Course Review

Part Three: Choosing Appropriate Analyses

Identify the statistical analysis appropriate to address each of the following questions.

1 Water quality in Lake Whatcom: What is the largest source of Phosphorous entering Lake?
Potential sources: Fertilizer runoff from residential properties
                    Fertilizer from golf courses and parks
                    Debris flows from logging
                    Sediment runoff from logged slopes
                    Failing septic systems

2 Does leaf litter from alders increase growth rates of young Douglas fir trees?
Douglas firs grown in plots with and without alder leaf litter.

3 Do whale watching operations increase dive times of orcas?
Orca dive times were recorded (1) in the absence of boats, (2) in the vicinity of many stationary whale watching boats, and (3) in response to pursuing whale watching boats.

4 Do residual concentrations of mercury remaining in marine sediments differ among various remediation methods? Mercury concentrations in sediments were sampled after the following treatments: (1) no action, (2) capping with clean sand, (3) hydraulic dredging, (4) clamshell dredging.

5 How different are residual mercury concentrations in marine sediments after the above treatments?

6 Travel mode preferences were surveyed among people commuting to WWU. Do mode preferences differ among students, faculty, and staff ?

7 Surveys described in (6) were repeated five years later, after implementation of an extensive transportation demand management program. Have mode preferences of students, faculty, and staff changed during those five years?

8 Do native butterflies (pollinators) prefer native flowers over introduced flowers?

9 Do controlled burns in forested areas increase densities of nesting woodpeckers?
Woodpecker densities were measured in 20 plots prior to burning and in the same plots five years after burning.

10 Does placing engineered large woody debris (LWD) in streams increase densities of aquatic invertebrates immediately downstream? Aquatic invertebrate densities were sampled in 20 locations: ten in areas without LWD and ten immediately downstream of engineered LWD.

11 Given large spatial variability in aquatic invertebrate densities, how could you address the question in (10) with greater power, but without increasing sample sizes?

12 Which factor(s) exerts the greatest influence on bird species richness in Whatcom County habitats?
Potential factors: Foliage height diversity
                      Snags (# / hectare)
                      Habitat type (coniferous forest, deciduous forest, shrub, grassland, wetland, …)
                      Plant density (stems / hectare)
                      Habitat area
                      Canopy cover and snag density

13 Research question: What is the oral reference dose (RfD) for methylmercury in children? [RfD assumes there is a threshold exposure for toxic effects. The RfD is an estimate of daily exposure in humans that is likely to have no appreciable risk of deleterious effects during a lifetime (EPA definition).] Performance on a finger-tapping test was measured in two hundred children from each of five methylmercury exposure levels (1000 children total) as assayed from blood samples: (1) 0 to 0.1 µg/kg/day, (2) 0.5 µg/kg/day, (3) 1.0 µg/kg/day, (4) 1.5 µg/kg/day, and 2.0 µg/kg/day.

(a) State two kinds of analyses that could be applied to these data to determine methylmercury RfD in children, where "deleterious effect" is defined as a decrease in finger tapping test performance.

(b) Which kind of analysis identified in (a) would yield the most accurate estimate of the real RfD? Why?

For the following research questions, determine the following:
        (a) the kind of statistical analysis appropriate to address the question
        (b) null and alternative hypotheses
        (c) assumptions necessary in using the appropriate statistical analysis
        (d) criteria for rejection of the null hypothesis or hypotheses
        (d) formula for calculating the test statistic

14 Do WWU students favor left vs. right hands in the same proportion as the global human population? Use this class as a sample of WWU students.

15 (In memory of the late Linus Pauling) Does daily consumption of vitamin C (ascorbic acid) tablets reduce cold virus infection rate? An experimental trial was conducted using 1000 human subjects, 250 each given daily doses of one of the following: (1) placebo, (2) 250 mg, (3) 500 mg, (4) 1000 mg.

16 Does driver use of cell phones increase risk of motor vehicle accidents? The accident rate (number of accidents per 1000 driving hours) was recorded for 100 people in each of the three categories (300 people total): (1) no cell phone use, (2) use hands-free cell phones while driving, (3) use hand-held cell phones while driving.

Identifying the Appropriate Statistical Analysis

The following questions may help you select an appropriate test. They are listed in arbitrary order.

1 How many samples and/or treatments do you have?

2 Do measurements within a sample represent true replication, or are they sub-samples?

3 Judging from sample frequency distributions, are the populations likely to be normally distributed? More appropriately, are the residuals (ε in a linear model) normally distributed? (parametric vs. non-parametric test)

4 Are the variances in your samples similar, or are they very different? (parametric vs. non-parametric test, or transformation prior to analysis)

5 Do you need to compare means, variances, or proportions?

6 If there are two samples, are their measurements paired? Is each measurement in one sample clearly related to one and only one measurement in the other sample? (paired vs. two-sample test)

7 Are you comparing means of three or more samples? (ANOVA) If so, how many factors influence each sample? (one: single-factor ANOVA; two: two-way ANOVA; three or more: take a course in experimental design)

8 Are factors in an ANOVA fixed or random?

9 Do you need to determine a quantitative relationship between two or more sampled variables?

10 If the answer to 9 is yes, are you interested in testing for a cause-effect relationship between the variables or simply an association? (regression or correlation)

11 Are all the hypotheses plausible? Avoid or revise null hypotheses that can be rejected a priori.