

In this session we will work through examples using one-way and two-way ANOVA.

### ONE-WAY ANOVA

We begin with the lobsters\_lab data on the website. Input these data into JMP, and make sure that location and year are 'nominal' variables.

- 1 Use ANOVA to test the null hypothesis that there is no difference in the mean number of lobsters by location, and pool the test across both years (i.e., pretend there was not a marine reserve policy in 2003).
  - a) What do we conclude?
  
  - b) Increase the 'within-group' variability of the data using the 'lobsters2' column of data in the following way: (a) subtract 2 from row 1, add 2 to row 2; (b) subtract 2 from row 5, add 2 to row 6; (c) subtract 2 from row 9, add 2 to row 10. Notice that these changes are mean preserving.

Now test the null hypothesis again. How has the F-ratio changed from part a?
  - c) Now test the null hypothesis that there is no difference in the mean number of lobsters by location separately for year 2002 and 2003 using the 'lobsters' column. What do you conclude for 2002? For 2003?
  - d) Do a Tukey test to determine if we rejected the null of equality because of changes in inside our outside catch. Do this separately for 2002 and 2003. What do you conclude?
  - e) Do the results from (c) and (d) suggest that the marine reserves (initiated in 2003) improved lobster populations?
  
- 2 Let's reconsider the private land conservation data from the first lab. First we will create a new 'nominal' variable to place the counties into income quartiles. Call this variable 'pciquartile' and set it equal to '1' for the poorest 25% of counties; equal to '2' for the counties in the 2<sup>nd</sup> quartile for income, etc.

*ESM 206 Lab Exercise #2*  
*Week 8, Winter Quarter*

- a) Test the null hypothesis that there is no difference in the mean amount of private land conserved across the different income quartiles. What do you conclude?
- b) Now do a Tukey test to evaluate more precisely what caused you to conclude what you concluded in part a. Do the results suggest there is a linear relationship between income and private conservation?

Now create a variable that ranks counties into quartiles based on the natural amenities scale. Call this variable 'amquartile' and set it equal to '1' for the 25% of counties with the lowest amenity ranking; equal to '2' for the counties in the 2<sup>nd</sup> quartile, etc.

- c) Test the null hypothesis that there is no difference in the mean amount of private land conserved across counties in the different amenity scale quartiles. What do you conclude?
- d) Now do a Tukey test to evaluate more precisely what caused you to conclude what you concluded in part a. Do the results suggest there is a linear relationship between amenities and private conservation?

TWO-WAY ANOVA

- 3 Use the lobster data from #1 to conduct a more rigorous test of the effect of marine reserves by using two-way ANOVA. In this test you will be examining the interaction of location and year (before versus after implementation of reserves). Remember that all locations were fished prior to 2003 when reserves were established.

Can you reject the null hypothesis that there was no effect of the marine reserves on lobster populations? At  $P \leq 0.05$ ? At  $P \leq 0.01$ ?