**Tools**

**Lesson Title: Adult Lake Sturgeon (*Acipenser fulvescens*) Growth**

Since 2001, Michigan State University and Michigan Department of Natural Resources scientists have captured Lake sturgeon as they ascend the Upper Black River to spawn. Once captured, data are gathered from each individual Lake Sturgeon. Data recorded includes but is not limited to: Location, Total Length (cm), Fork Length (cm), Girth (cm), Weight (kg) etc. Over the years Lake Sturgeon greater than 6 feet in length weighing well over 100 pounds are not uncommon among captures. Lake sturgeon spawn periodically and may not even begin to spawn until they are 15-25 years old.  Males typically reach sexual maturity at 15-20 years of age, and then spawn only every other year.  Once females mature at about 20-25 years of age, they spawn on average every three or four years.  Adult Lake Sturgeon have been captured over the period 2001-2012 using large trapezoid dip nets.

Procedure:

Day 1

1. Discuss the process of conducting the adult lake sturgeon population census survey. Begin with a lecture about how, where and when the survey is conducted. Also, describe the details or methods associated with the information collected. Topics to discuss during the lecture may include:
   1. Survey is conducted in the early spring when river temperatures reach 11 degrees Celsius. This is typically when Lake Sturgeon begin ascending the river to spawn.
   2. Survey is conducted on the Black River below Tower-Kleiber Dam. Sample sites are listed as “Zones” and are numbered 1 thru 7. Zone 1 (abundant large rock) is the farthest most upstream sample region which is characterized more as a prime spawning area compared to habitat located Zone 7 (abundant fine sediment/sand).
   3. Data collected are used to estimate harvest numbers as well as provide researchers with baseline information regarding lake sturgeon growth and reproduction.
2. Provide students with the spreadsheet which includes the raw data from Excel as well as the diagram which depicts the type of measurements that are taken from the fish (e.g., total length, fork length).
3. This data includes a worksheet entitled “Lesson 5 Adult Sturgeon Growth” (Figure 1) and another entitled “Raw Data” (Figure 2).

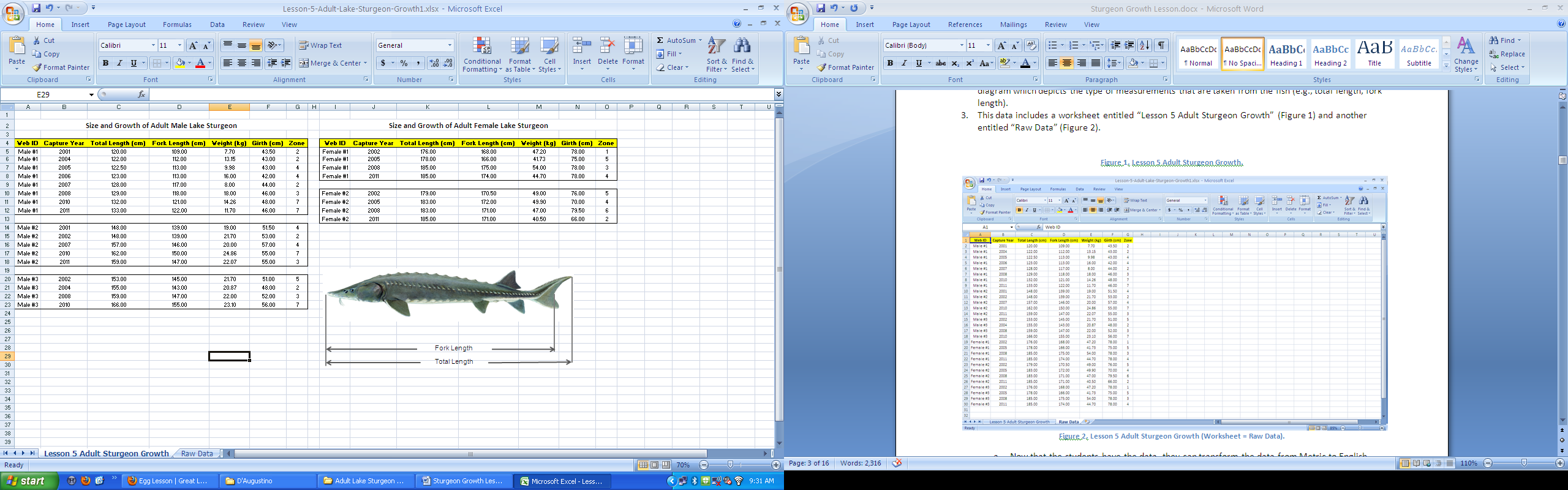


Figure 1. Lesson 5 Adult Sturgeon Growth.

