Question #1.

You just read a paper in *Nature* reporting results from a selection experiment designed to test a long-standing hypothesis that high levels of herbivore pressure favor the evolution of small leaf size in plants. In brief, the results reported in this paper were based on taking a single population of the annual hermaphroditic plant, *Heuchera bogusiensi*, and dividing it into two experimental populations. Each experimental population had an initial population mean leaf size of 20mm and an effective population size of 30 individuals. Previous studies in this system provided evidence that leaf size was heritable within this species, with an additive genetic variance equal to 0.75mm^2. After the populations were divided, they were planted within a common garden as seedlings with individuals of one population exposed to natural levels of herbivory (high herbivory treatment) and individuals of the other population freed from herbivory by continued pesticide application (low herbivory treatment). At the end of the flowering season, seeds from each experimental population were collected and planted to produce the next generation. Once these seeds germinated, plants were thinned to maintain a constant population size of 100 individuals within each experimental population. This process was repeated for twelve generations and the mean leaf size of each population recorded within each generation. At the end of the study the authors analyzed their data and found that the mean leaf size of the high herbivory treatment was significantly smaller than the mean leaf size of the low herbivory treatment. Because the population mean phenotypes of the herbivory and no-herbivory treatments were significantly different (p = 0.012), the authors concluded that small leaf size is indeed an adaptation to high levels of herbivory, thus providing support for the long-standing hypothesis and landing their paper in *Nature*.

Being somewhat skeptical, you are not convinced that the authors study effectively rules out the possibility that their results are simply the product of random genetic drift. Consequently, you decide to have a look at the supplemental online material for this article, which can be found in the file "P1Data.csv". Based on this data, do you believe the results of this study?

Be prepared to clearly explain the methodology and assumptions you used to come to your conclusions. I recommend preparing a 5 minute mini-presentation just in case you get the lucky card!!!

Question #2.

As part of your graduate work, you are trying to understand the factors that drive diversification of body size in Cutthroat trout. Fortuitously, early in your dissertation you stumbled upon stocking records for the Selway-Bitteroot Wilderness which provide very detailed records for four small lakes, each of which was stocked 68 years ago with approximately 1500 trout taken from a single source population for which mean body size was measured at the time of stocking (26cm). What peaked your interest about this data was the fact that two of these lakes are above treeline (Lakes 1 and 2) where the fish have access only to insects as food whereas the other two are below treeline (Lakes 3 and 4) where the fish have access to large prey items such as smaller fish species and crustaceans. Your working hypothesis is that much of body size evolution in Cutthroat trout is driven by the size distribution of available prey, leading you to predict evolution of small body size in the lakes above treeline and evolution of large body size in the lakes below treeline. To test this prediction, and to better capitalize on the existing historical data, you have collected the following additional data over the course of your dissertation:

1. Using fish collected from Lake 1 and Lake 3 you estimated the additive genetic variance for body size by breeding pairs of wild caught fish in the lab and measuring both parental and offspring phenotypes, resulting in the following estimates for additive genetic variance:

Lake 1: $0.71cm^2$

Lake 3: $0.69cm^2$

2. You have conducted annual census of cutthroat trout within the four study lakes over a three year period resulting in the following estimates of population size for each lake:

Lake 1: 1250, 1175, 1184

Lake 2: 1350, 1267, 1189

Lake 3: 1420, 1367, 1299

Lake 4: 1183, 1455, 1374

Within your census samples the sex ratio was approximately equal in all lakes, such that the effective population size is approximately equal to the census size.

3. You have reviewed several published studies and used the data to estimate the average generation time of Cutthroat trout to be approximately 3 years.

4. You have used your census samples to estimate the population mean body size for trout in each of the lakes in the three years you conducted censuses:

Lake 1: 24.4cm, 24.6cm, 25.2cm

Lake 2: 25.6cm, 24.1cm, 23.9cm

Lake 3: 26.9cm, 27.6cm, 27.2cm

Lake 4: 27.7cm, 26.7cm, 27.2cm

Use this data to critically evaluate your hypothesis that body size in Cutthroat trout evolves in response to natural selection favoring larger body size in low elevation lakes as an adaptation for feeding on large prey items and natural selection favoring smaller body size in high elevation lakes as an adaptation for feeding on smaller prey items.

Be prepared to clearly explain the methodology and assumptions you used to come to your conclusions. I recommend preparing a 5-10 minute mini-presentation just in case you get the lucky card!!!

Note: For this question, there is no single correct answer or methodology. The goal, instead, is to stimulate discussion of the challenges that must be overcome and the assumptions that must be made to infer adaptation in the wild.