**Dendroclimatology – post-lab assessment**

***Learning objective 1: Students will be able to interpret linear regression analyses (including R2, p-values, hypothesis testing, slopes/y-intercepts)***

The two figures below represent data from an experiment where fish were prodded to swim for different amounts of time and the investigators measured how far they swam during that time. The two figures represent two different species of fish. Examine the figures and answer questions 1–5.

1. Which figure would you expect to have a higher R2?
   1. The one on the right
   2. **The one on the left**
   3. They should have the same R2
   4. Neither figure has an R2
   5. I don’t know

**Explanation: B is correct because the figure on the right quite clearly has much more variation in the data around the regression then does the figure on the left. Thus, the figure on the left will have a higher R2.**

1. Which statement most accurately describes the figure on the left based on the information you have?
   1. **As fish swim for longer, they also swim farther**
   2. When fish are prodded to swim, they swim as far as they can and then stop
   3. Some fish swim very far even when prodded to swim for a very short time
   4. There is no relationship between the length of time a fish swam and the distance it swam
   5. I don’t know

**Explanation: A is the most correct description of the data in the figure on the right. A clear positive relationship can be seen between the independent variable (time a fish spent swimming) and the dependent variable (how far a fish swam). B is possibly correct, but it is not based on any information students have been given. C more accurately describes the figure on the right. D is clearly incorrect.**

1. What is the independent variable in these figures?
   1. **Amount of time a fish swam**
   2. Number of times a fish was prodded
   3. Distance that a fish swam
   4. Number of fish used in the experiment
   5. I don’t know

**Explanation: A is the independent variable as visible in the figure and also based on the introductory information given. B and D are data that are not represented in this figure. C is the dependent variable.**

1. If you were told that the p-value for the figure on the right was 0.102, what would that mean?
   1. There was a significant relationship between the amount of time a fish swam and the distance it swam
   2. **There was not a significant relationship between the amount of time a fish swam and the distance it swam**
   3. For every second that a fish swims, it travels 0.102 cm greater distance
   4. The regression line explains 10.2 % of the variance in the data
   5. I don’t know

**Explanation: B is correct because a p-value greater than 0.05 indicates a lack of a significant relationship between the two variables. A is the opposite. C is a confusion of the slope and D is a confusion of R2.**

1. If the slope of the regression in the left figure is 0.5 and the intercept is 2.5, about how far would you expect a fish to swim if it swam for 7 seconds?
   1. 4.5 cm
   2. 2.5 cm
   3. **6 cm**
   4. 10 cm
   5. I don’t know

**Explanation: C is correct and requires students to do some very basic math. The equation for the regression is given as y = 0.5\*x + 2.5. Students should be able to calculate that 7 \* 0.5 = 3.5. Added to the intercept, this means a fish would swim 6 cm. A and B are too small, and D is far too large.**

The figure to the right represents data on the relationship between the length of time tadpoles spent in the water and their size at metamorphosis (when they grow arms and crawl on to land). Answer questions 6–8 about the figure.

1. Which of the following is a likely slope for the regression line shown in the figure?
   1. 1.0
   2. 6.4
   3. 0.0004
   4. **0.1**
   5. I don’t know

**Explanation: This seems difficult but is not too hard. Students should be able to see that the regression line is from 20–40 on x-axis (20 days total) and moves 2 g on the y-axis, from 1 g to 3 g. A rise-over-run of 2 over 20 gives a slope of 0.1. All other values are clearly incorrect.**

1. Which is the dependent variable?
   1. Length of the larval period
   2. Number of tadpoles in the experiment
   3. **Size at metamorphosis**
   4. Slope of the regression
   5. I don’t know

**Explanation: C is clearly the dependent variable, or the y-axis. A is the independent variable. B is not related and D is clearly incorrect.**

1. What would it mean if the R2 for the regression was 0.32?
   1. The regression line passes through 32 different data points
   2. **The regression explains 32% of the variation in the data**
   3. The regression explains 0.32% of the variation in the data
   4. For every day that a tadpoles spends in the water, it grows 0.32 grams
   5. I don’t know

**Explanation: B is the correct interpretation of what R2 means. A, C and D are red herrings. C in particular tests if students understand the difference between proportions and percentages. D is an interpretation of the slope.**

Read the following scenario and answer questions 9–11.

“A scientist comes to you looking for an volunteer to help analyze some data. She conducted research in the Amazon studying the number of piranhas that were swimming at different times of day, trying to understand patterns of activity in these predatory fish. The data were collected by taking still photographs and video underwater of piranhas swimming at three locations: 1) at the base of a dock near a village, 2) in the middle of the river, and 3) where a tributary joins the main river. The photos and videos were taken every 2 hours throughout the day.”