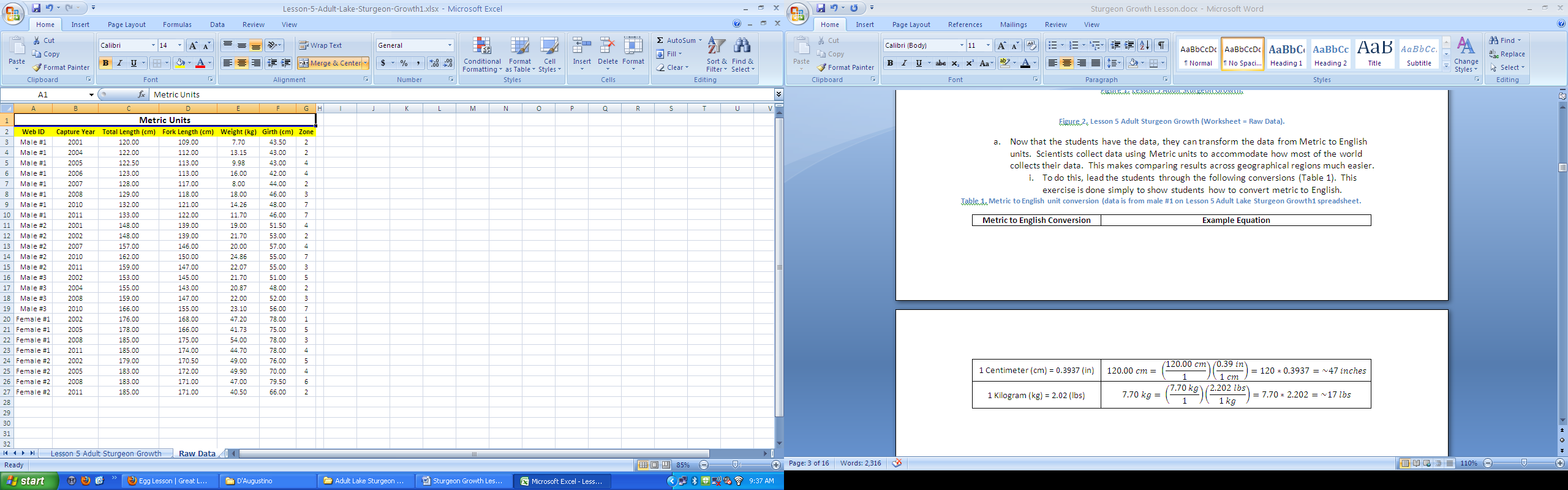


Figure 2. Lesson 5 Adult Sturgeon Growth (Worksheet = Raw Data).

* 1. Now that the students have the data, they can transform the data from Metric to English units. Scientists collect data using Metric units to accommodate how most of the world collects their data. This makes comparing results across geographical regions much easier.
     1. To do this, lead the students through the following conversions (Table 1). This exercise is done simply to show students how to convert Metric to English.

Table . Metric to English unit conversion (data is from male #1 on Lesson 5 Adult Lake Sturgeon Growth1 spreadsheet.

|  |  |
| --- | --- |
| **Metric to English Conversion** | **Example Equation** |
| 1 Centimeter (cm) = 0.3937 (in) |  |
| 1 Kilogram (kg) = 2.02 (lbs) |  |

* + 1. Using the formula above and Figure 3, enter the equation “=C3\*0.3937” into cell “K3” and hit enter. This converts Total Length in centimeters to Total Length in inches (Figure 3).

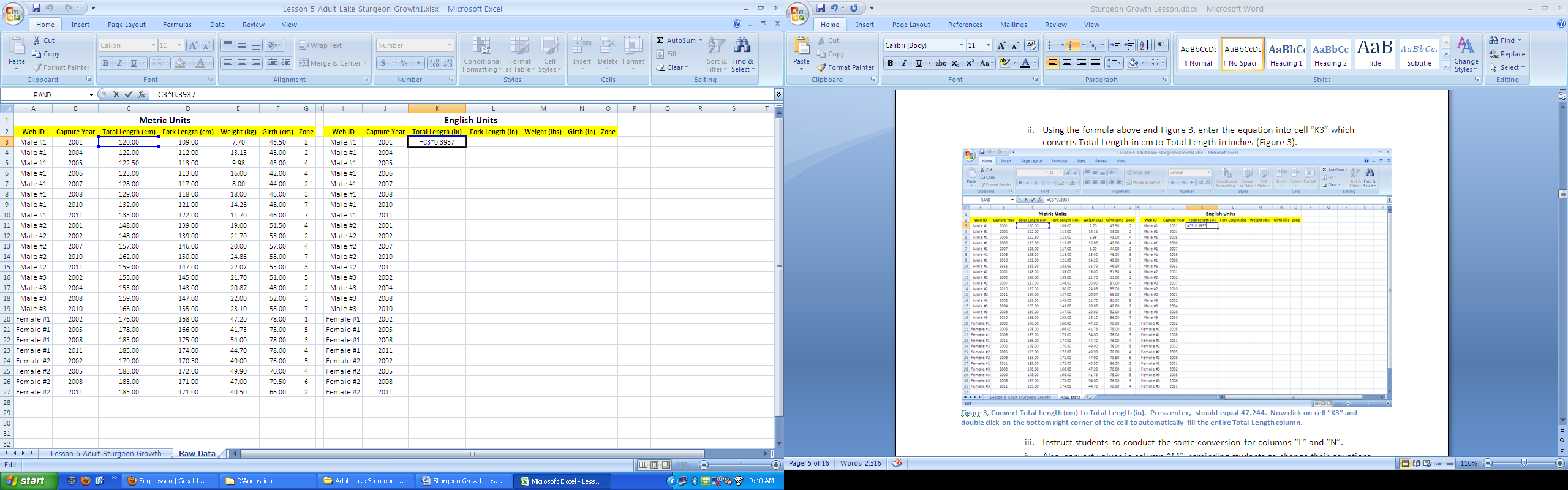


Figure 3. Convert Total Length (cm) to Total Length (in). Press enter, the value should equal 47.244. Now click on cell “K3” and double click on the bottom right corner of the cell to automatically fill the entire Total Length column.

* + 1. Instruct students to conduct the same conversion for columns “L” and “N”.
    2. Also, convert values in column “M”, reminding students to change their equations given the different unit of measure (pounds (lbs)).
    3. Once the cells are filled in the “English Units” section, the data should look like this (Figure 4 (a)). You can “clean” up the data a little by clicking the “decrease decimal” button (Figure 4 (b)). This will standardize the values to a set number of decimals. You can also center the highlighted data to make it appear as the “Metric Units” section appears. You can ignore the green tabs in the “Weight (lbs)” column. Also, you will want to copy and paste the “Zone” column from the “Metric Units” section to the “English Units” section.

