is 1- Pr[fixation]. The probability of fixation is equal to the starting allele frequency for a neutral allele, or 0.45 in this case. So the probability of loss is 0.55.

b. The genetic variance at this locus is 2(0.45)(0.55) = 0.495 in the starting generation. What is the genetic variance expected to be after 7 generations?

The genetic variance will drop in proportion to *F*. *F* after 7 generations will be

$$F_7 = 1 - \left[\left(1 - \frac{1}{2N_e}\right)^7\right]$$

N_e can be calculated from

$$N_e = \frac{4N_m N_f}{N_m + N_f} = \frac{4(4)(30)}{34} = 14.1$$

Therefore $F_7 = 0.223$.

Thus the genetic variance is expected to be 0.495 (1- 0.223) = 0.385 after 7 generations.

c. How could we keep the cats such that there was as much variance as possible after 7 generations?

We could try to equalize the numbers of males and females that we kept each generation. We could also try to keep the number of offspring per pair as equal as possible, so that the variance in reproductive success was minimized.

3. It was planned to keep a mouse stock with 8 pair-matings per generation and minimal inbreeding. The plan, however could not be strictly adhered to because some pairs fail to provide the two offspring required. In one particular generation the 8 matings provided the following numbers of offspring that were used as parents: 0, 1, 1, 2, 2, 3, 3, 4. What was the effective population size in this generation?

The mean reproductive success is 2. The variance in reproductive success (using the population, not the sample formula) is

$$V = \frac{(0-2)^2+(1-2)^2+(1-2)^2+(2-2)^2+(2-2)^2+(3-2)^2+(3-2)^2+(4-2)^2}{8} = 1.5$$

So the effective size is

$$N_e = \frac{4N-2}{V+2} = \frac{4(16)-2}{1.5+2} = 17.7.$$

4. If the population of mice in problem 4 were maintained exactly as planned, what fraction of its genetic variance would have been lost after 5 generations? How much would have been lost of the mice had a Poisson distribution of reproductive success, with mean =2?

If the mice had been kept as planned, the variance in reproductive success would be 0, so the effective size would be

$$N_e = \frac{4N-2}{V+2} = \frac{4(16)-2}{0+2} = 31.$$

The loss of genetic variance would be proportional to F, or

$$F_5 = 1 - \left[\left(1 - \frac{1}{2(31)}\right)^5\right] = 0.078.$$

If the mice had a Poisson distribution of reproductive success, the variance would equal the mean, or V=2. Then N_e would be equal to 15.5, and F would be:

$$F_5 = 1 - \left[\left(1 - \frac{1}{2(15.5)}\right)^5\right] = 0.151.$$