Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Goals: Work with quantitive stand information to assess baseline mortality for Northern New York Forests.

Objectives:

1. Produce graphs of mortality rates by species and diameter class.
2. Compare observed to predicted mortality using chi-square.
3. Make an assessment of forest health based on mortality rates

The data used here was collected by Paul Manion and his students in 2001 in the Adirondack Park in northern New York State. The park is a 2.4 million ha patchwork of private and public land designated in 1892 to protect forests from illegal clearing. In the 1890s, beech bark disease (BBD), an exotic disease complex of American Beech spread to North America. By the 1960s it began impacted the Adirondack region. **How has the disease impacted the health of American Beech in northern New York?**

154 randomly selected plots were established, and data was collected using a prism. Saplings were sampled in three smaller subplots within the overstory plot.

Follow the instructions to model baseline mortality using excel on a computer.

1. Open the excel data sheet (from the website) for todays lab. Save this file in a logical place with a logical name.
2. Examine the data set. The data was collected using a prism, so, the trees are calculated as trees/prism. We first need to use a expansion factor to convert to trees/prism to trees/acre.
3. Open the ref worksheet. Label column B “expfactor”.
   1. Expansion factor = 43560/[(tree dbh \* 2.75)2 π]. In excel this is (43560/(((dbh\*2.75)^2)\*3.1416)) To get ^2 press shift 6, then 2.
      1. 42560 = ft2/acre. Radius of the tree plot = tree dbh \*2.75, where 2.75 is a constant that adjusts for the conversion from inches to feet.
      2. The expansion factor for stems less than or equal to 3.5 inches dbh, however, is calculated from the following formula
         1. 43560/[(5.82)3π]. This is necessary because saplings were sampled within three smaller radial plots, not over the entire overstory sampling area.
4. Go to the cell directly below the heading (B2) and type:= (43560/((5.8^2)\*3\*3.1416)) Enter. Copy this formula down to cell B31. Why are you copying this formula to this cell?
5. In cell B32 type: =(43560/(((A32\*2.75)^2)\*3.1416)). Go to the bottom right-hand corner of that cell until you see a black cross hair “+”, then double click. The entire column should autofill. If not, click the bottom right corner and drag down until all cells are filled
6. **Use the insert name procedure and the V lookup function to first establish a name for the expansion factor that you created on the ref worksheet, and to fill a new column in the main data set labeled trees/ac (trees/acre).** 
   1. In the ref worksheet highlight dbh through expansion factor (columns A and B) all the way down to the last row of numbers.
   2. Go to the Formulas tab and click Define Name. Type “expfactor2” into the name field, click OK.
   3. In the dataset worksheet, insert a column next to the dbh column (right click on the column to the right of the dbh column, then click on the letter at the top of that column, insert column). Label the new column trees/ac.
   4. If f(x) is not an icon on your toolbar, then go to VIEW, toolbars, click off formatting or other options (only standard formatting needed).
   5. Go to f(x), find VLOOKUP. Double click VLOOKUP.
   6. Lookup\_value = C2
   7. Table\_array= expfactor2
   8. Col\_index\_num=2
   9. Range\_lookup=false (False means it has to be the exact value).
   10. Go to the first cell under tr/ac heading in the datasheet, rick click on the bottom corner. You should get a cross hair, double left click. Make sure it autofilled all the way to the bottom of the page.
7. **Use the round function to dill a new column in the main datasheet labeled dclass.** 
   1. Insert a new column to the right of dbh and name it dclass.
   2. Click on the cell below the heading for dclass and go to f(x), round number:C2. #digits: 0. Autofill. Digits 0 means no decimals. To do this type =ROUND(C2, 0).
8. **Save your progress!**
9. **Use the PIVOT TABLE function to generate a worksheet that summarizes trees/acres living, dead, and total for each diameter class. The pivot table will use dclass for Row, alive for Column, and tr/ac for data.**
   1. Highlight the entire dataset worksheet by double clicking in the triangle at the upper left of the worksheet. Then go to the INSERT tab, PivotTable, (make sure the entire range is highlighted, if it is it will have blinking dashes around the entire worksheet). Make sure the option to place the report into a new worksheet is selected. Click OK.
   2. Left click on dclass and drag to the Row field.
   3. Left click on health and drag to Column field.
   4. Left click on trees/ac and put it in the Values field.
   5. Rename the sheet “Pivot Table”
   6. In row one, type D class in A1, Alive in B1, dead in C1 and Total in D2
   7. Highlight the data in the pivot table A5:D45 and right click, copy and then in A2 paste values. Sometimes excel will not let you overright the values in the picot table so you may need to do this in an empty space and then cut and paste them here.
10. **Using number of trees/acre as the Y variable and diameter class as the X variable from the pivot table output above, use the REGRESSSION function to generate the parameters for the best-fit regression line for the density distribution across diameter classes.** 
    1. Pick an empty column next to the pivot table output. Label Cell G4 ‘observed trees/acre’. In cell G1 type =B5/462 (the number of sampling plots). Left click the bottom right corner to autofill (or drage bottom if the data
    2. Label the next column Ln(observed trees/acre). On the first cell underneath the column header type =ln(cell under heading observed trees/acre). Autofill by double left clicking on the cross hairs in the bottom right corner.
    3. Go to the DATA tab, data analysis, regression, OK
    4. Input Y range: click on icon at the corner of the blank, highlight the column labeled Ln observed trees/acre (do not include the total at the bottom).
    5. Input X range: click on the icon next to blank, highlight the column labeled d class.
    6. If you hgave highlighted the column headings, then click on LABELS.
    7. Click on residuals and residual plots, then OK.
    8. Write down the slope from the regression output. In the output table this value is the coefficient of the x variable.
    9. Rename the datasheet tab as Regression.

