11. REVIEW PROBLEM

In previous exercises you have used the computer program to answer example problems associated with specific statistical tests. In this exercise you are given an example problem and you must decide which statistical test is appropriate to answer each question. You should explore each data set before you proceed with any tests. Use as many of the components of the program as possible. When you answer a question you should provide a fairly standard set of information. When a test is called for, show all your steps:

1. State your null and alternate hypotheses (mathematically, if possible and appropriate).
2. State your significance level (α).
3. Note any problems with assumptions and any transforms or changes you made to correct those problems.
4. Report the test statistic (F, t, W, z, etc.)
5. State the degrees of freedom (or sample sizes in the case of nonparametric testing).
6. State the P-value (report the critical value when using the tables, whether the corresponding test statistic is greater or less than the critical value, and what this implies about the magnitude of P).
7. Compare the P-value value to α (by hand, compare the test statistic to the critical value).
8. Report your conclusion (reject or fail to reject H_O). For exams, it's safest to stop here. In the real world you would restate your conclusion to explain what it means for your study.

Hints for the lab exam:

Read the questions thoroughly. One of the most common ways people lose marks is by providing a thorough answer to a question we didn't ask.

Look for key phrases: causation, prediction or functional relationship implies regression if the Y-variable is continuous. Describe a regression relationship algebraically means tell us the equation of the line (don't forget to include any transformations in the equation). Describe the strength of a relationship implies r^2 in the regression framework, when X and Y are continuous, or r in the correlation framework. Association or vary together implies correlation when both X and Y are continuous. Independence of variables or do the ratios vary points to a contingency test when both variables are nominal. Summarize the differences between all pairs of means should tell you to do a Tukey test.

Try the following set of problems to review some of the ideas you have learned this year. This exercise is very similar to the lab exam you will write next week, although the lab exam will have fewer questions. You should not consider this set of questions to be all-inclusive, however. Any of the topics that we have dealt with in lab are fair game for the lab exam.

Problems

A study of clutch size (i.e. number of eggs laid per nest) in great blue herons *(Ardea herodias*) was undertaken in south coastal British Columbia. Nests were randomly sampled from three different colonies (populations) and the number of eggs in each nest were counted. The wing length (mm) of the female heron occupying each nest was also measured, as an index of body size. The data are stored in a file named **clutch.jmp** in the shared directory.

a) Visually inspect the data from each of the three colonies and describe the distributions of clutch size and wing length. Test whether the distributions are normal.

b) Are there differences in mean clutch size among the colonies? Are there differences in mean female wing length among the three colonies?

c) In your analyses of part (b), what was the power of each test to reject the null hypothesis, based on the default power estimates from your samples. What were the smallest sample sizes that would have allowed you to reject the null hypotheses?

d) The researchers observed that Douglas fir and alder trees were equally abundant at the three colony locations. Subsequently, they determined the frequency with which heron nests were located in different trees:

Colony #	**Douglas fir**	**Alder**
1	5	7
2	31	5
3	30	11
Totals	**66**	**23**

Are the ratios of herons nesting in Douglas fir to herons nesting in alder trees the same in all colonies?

e) The average wing length of female great blue herons in North America is 500 mm and the average clutch size is 4. For the combined sample (i.e. assuming no differences among colonies in mean or variance for each variable), test whether or not clutch size of great blue herons in south coastal British Columbia is representative of great blue herons in North America. Carry out a similar analysis using female wing length.

f) For the combined sample (assuming no differences among colonies in mean or variance for each variable), decide whether or not it is possible to use female body size to predict clutch size in great blue herons from south coastal British Columbia. If so, describe the relationship algebraically.

Selecting a statistical method (partial review of appropriate methods in Bio 300)

Goal	**Normally distributed population(s)**	**Non- normal population(s)**	**Nominal data (categories or names)**
Estimate a parameter	Standard error and confidence interval for the mean and variance	Standard error of the mean	Standard error and approximate confidence interval for a proportion
Compare one group to a hypothetical value	One-sample *t* test	Wilcoxon signed rank test	Chi-square goodness of fit test or Binomial test (two outcomes)
Compare two unpaired groups	Two-sample *t* test (means) Two-sample *F* test (variances)	Mann-Whitney *U* test (rank sums) Levene test (absolute deviations)	Chi-square contingency test Fisher's exact test (two outcomes)
Compare two paired groups	Paired *t* test (mean difference)	Wilcoxon signed rank test	
Compare three or more unmatched groups	One-way ANOVA (means) Bartletts test (variances)	Kruskal-Wallis test Levene test (absolute deviations)	Chi-square contingency test
Measure or test association between two variables	Linear (Pearson) correlation	Spearman rank correlation	Contingency test
Predict value from another measured variable	Linear regression		