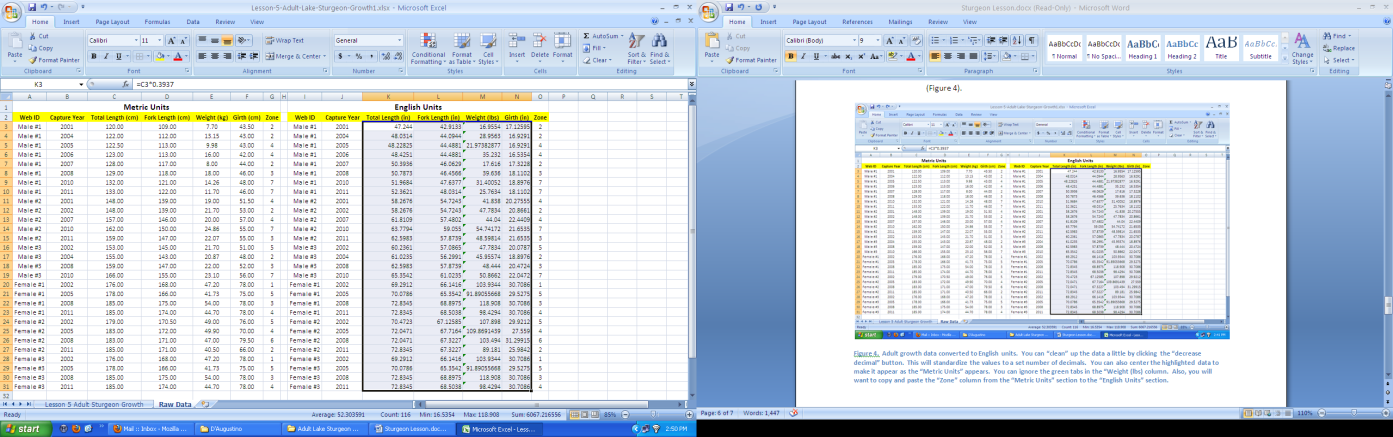
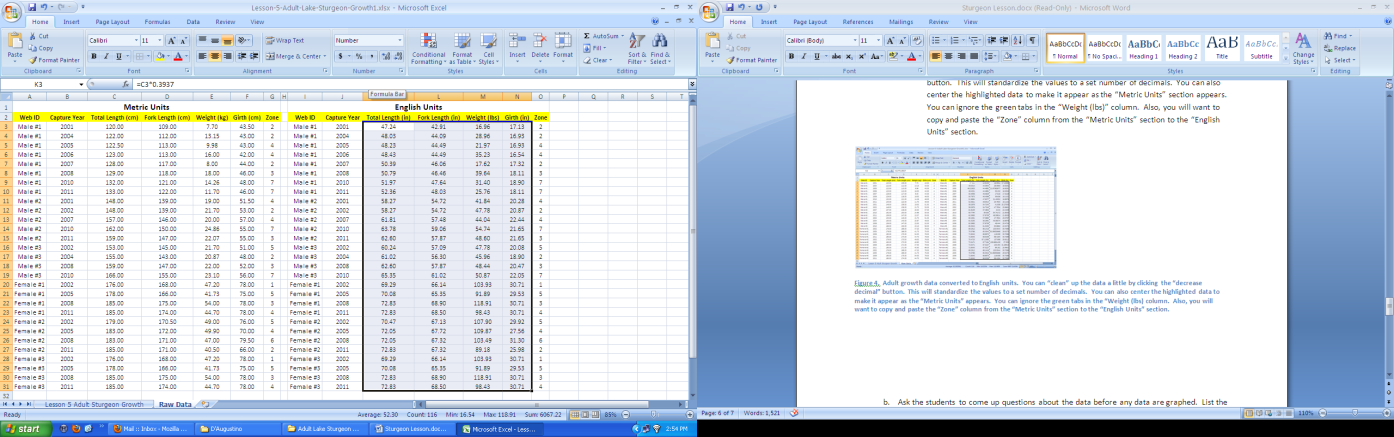
 

Figure 4. (a). At Left, Adult growth data converted to English units. (b). At right, you can “clean” up the data a little by clicking the “decrease decimal” button. This will standardize the values to a set number of decimals. You can also center the highlighted data to make it appear as the “Metric Units” appears. You can ignore the green tabs in the “Weight (lbs) column. Also, you will want to copy and paste the “Zone” column from the “Metric Units” section to the “English Units” section.

* 1. Now that the raw data has been converted, ask the students to come up questions about the data before any data are graphed. List the questions on the whiteboard and select those questions which are mentioned most frequently by students.
     1. If not mentioned, other sample questions may include:
        1. Are Male and Female Lake Sturgeon similar in size (total length, girth, etc.)?
        2. Do individual Lake Sturgeon prefer a specific spawning zone?
        3. Do Male or Female Lake Sturgeon spawn at similar intervals? In other words, can you tell from the data provided how often these adults spawn?
        4. Why might researchers collect Fork Length if Total Length is already collected? What is the difference between Total and Fork Length?
        5. In what year can researchers expect to capture Female #1 again?
        6. In what year can researchers expect to capture Male #3 again

Day 2

1. Instruct students on how to create a graph in Excel using the data provided during previous lecture. Data can be used from either the “Raw Data” worksheet, or the “Lesson 5 Adult Sturgeon Growth” worksheet. Also, you could use data from those two spreadsheets to construct a new worksheet that may help students address a particular question.
   1. For Example, let us hypothesize that at first capture, the average Total Length is equal between that of male and that of female lake sturgeon.
      1. For this example, we will use data from the “Raw Data” worksheet. For this question we won’t need to create a graph. Simply highlight the “Metric Units” section as shown in Figure 5.

