

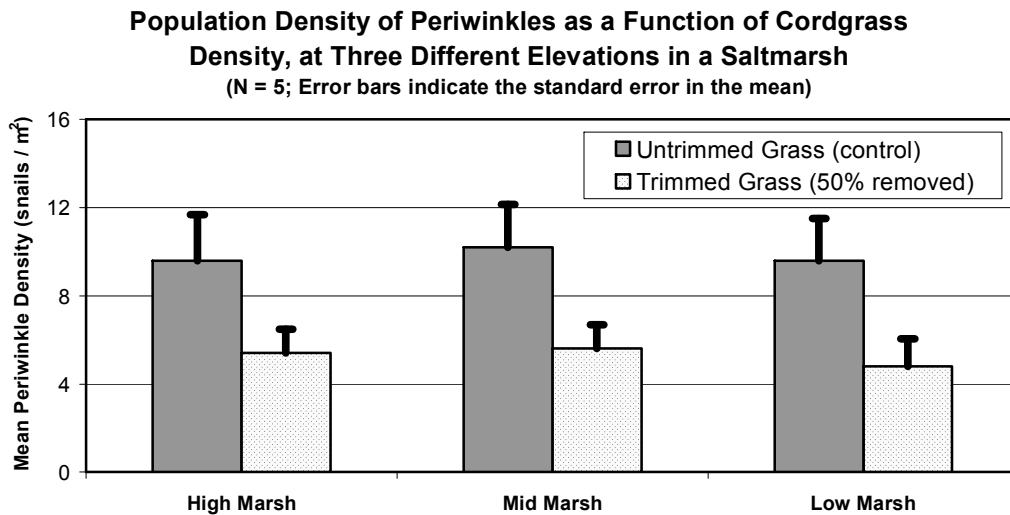
## Good Advices for Graphing in Excel

When making a graph in Excel, there's always more than one way to get where you're going, and everyone has his/her own tricks of the trade. You will develop your own preferences, of course, but I offer the following good advices:

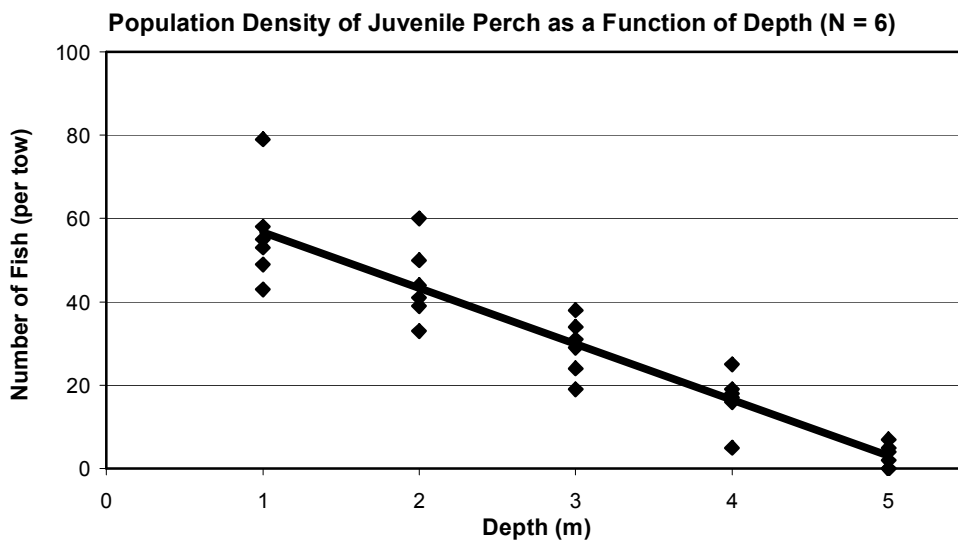
☺ **Scatterplots and Bar Graphs Yes, Line Graphs No!**

With scientific data, nine out of ten times your best bet is either a **Scatterplot** of **RAW** data (what Excel calls an "XY" plot) or a **Bar graph** of your **MEANS** (what Excel calls a "Column" graph). Stay away from the "Line" graph option altogether, as it often leads to headaches. And anyhow, a scatterplot makes a perfectly good "line" graph, if you just tell it to connect the dots.