1. **From the regression output, calculate expected density or predicted trees/acre.** 
   1. On the regression datasheet label a column “predicted trees/acre (D24, next to the residuals column at the bottom of the page). In D25, type =exp (click on cell under column heading predicted, B25. B25 must be in parentheses. Autofill.
   2. Highlight and copy the columns predicted trees/acre.
   3. PASTE VALUES, into pivot table worksheet. SAVE!
2. **From the regression output, calculate the baseline % mortality (percent mortality per diameter class to maintain stability within the population).** 
   1. In the regression worksheet, INSERT another column to the right of predicted trees/acre and label it baseline % mortality. This is the baseline mortality calculated from the regression equation using the formula (1-2.7^(slope of regression line multiplied by the diameter class size of 1 inch))\*100.
   2. Copy this column and paste the values into the PivotTable worksheet to the right of predicted trees/ac
   3. Back in the regression worksheet, label the column next to baseline % mortality, predicated baseline mortality. =((D25-D26)/D25)\*100. Autofill. Baseline morality calculated by both methods should be equivalent. I just wanted you to see that for yourself.
3. **Calculate actual mortality or observed mortality.** 
   1. In the pivot table worksheet, label a column “observed % mortality” next to the predicted trees/acre and baseline % mortality columns that you just copied and pasted.
   2. In the first cell underneath the column heading type =(C2/D2)\*100. Autofill.
4. **Arrange the four columns labeled : “observed trees/acre”, ”predicted trees/acre”, “baseline % mortality”, and “observed % mortality” in the pivot table worksheet so that they are together by moving the “Ln observed trees/acre” column. Now we will generate a chart to display these data.** 
   1. In the INSERT tab, click Line Chart, then Line with Makers from the menu
   2. A blank graph window will appear. Right click within this and click select data. Click on Add in Legend Entries (Series). Type Observed trees/acre in the Series Name field. Next click the button at the right end of the Series Name field and hightlight the column heading for observed trees/acre, then click the button to select the data range for the y-values
   3. To add additional data to the chart, again, click Add in Legend Entries (Series). Follow the instructions detailed above, but this time for Predicted Trees/acre. Now do the same for Baseline % mortality and Observed % Mortality. Make sure the data ranges selected span the same range of cell rows.
   4. Next add horizontal axis values. Do this by clicking Edit in the Horizontal (Category) Axis Labels Box, Highlight the range of diameter classes you want to use, cells A2-A44 in this example. Click OK.
   5. Click OK in the Select Data Series window. This will generate a chart, albeit a fairly messy one.
   6. Relocate chart to its own worksheet by clicking the DESIGN tab and selecting Move Chart. Click New Sheet and type NNY Chart in the neighboring field.
5. **Format chart to clearly display data series, label axes, and create a title.** 
   1. The two trees/acre data are based on a logarithmic data; therefore we must reformat the y-axis. Right click on this axis, select Format Axis and check the box left of Logarithmic Scale. Also, in the Horizontal Axis Crosses section, click Axis Value and type 0.001 in the field box. Click Close. The Predicted trees/acre line should now appear linear, while the observed trees/acre line will be roughly linear.
   2. Right click on the Baseline % Mortality line and select Format Data Series. Within Series Options: Plot Series on, click Secondary axis. Click Close. Do this also for the Observed % Mortality Line.
   3. Set the right y-axis range from 0-100 by right clicking on the axis and selecting Format Axis. In Axis Options, switch Maximum from Auto to Fixed and type 100 in the field box. Click close.
   4. To label the axes, click the Chart Design tab then Add Chart Elements, Axis titles. Add the needed axis titles (horizontal, primary, and secondary. Use labels that are appropriate for the data, hint do not forget that we used a log scale for one of the axis.
   5. In science journals, we do not generally use titles for figures. But for other audiences a title maybe appropriate. Title your chart appropriately.
   6. Add a chart element of a legend.
6. **Statistical comparison of observed mortality and baseline mortality for each diameter class using Chi-square analysis.**
   1. In the pivot table sheet label the two rightmost empty column as X2 and significance.
   2. The X2 column will contain chi-square values for each corresponding diameter class. These values are calculated from the following formula: (observed dead trees-expected dead trees)2/ expected dead tress.
   3. Use the above formula to calculate X2
   4. Because we will be performing multiple statistical comparisons (one for each diameter class) we need to adjust the alpha value associated with our critical chi-square value first. This is done to correct for alpha inflation, an increase in the chance of a type 1 error (false rejection of the null hypothesis) occurring while making multiple comparisons. This is done by dividing the alpha value (0.05) by the number of comparisons to be made.
   5. Using the adjusted alpha value and 1 degree of freedom, a critical chi-square value can be obtained from a chi-square table.
   6. Compare the calculated values in the X2 column against the critical value obtained in the above step using a Chi-square table. If the calculated value is greater than the critical value, the observed % mortality of that diameter class is significantly different from baseline % mortality. In the Significance column type Y for each significant diameter class and a N for each nonsignificant diameter class.