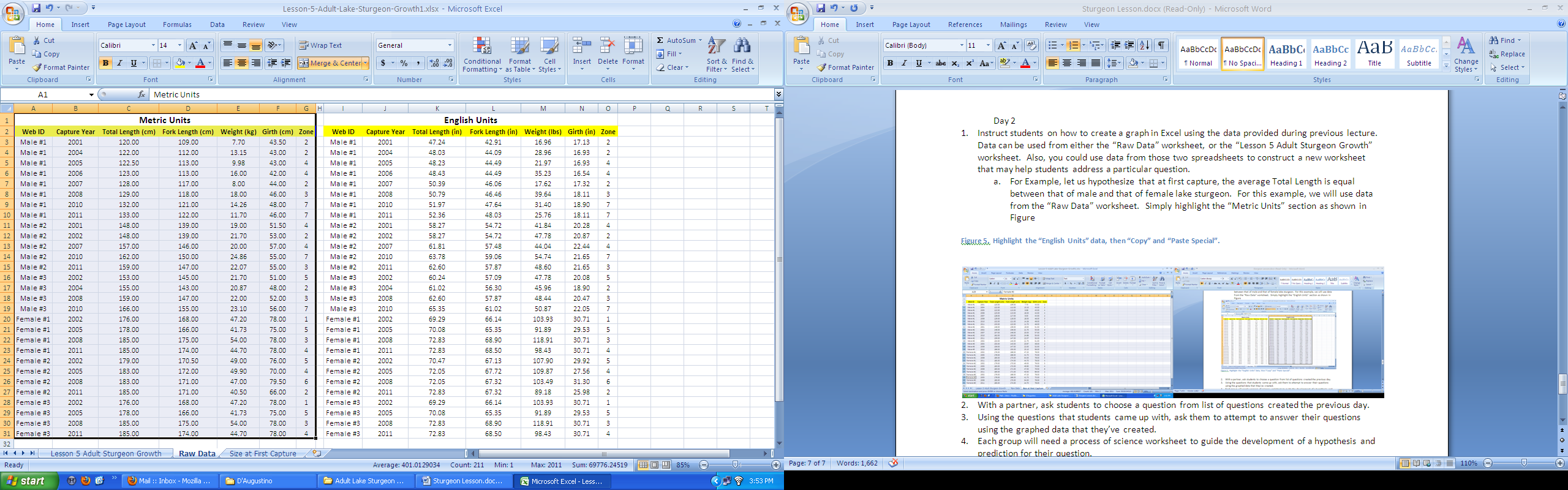


Figure 5. Highlight the “Metric Units” data, then “Copy” and “Paste” into a new worksheet. Right click on the new worksheet and rename the sheet “Size at First Capture”.

* + 1. Once the data are pasted into the new worksheet, highlight all data except the first capture event for each individual fish, by clicking on the row numbers at the left side of the worksheet. For example, if I wanted to delete all but the first capture event for Male #1, I would delete Rows A4 to A10, leaving A3 because that was the first capture event. Once you have all but the first captures highlighted, right click and hit “Delete”.

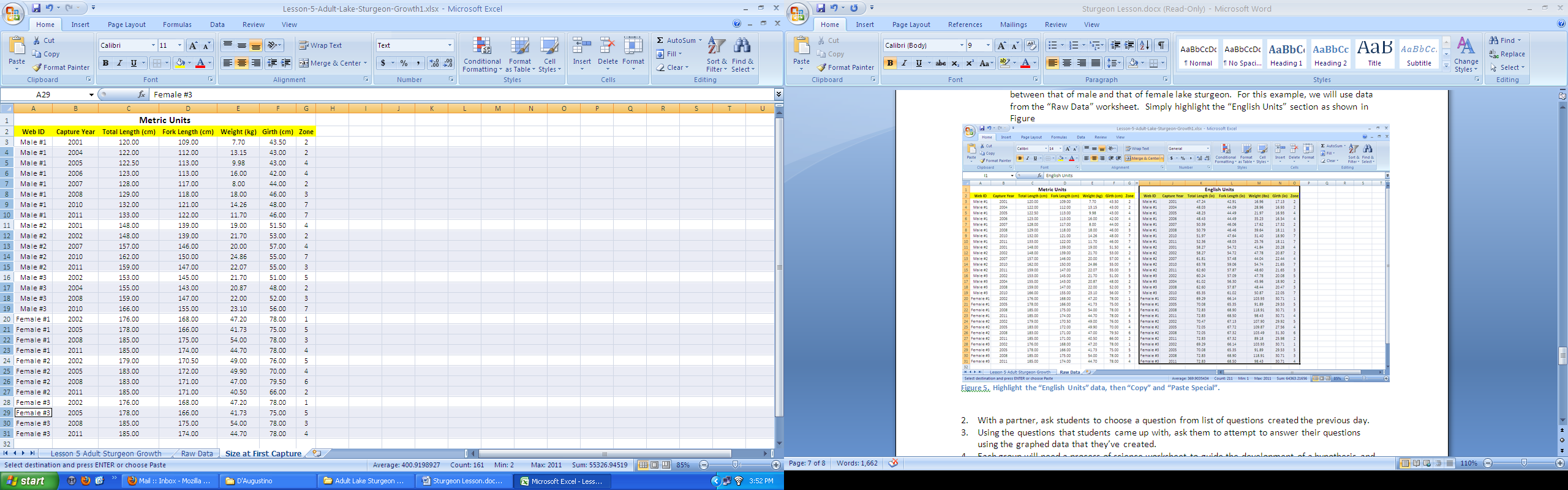


Figure 6. Highlight to delete all rows of data that are not the first capture point for each adult sturgeon.

* + 1. Once you have deleted the extra rows, create two new column names in cell I:2 and J:2. Title them “Average Total Length Male” and Average Total Length Female”. Calculate the average total length for all three males using the formula depicted below. Do the same for the females as well (Figure 7).