Sample Bar Graph of Means, including Error Bars:



Sample Scatterplot of Raw Data, with a Trendline:



**Alert! Important cautions:**

- For a scatterplot, all data cells (for both the x and y axes) must contain numerical values. They cannot contain any letters, symbols, or units! So if you want the x-axis to contain days of the week or months of the year, this is the rare case where you'll have to go with a "Line" graph instead.
- To make a scatterplot, you will first have to "stack" your raw data in X and Y columns. For guidance, see the next smiley face.
- Do NOT plot RAW data in a Bar graph! Means only!

☺ ***First Step: Organize Your Data and Do Descriptive Stats***

You'll initially want to organize your raw data by **treatment groups**, each in its own column, as shown below:

	Untrimmed			Trimmed		
	High Marsh	Mid Marsh	Low Marsh	High Marsh	Mid Marsh	Low Marsh
Raw Data (snails per m <sup>2</sup> )	12	9	7	6	7	6
	15	8	12	2	3	1
	7	16	15	7	5	8
	3	5	4	8	9	6
	11	13	10	4	4	3
<b>N</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>
<b>Mean</b>	<b>9.6</b>	<b>10.2</b>	<b>9.6</b>	<b>5.4</b>	<b>5.6</b>	<b>4.8</b>
<b>Std Dev</b>	<b>4.7</b>	<b>4.3</b>	<b>4.3</b>	<b>2.4</b>	<b>2.4</b>	<b>2.8</b>
<b>S.E.</b>	<b>2.1</b>	<b>1.9</b>	<b>1.9</b>	<b>1.1</b>	<b>1.1</b>	<b>1.2</b>

After organizing your raw data this way, you'll want to calculate **descriptive statistics** for each column. Excel has a readymade function for each of these except the last. Use "COUNT" for **sample size (N)**, "AVERAGE" for the **mean**, and "STDEV" for the **standard deviation**. The final stat is the **standard error in the mean** (S.E. or SEM), which you calculate simply as the standard deviation divided by the square root ("SQRT" in Excel) of the sample size:

$$S.E. = \frac{\text{Std Dev}}{\sqrt{N}}$$

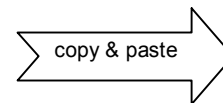
***\*\*\*This is an important stat, as it's probably what you'll use for Error Bars on your bar graphs!***

Hey Kids! Don't forget the "little black box" trick! Once you've plugged in all the stat formulas under the first data column, you can simply highlight those cells, grab the little black box in the lower right corner, and drag to the east. Presto! It carries all the formulas across!

☺ **Planning a Scatterplot? If so, stack your X's and Y's.**

If you are going to make a scatterplot, then you'll first need to "stack" your raw data in vertical columns: an X column and one or more Y columns. This is easy to do, simply by copying and pasting your raw data into new columns, one group atop the next.

	Depth (m)				
	1	2	3	4	5
Raw Data (# of perch per tow)	43	60	38	18	0
	55	33	34	16	2
	58	44	19	5	7
	79	39	29	25	4
	53	41	24	17	0
	49	50	31	19	5
<b>N</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>
<b>Mean</b>	<b>56.2</b>	<b>44.5</b>	<b>29.2</b>	<b>16.7</b>	<b>3.0</b>
<b>Std Dev</b>	<b>12.3</b>	<b>9.4</b>	<b>6.9</b>	<b>6.5</b>	<b>2.8</b>
<b>S.E.</b>	<b>5.5</b>	<b>4.2</b>	<b>3.1</b>	<b>2.9</b>	<b>1.3</b>



