

CALCULATING AND GRAPHING STANDARD ERROR

Beak of the Finch: Part D Supplement

(staple to the back of packet)

Part D: Adaptive Traits and Constructing Graphs

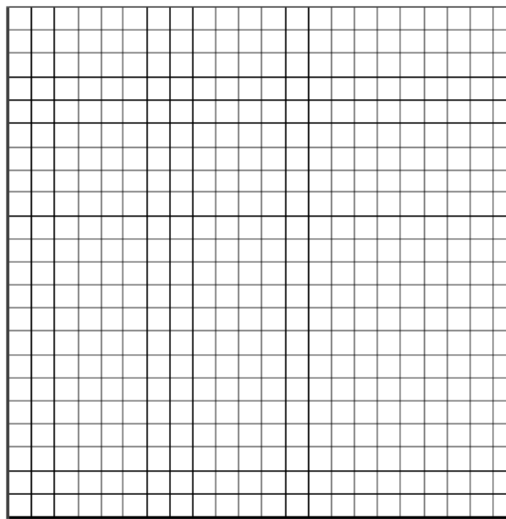
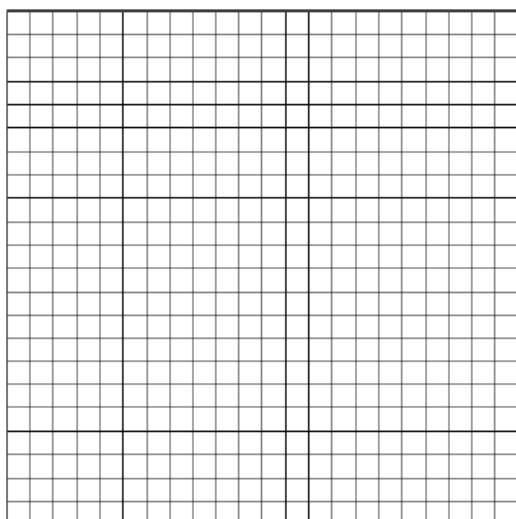
In addition to beak depth, Peter and Rosemary Grant collected dozens of other measurements, for example, wing length and body mass. Table 3 below summarizes the mean and standard deviation of body mass and wing length for **50 birds** that did not survive the drought and **50 birds** that did survive the drought.

- For each sample, what is n ? _____

Table 3. Body Mass and Wing Length Measurements of Nonsurvivors and Survivors

	Body Mass		Wing Length	
	Nonsurvivors	Survivors	Nonsurvivors	Survivors
Mean	15.70 g	17.00 g	67.8 mm	69.3 mm
<i>s</i>	1.36	1.77	2.28	2.33
<i>SEM</i>				
<i>95% Confidence Interval</i>				

First, graph the **means only** of each variable studied. In the space below, construct two bar graphs showing the mean values for body mass for the two groups of birds on one graph and mean values for wing length on the other. Title your graphs and label your axes.



Calculating Standard Error of the Mean

Looking at the graphs of the means, we can definitely tell that the means are different between the nonsurvivors and the survivors. In general, it seems that survivor birds were larger in all aspects. However, if we look closer at the numbers, we can see that the difference in the means is merely a millimeter or two. Is this difference statistically significant? Can we actually say that the difference in the means of body mass and wing length actually means something?

The way we can figure that out is to use our standard deviation and sample size to estimate a range in which we can be pretty certain the **true mean of the entire sample will fall**. We know it is unlikely that **our sample's mean** is equal to the true mean of the entire population. However, we can use it to project this estimated range.

Standard Error of the Mean is used to determine the **precision** of our calculated mean.

$$SE_{\bar{x}} = \frac{s}{\sqrt{n}}$$

s = sample standard deviation (i.e., the sample based estimate of the standard deviation of the population)

\bar{x} = mean

n = size of the sample

The larger the standard deviation, the more it indicates that our mean is not very precise, and there may be a large amount of error in our sample's mean. The smaller the standard deviation, the more it indicates that our mean **IS** precise and there most likely isn't much error and our mean is close to the true one.

The larger the sample size, the larger the denominator, and thus the smaller the error of our mean will be. The more data we have behind our average, the better.

Let's calculate the standard error of each of the data sets above and then record them in the chart. Remember, $n =$ _____.

Body Mass:

➤ Nonsurvivors:

➤ Survivors:

Wing Length:

➤ Nonsurvivors:

➤ Survivors:

Using Standard Error to Create a 95% Confidence Interval

Now that we know how "precise" our mean is likely to be, we can use this measure of precision to create a 95% confidence interval. A 95% confidence interval is a range of values in which we are 95% confident the true mean of the population lies. A different way of looking at the confidence interval is that it is a range wherein if we were to repeat our test an infinite amount of times, 95% of the time, the mean would fall in this range. We can never be 100% positive because we cannot perform a test an infinite amount of times.

To calculate the 95% confidence interval, we simply double the SEM then add **and** subtract that new value from the mean.

$$\text{95\% Confidence Interval} = \bar{x} \pm 2(\text{SEM})$$

So for example, if our mean for a sample was 5, and the SEM was 1, we would find the 95% confidence interval by calculating: $5 \pm 2(1)$. This would be reduced to 5 ± 2 . So our range would have the lower limit of $5-2$ which is 3, and it would have the upper limit of $5+2$ which is 7. For the example data set, we could say that we can say with 95% confidence that the true mean for this data lies between 3 and 7. In other

words, if we were to do this test an infinite amount of times, the mean would be in the range of 3-7 95% of the time.

Let's calculate the 95% confidence interval for each of the variables above:

$$\mathbf{95\% \text{ Confidence Interval} = \bar{x} \pm 2(\text{SEM})}$$

Body Mass:

➤ **Nonsurvivors:**

$$2 \times \text{SEM} =$$

$$\bar{x} + 2(\text{SEM}) =$$

$$\bar{x} - 2(\text{SEM}) =$$

95% confidence interval:

➤ **Survivors:**

$$2 \times \text{SEM} =$$

$$\bar{x} + 2(\text{SEM}) =$$

$$\bar{x} - 2(\text{SEM}) =$$

95% confidence interval:

Wing Length:

➤ **Nonsurvivors:**

$$2 \times \text{SEM} =$$

$$\bar{x} + 2(\text{SEM}) =$$

$$\bar{x} - 2(\text{SEM}) =$$

95% confidence interval:

➤ **Survivors:**

$$2 \times \text{SEM} =$$

$$\bar{x} + 2(\text{SEM}) =$$

$$\bar{x} - 2(\text{SEM}) =$$

95% confidence interval:

What can the confidence interval tell us?

Record these values on the table above, then construct error bars on the graph to indicate the 95% confidence intervals. *If the intervals overlap, then the true means of the compared data sets **may** be the same in some circumstance and therefore the difference between them definitely **is not** statistically significant. If the intervals do not overlap, then the true means of the compared data sets are very likely to be different from one another and therefore the difference **could be** statistically significant.* There are usually follow-up calculations to ensure the statistical significance, but we'll learn that another time!

Analysis: Describe whether or not the error bars overlap for both the body mass and wing length graphs. What does this tell us about the statistical significance of the mean differences?