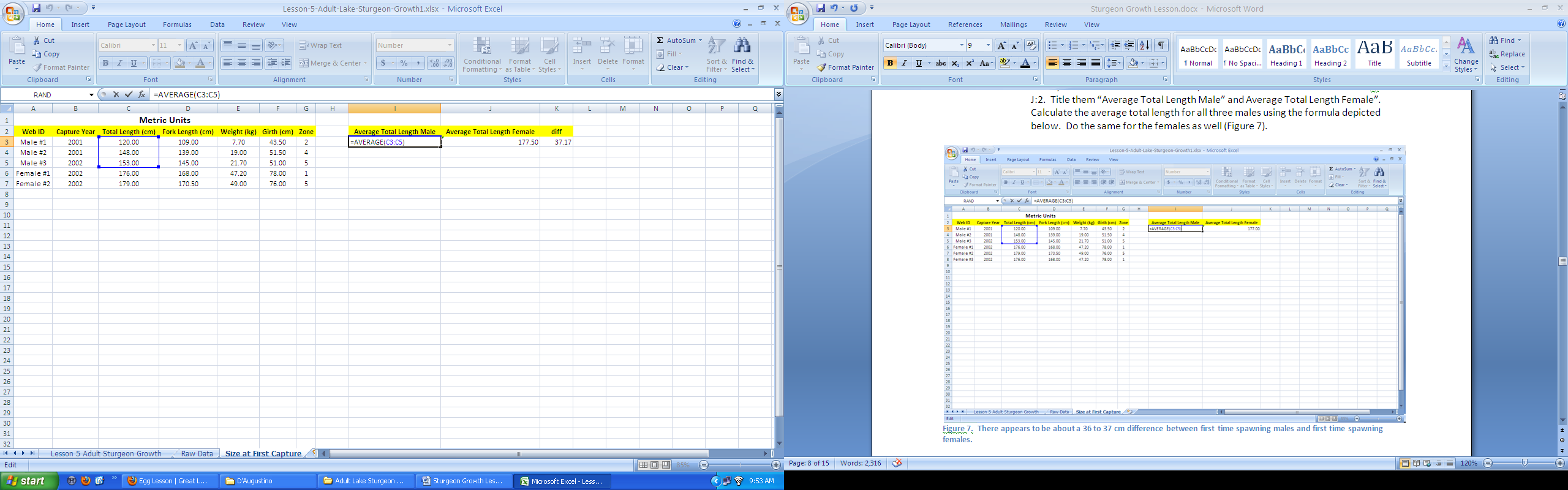


Figure 7. There appears to be about a 36 to 37 cm difference between first time spawning males and first time spawning females. An explanation for the difference may be found in the “Background” section of this lesson…

* + 1. Instruct students to try and provide a biological explanation as to why there appears to be a difference between the sizes of first time spawning males versus first time spawning females. How does this affect their initial hypothesis? For example, if their null hypothesis was that male and female Lake Sturgeon would be similar in size at the first capture event, ask the students why this does not appear to be the case.
  1. For this next example, let’s use a graph to address the hypothesis question: Do male and female Lake Sturgeon appear to grow at the same rate over time?
  2. Copy the “Metric Units” section of the “Raw Data” worksheet and paste it into a new worksheet entitled “Adult Sturgeon Growth” (Figure 8).

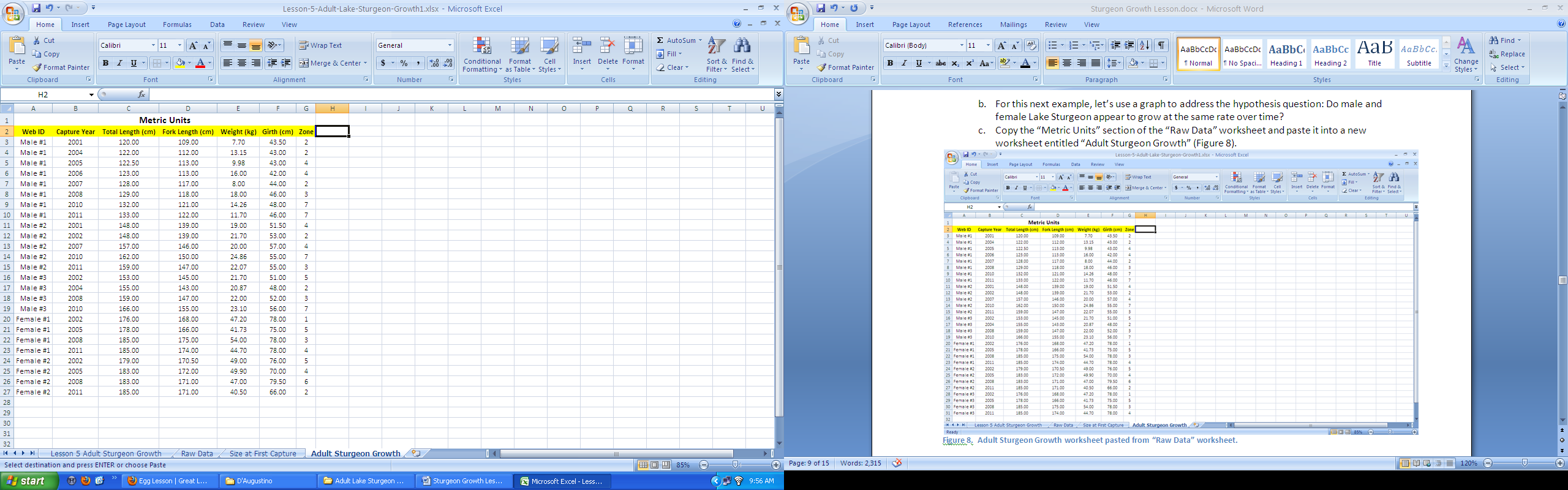


Figure 8. Adult Sturgeon Growth worksheet pasted from “Raw Data” worksheet.