Depth (X)	# of Fish (Y)
1	43
1	55
1	58
1	79
1	53
1	49
2	60
2	33
2	44
2	39
2	41
2	50
3	38
3	34
3	19
3	29
3	24
3	31
4	18
4	16
4	5
4	25
4	17
4	19
5	0
5	2
5	7
5	4
5	0
5	5

☺ **Hey, Hey! Graph One Data Series Right Away! Without Delay! Then Fuss with IV's & Such Later in the Day!**

Hurry up and get that first data series plotted! Begin every graph by highlighting ONE AND ONLY ONE column of raw data (for a scatterplot) or ONE AND ONLY ONE row of means (for a bar graph). No headings! Invoke the **Chart Wizard**, pick a chart style (either "**XY Scatter**" or "**Column**"), then hit **Finish**. Don't wade through all those "Next" buttons. Excel will automatically plot this lone data series against the y-axis, which is right where all response variables belong! Forget about your independent variable (the x-axis) until later. Also, you might have several more RV data series to plot on the same graph, but wait and stitch them in later. You can fool with titles, gridlines, axes, legends, and chart location later, too, AFTER you've created your initial graph.

☺ **Separate Sheet Beats Same Sheet.**

Once you've made that initial graph, you'll probably want to move it to its own worksheet. Some folks do prefer to keep it on the same sheet with their raw data, but I find that the graph gets in the way of my data, forcing me to do a lot of needless dragging and scrolling. It's easier to place the graph on a separate sheet, like this: go to the **Chart** menu... **Location... As new sheet... OK**. Then just navigate back and forth between your data sheet and your graph sheet by clicking the worksheet tabs down at the bottom. Simple!

☺ ***Next order of business: Anchor Data to the X-Axis.***

At the outset, all you plotted was a single data series against the y-axis. Notice that Excel, by default, just numbered the x-axis 0, 1, 2, 3, 4... So now it's time to anchor your data series to the proper Independent Variable values. It's easy: under the **Chart** menu select **Source Data... Series** tab. Find the empty window that is asking for your X-axis labels or values, and click the red, white, and blue icon. This frees you to go back to your data sheet and manually highlight the row or column that contains the treatment levels of your independent variable (no headings!). Do so, then hit Enter, Enter.

☺ ***Got Other Data Series to Plot? Stitch 'em in now.***

If you have other Response Variables or Data Series to add to the graph, now's the time to do it. Here's the easiest way: under the **Chart** menu select **Source Data... Series** tab. Click the "Add" button. Now beside the window that is asking for your "Values" or your "Y values," click the red, white, and blue icon. Then navigate back to your data sheet and manually highlight another column of raw data or another row of means. Enter, Enter. Repeat as necessary for each additional data series.

*NOTE: If you want, with Scatterplots you can plot your second data series against its OWN y-axis with its OWN units, over on the right hand side of the graph. To do so, double-click your second data plot, hit the **Axis** tab, and choose "Secondary axis."*

☺ ***If something ain't right, fix it under SOURCE DATA ...SERIES TAB!!!***

The **Source Data ...Series** tab under the **Chart** menu is your best friend! Honest! When something is wrong with one or more of your data series, or the axes they're anchored to, or the names in the legend, this is usually the place to fix it. If you're having problems, check the following:

- Under the **Series** tab, you can "Remove" any unwanted data series. More importantly, this is where you can make sure that your plots are linked to their proper data cells (columns or rows). Just select any of your series, then click the red, white, and blue icon beside the "X values" and "Y values" windows (or if it's a bar graph, beside the "Category" and "Values" windows). Navigate back to your data sheet and highlight the proper cells manually.
- Also, here, you can give each of your data series a **Name** ...in the "Name" window, of course. Simply select a data series, click in the name window, and type in a title. This is an important trick, because this is how you get the names to show up in your **Legend**.