The above was for all species and locations combined. Repeat the process and make graphs for American beech and Yellow birch as separate graphs. You can use the filter and sort functions in Excel to select the data for only these species. Hint: Stay organized by copying and pasting data into new tabs and labeling everything well. In the end you should have three graphs, each with diameter class, tree density, observed mortality and predicted mortality. Answer the following questions. Please use complete sentences to answer these questions.

HINT: You may encounter the challenge of taking an ln(0). Do you know what the ln(0)= ? Well, lets just “drop” these data points to make your life easier. Delete rows that have ln(0) challenges.

You will be graded on completeness of answers and proper grammar. All charts must have proper captions and labels for full credit.

* + - 1. **For all species**, is observed mortality generally above or below baseline mortality? Which diameter classes are significantly different? Of these, which ones are lower than baseline compared to higher than baseline? (5 points)
      2. **For American beech,** is observed mortality generally above or below baseline mortality? Which diameter classes are significantly different? Of these, which ones are lower than baseline compared to higher than baseline? (5 points)
      3. **For yellow birch,** is observed mortality generally above or below baseline mortality? Which diameter classes are significantly different? Of these, which ones are lower than baseline compared to higher than baseline? (5 points)
      4. Are these forests healthy and sustainable? Which species is most likely to be sustained and which species is less likely to be sustained? What **evidence** are you using to make an assertion about forest health and sustainability? (10 points)

Copy your graphs from excel and insert them into this word document as separate pages. Add figure captions to each one and turn in this worksheet. Each graph is worth 5 points. Lastly make a table (5 points) for each of your Chi-square results (or three tables) and insert these with captions into this word document.