* 1. Click on the “Insert” tab at the top of the Excel page and go to scatter and click on the “Scatter with Smooth Lines” icon (Figure 9). A blank chart page should appear. Right click on the blank chart and click on “Select Data”

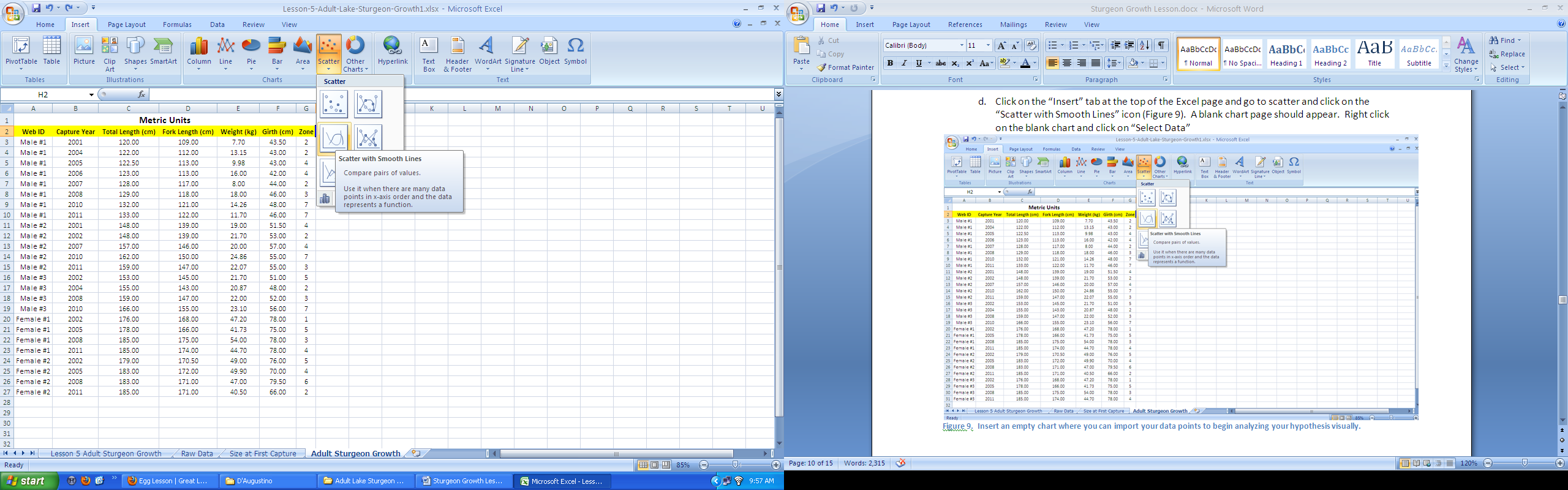


Figure 9. Insert an empty chart where you can import your data points to begin analyzing your hypothesis visually.

* 1. A “Select Data Source” window will appear. Click on the “Add” button and the “Edit Series” window will appear. For the “Series X values”, highlight B3 to B10, these are the years in which Male #1 was captured. Now for the “Series Y values” highlight C3 to C10, this includes the total length that was recorded each year of capture for Male #1 (Figure 10). Label the “Series name” as “Male #1” and press “OK”.

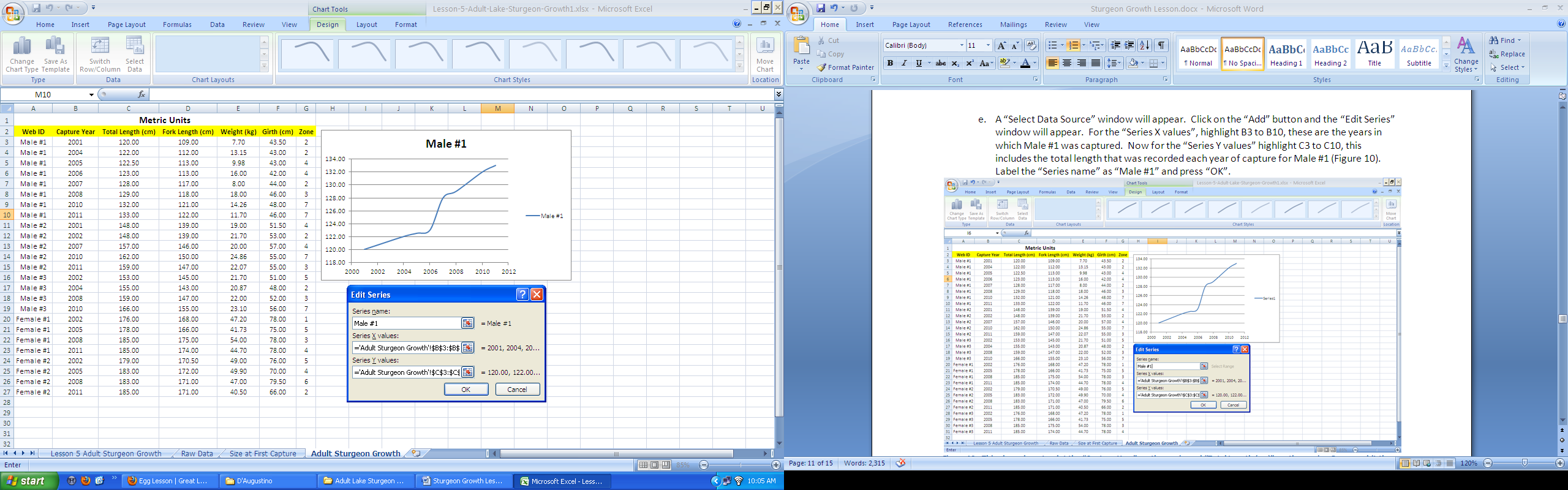


Figure 10. This shows how to plot the “Capture Year” on the x-axis and “Total Length (cm)” on the y-axis. Once you hit the “OK” button in the Edit Series window, the legend name should change from “Series1” to “Male #1”. A title also appears automatically (“Male #1) above the chart, but this will disappear as we add more data.

* 1. After you hit “OK” on the Edit Series window to graph data for Male #1, the “Select Data Source” should reappear. Now add a second set of data points from Male #2 by hitting the “Add” button again. Add the data for Male #2 (B11 to B15, and C11 to C15) in the same manner in which you added the data for Male #1 (Figure 11). You may see your chart change scale or shape, but we will fix that when all of the data is entered for each adult Lake Sturgeon.