☺ ***In the Main Title, express a RELATIONSHIP or TREND.***

Every graph is a visual representation of a relationship between an Independent Variable and one or more Response Variables. Your main title should tell the reader something about this relationship(s), or else the trend or distribution that the graph reveals. Simple one or two word labels are fine for axis titles, but not for the main title. Some good words and expressions: "the effect of," "as a function of," "versus," "per," "over," "across," "against," "the distribution of," "the response of," "in response to," etc. To title your graph, go to **Chart Menu... Chart Options ...Title** tab.

☺ **UNITS!!!!!!!!!!!!!!!!!!!!!!**

Oh please, for the love of Pete, don't forget to state units of measure in your axis titles (usually in parentheses). Title your axes under **Chart Options ...Title** tab.

☺ **Wanna change the parts and pieces? Double-click 'em.**

Double-clicking any component of a graph brings up a Format box with lots of options for altering its appearance. There are many possibilities, and the best way to explore them is by trial-and-error. (Instead of double-clicking, you can also right-click and choose "Format...")

☺ **Including a Trendline? Then Axe that Connect-the-Dots Plot.**

With Scatterplots, you can easily pass a "best fit" line through the data points. First click on any data point on the graph. Then simply select **Add Trendline...** from the **Chart** menu. BUT, if you do add a "best fit" line, you do NOT want another zig-zagging line connecting your data points! So to turn a "connect-the-dots" plot into a "best fit" plot, you first need to double-click any data point, and then under the **Patterns** tab, choose "None" for the "Line."

You can and should give each individual data series its own Trendline, but keep 'em color-coded for your reader! To make a Trendline match the color of the corresponding data points, just double-click the Trendline and change the color under **Patterns**.

☺ **Error Bars, a Good Idea!**

Whenever your graph is a Bar Graph of the means from some set of data, it's also a good idea to represent the amount of spread or "noise" in your data using vertical Error Bars. Sometimes your Error Bars will signify the Standard Deviations in your data, but usually you'll instead be using the "Standard Error in the Mean" ( $SE = SD / \sqrt{N}$ ). *To add error bars, you must first calculate your Standard Deviations or Standard Errors over on your data sheet.* Then it's a snap to symbolize them as error bars: double click any colored bar on the graph and select the "Y Error Bars" tab. *You will want to make "Custom +" error bars* (+ means the error bars will stick upward, not downward). So down at the bottom click the red, white, and blue icon beside "Custom +" and then navigate back to your data sheet to manually highlight the row containing your Standard Deviations or your Standard Errors. Enter. Hooray! (To give your errors bars a heavier weight or a different color, just double-click 'em and go to the **Patterns** tab.)

☺ **Pretty colors and fancy fonts are nice, I guess, but for a really handsome graph, SCALE YOUR AXES!!!**

Let's correct a common misconception: your x and y axes do NOT have to begin at zero! What's more, the x-axis does NOT have to cross the y-axis at zero, or vice versa. For maximum resolution and to get rid of needless empty space, double-click either axis and select the **Scale** tab. Here you can specify where your axis begins ("Minimum"), where it ends ("Maximum"), how often to place hashmarks ("Major unit"), and where the other axis should cross it. If you want a good-looking graph that's easy on the eyes, tighten and tidy up your axes!

☺ ***Whenever possible, Legend Inside not Outside.***

If you're plotting only one data series, you don't need a Legend, so go to **Chart Options... Legend** tab, and remove it. With two or more data series, you do need a legend. But Excel automatically places the legend off to the right side of the graph, where it takes up a fat chunk of valuable real estate. Often, however, you'll have some empty room within the plot area itself where the legend would fit quite nicely. Just drag the legend on in there. ***Then click the plot area and drag the right hand border to the east!***

***\*\*\*NOTE: to change names in the legend, you have to go to Source Data... Series tab. For an explanation, see the SOURCE DATA smiley face above.***

☺ ***For Your Eyes Only ...NOT!***

Remember, a graph is a vivid, powerful instrument for visualizing and expressing relationships between scientific data. But ultimately the graph isn't for you. It's for the READER. I encourage color and creativity, but not at the expense of clarity. Readability is job one!