Genetics, Problem Set #5 Due Thurs, Feb. 22 Name: _____

1. You've been working with an endangered species of fish, helping monitor some of the populations that are left. These fish live for one year, and reproduce once. One of your concerns is whether inbreeding might be putting isolated populations at risk. In one large lake, you genotype fish at a single locus, and find the following counts:

   MM: 7
   Mm: 59
   mm: 176

   a. What is the F statistic in this population? Do you expect them to have a lot of inbreeding depression?

   b. A new roadway is built that cuts off a small piece at one end of the lake from the rest, completely isolating the fish from those on the other side. Immediately after the roadway is built, do you have an approximate prediction for the F statistic for that isolated population?

   c. Five years after the roadway is built, you sample the fish in the isolated population. You find the following counts:

      MM: 10
      Mm: 7
      mm: 28

      What is the F statistic for this isolated population now? Do you expect them to have a lot of inbreeding depression?

d. The locus that you're using is not in a gene or a regulatory sequence, making it unlikely to be under selection. Why has the the allele frequency changed in the isolated population compared to the original frequency?

e. Based on your evidence, the county is convinced to build several channels under the roadway, which allow free movement of the fish between the two parts of the lake. A year or two later, you sample fish from the part that used to be cut off. What do you expect the F value to be, approximately?

2. You're also interested in how connected populations of fish in different lakes are. You collect fish from lakes across their geographic range, and genotype them at the same locus you used earlier. You find the following counts:

   MM: 231
   Mm: 88
   mm: 181

   a. What is F_{ST} for this species of fish?

   b. Based on the F_{ST} value that you calculated, do you think that many fish move between lakes in each generation?

   c. Why did you use F_{ST} instead of F for this experiment?

3. For each of the following circumstances, make a prediction about how f(A) will change over many generations. Indicate whether you expect A to be either fixed or eliminated, or neither. For each example, sketch a graph of f(A) versus time. In some cases, there may be multiple possible outcomes; choose the most likely one..

   a. In a very large population, a new mutation occurs; homozygotes for this new allele (A) have a strong selective advantage.

   b. In a small population, a new mutation occurs; homozygotes for this new allele (A) have a very weak selective advantage.

   c. In a medium-sized population, an allele in a gene that is not under selection is at the frequency f(A) = 0.75.

   d. In a very large population, a new dominant mutation (A) arises, and is favored by selection.

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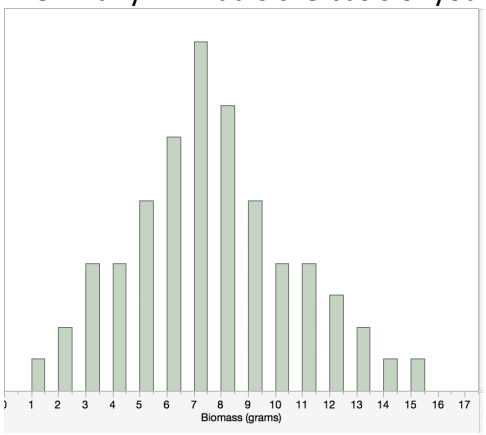
4. You're studying the genetic basis of biomass in a self-fertilizing species of wildflower. You have collected seeds from 60 plants growing prairies across the midwest.

   a. First, you grow your collected seeds in the greenhouse and measure biomass of mature plants. The histogram of your data is shown below. Based solely on these results, do you have a prediction about how many genes control biomass? If you think it's more than one or two, you don't need an exact number, just something like "many". What is the basis of your prediction?



   b. You allow each of your 60 plants to self-fertilize. You then plant ten seeds from each and grow them in the greenhouse, measuring biomass when they're mature. The variance for the entire dataset is 10.4. The average variance in biomass *within* the offspring from a single plant is 4.2. What are V_P, V_G, V_E, and H^2 for biomass in the greenhouse?

   c. Wanting to know more about biomass under natural conditions, you repeat this experiment in a plot out a Green Oaks, also planting 10 seeds from each of the original 60 collections. Do you expect H^2 to differ from the greenhouse experiment? Why or why not?

5. In an isolated Dutch population, the heritability of systolic blood pressure was found to be 0.32. Assuming that these data came from a study of the relationship between parents and offspring, sketch the graph of the mid-parent mid-offspring relationship, being sure to include the slope of the line of regression.