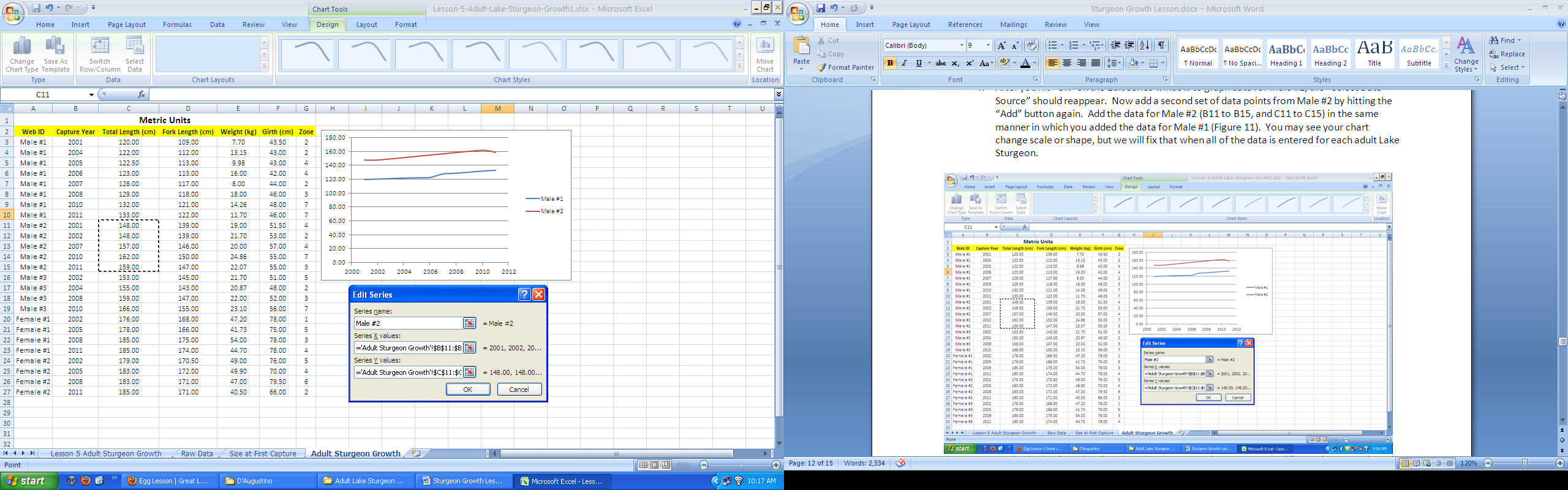


Figure 11. As you plot the data for each Male and Female Lake Sturgeon, keep an eye on the difference between Males and Females. Also, take note on the changes in Total Length (cm) over time.

* 1. Enter the rest of the data for each Male and Female until a smooth line appears for each Lake Sturgeon (Figure 12).

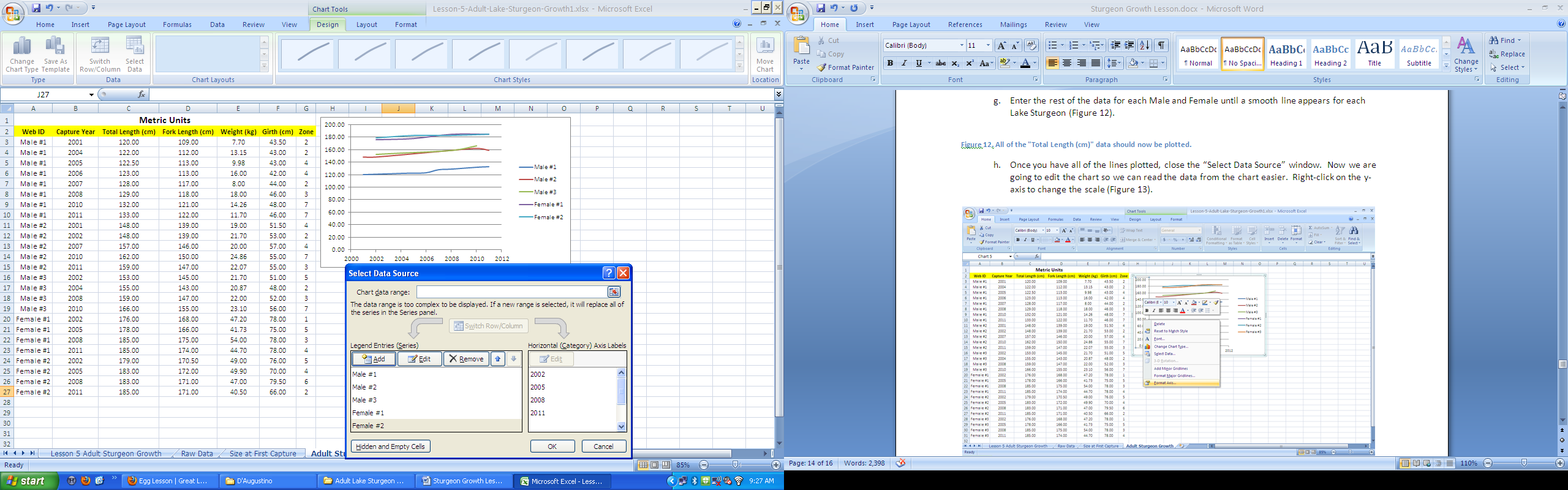


Figure 12. All of the "Total Length (cm)" data should now be plotted.

* 1. Once you have all of the lines plotted, close the “Select Data Source” window. Now we are going to edit the chart so we can read the data from the chart easier. Right-click on the y-axis to change the scale (Figure 13).

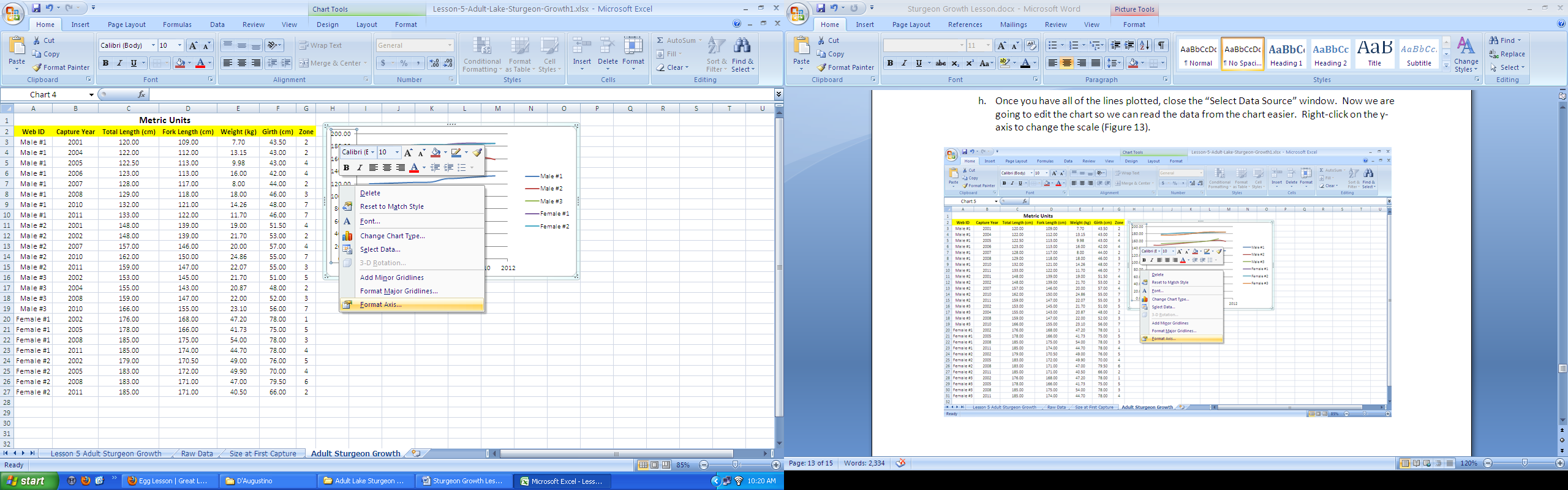


Figure . We format the axis so that the scale removes any empty space on the chart. This makes the graphed data more legible.

* 1. The “Format Axis” window should appear. In the Axis Options section, change the Minimum to 115, and the maximum to 200. This should shrink the scale and remove any empty graph space that isn’t needed.

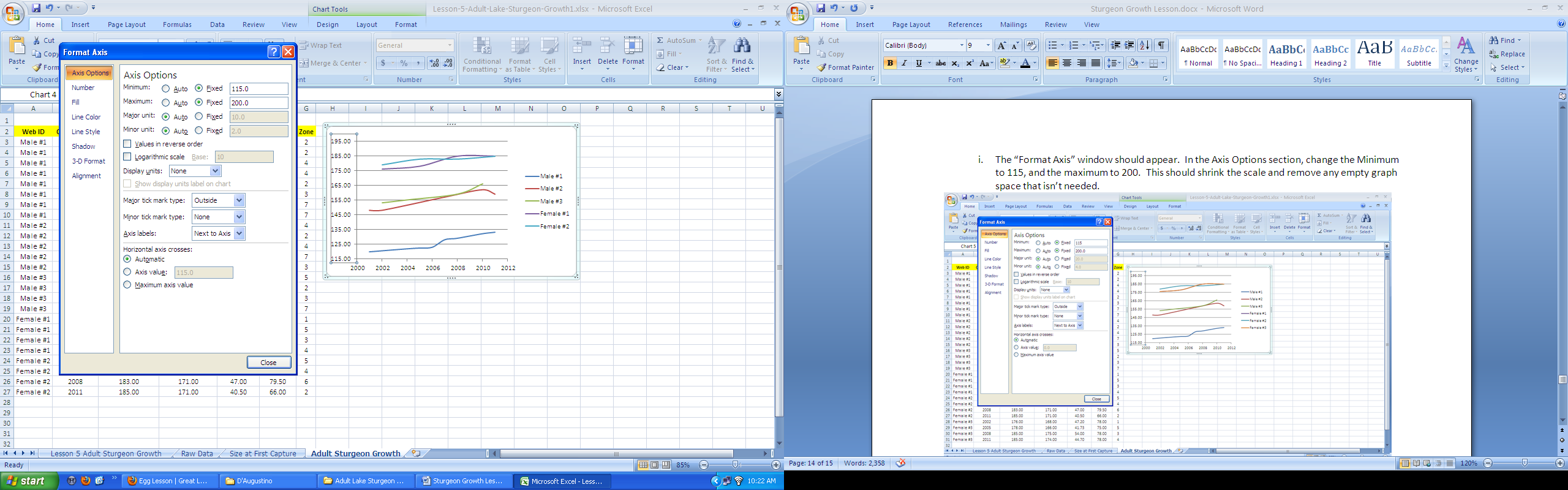


Figure . The Format Axis window allows you to change the scale of your axis and well as change the color of the lines if needed.

1. With a partner, ask students to choose a question from the list of whiteboard questions created the previous day.
2. Using the questions that students came up with, ask them to attempt to answer their questions using the graphed data that they create in Excel on their own. What is shown here in this lesson are only a few examples of data that may be analyzed from the spreadsheets provided.
3. Each group will need a process of science worksheet to guide the development of a hypothesis and prediction for their question.
4. Allow time for students to analyze and compile data for their hypothesis.
5. Students present their initial question, hypothesis, data, additional questions that arose and conclusion for peer review and discussion. The teacher should keep a running list of the additional question that arose during the analysis. This is a good reminder of the circular nature of science.