***Learning objective 2: Students will use image analysis software to generate data from an image set.***

1. Which of the following are NOT data you could collect from the images or videos?
   1. Average size of piranhas swimming in different locations
   2. Average number of piranhas active at different times of day
   3. Average of size of piranhas swimming in different locations at different times of day
   4. **Average level of hunger of piranhas at different times of day**
   5. I don’t know

**Explanation: D is the correct as it is the only type of data that you could not retrieve from still images or videos. A, B and C could all be obtained easily.**

1. You are using the program ImageJ to measure average length of piranhas seen at different times. A 20 cm bar was placed in the view of the camera for a scale. Which of the following steps is necessary for every picture you analyze.
   1. Adjust the contrast so you can more clearly see every fish
   2. Zooming in and out to see a particular fish better
   3. **Measuring the 20 cm bar for scale**
   4. Exporting the measurements to MS Excel to analyze the data
   5. I don’t know

**Explanation: C is the only step that would have to be done in every single image. A, B and D are useful but are not necessary for every image analyzed.**

***Learning objective 3: Be able to describe the basic procedures and purposes of dendrochronology, including how cores are obtained and prepared for observation, what measurements are routinely taken, how data are treated, and name some scientific questions that can be addressed.***

1. Imagine that you have obtained data on daily temperature and rainfall from a local forest and you are interested in using these data to understand how climate affects tree growth. Which of the following techniques is appropriate when coring a tree?
   1. If you insert the extractor and it indicates that your core may be jammed, keep twisting the increment borer until the core break free
   2. If you drill all the way through the tree, keep twisting the borer to make sure that at least 1 inch pokes through the far side
   3. **Put the increment borer low on the base of the tree to ensure that the core reflects that maximum number of years possible**
   4. Make sure to lay the extractor on the ground while you are coring so you don’t lose it
   5. I don’t know

**Explanation: C is the only aspect of proper coring technique, as demonstrated in the video by Henri Grissino-Mayer. A is wrong because if jamming is indicated you should back the borer out and start over. B is wrong because you should not drill so far through that the threads are no longer engaged with the tree. D is wrong because you might step on the extractor and ruin it.**

1. Now that you have obtained tree cores to go along with your climate data, you are ready collect and analyze some data. Which of the following questions could you NOT answer using the tree cores and climatic data?
2. **Quantify how annual tree diameter growth corresponds with annual tree height growth**
3. Quantify how annual tree diameter growth is effected by annual precipitation
4. Quantify how annual tree diameter growth is effected by mean monthly precipitation
5. Quantify how tree diameter growth is effected by the amount of variation in monthly precipitation
6. I don’t know

**Explanation: A is the only thing that you cannot study since we do not records of tree height. B, C and D require different degrees of data massaging before they could be obtained, but all are measureable.**

1. Which of the following is a correct description of tree growth?
   1. When trees receive little rainfall they produce thicker rings
   2. During stressful years trees grow the most because they need to focus on getting as big as possible
   3. Trees grow at the same rate throughout their lives, regardless of environmental conditions or age
   4. **As trees age, they produce smaller growth rings in terms of thickness**
   5. I don’t know

**Explanation: D is the correct answer because as trees grow and their diameter increases the produce thinner tree rings, even though this means they produce more mass per year. A is incorrect because lack of rainfall reduces growth. B is wrong because trees do not invest in growth during stressful times. C is wrong because growth is strongly determined by age and climatic conditions.**

***Learning objective 4: Interpret a negative exponential growth curve and the concept of residuals.***

The figure to the right represents growth in height (in cm) each year from birth until age 19 for a group of African primates. The black line represents the average growth for the species and the blue and red points represent measurements from two individuals. Use the figure to answer questions 14–16.

1. Which individual would you expect experienced more stress during development?
   1. Individual 1
   2. **Individual 2**
   3. Both were equally stressed
   4. Neither were stressed
   5. I don’t know

**Explanation: B is correct because in any stressful years (when points fall below the species average curve) Individual 2 is farther from the line, indicating it was more stressed than individual 1. For this reason, the two individuals were neither equally stressed or not stressed, so A, C and D are all incorrect.**

1. Which of the following is a correct conclusion from these data?
2. The growth rate of primates is consistent throughout the life of the animal
3. After 19 years, individuals 1 and 2 are most likely the same height
4. We cannot determine anything conclusive about the height of primates from these data
5. **The growth of primates decreases with age**
6. I don’t know

**Explanation: D is correct because it is the only appropriate interpretation of the data. A is incorrect because the growth is clearly not a flat line. B is incorrect because there are at least 7 years when individual 2 grew less than individual 1. C is not correct because the figure clearly shows us concrete data about height.**

1. Which of the following best describes residuals?
   1. It is the distance between the red and blue points in each year
   2. It is the height of the red and blue points above the x-axis
   3. **It is the distance between the red or blue points and the black line**
   4. It is the distance between the red and blue points from the y-axis
   5. I don’t know

**Explanation: C is the correct description of residuals. A is the difference in growth between individuals each year. B is the amount that each grew in each year. D is the age of individuals in a given year.**

1. In general, image analysis refers to:
2. Determining the meaning of images
3. Using software like Photoshop to alter images
4. Producing quality graphs and figures that describe analysis of scientific information
5. **Obtaining data from images**
6. I don’t know
7. It is clear to me that mathematics and statistics are a critical part of the scientific process for biologists.
8. Strongly disagree
9. Disagree
10. Agree
11. Strongly agree
12. I would have been able to analyze and quantify variation in ant morphology or movement without mathematics and statistics.
13. Strongly disagree
14. Disagree
15. Agree
16. Strongly agree
17. Learning about statistics was more interesting as part of the leafcutter ant lab than it would have been otherwise.
18. Strongly disagree
19. Disagree
20. Agree
21. Strongly agree
22. Learning about statistics was more interesting because of the background information and videos about ants.
23. Strongly disagree
24. Disagree
25. Agree
26. Strongly agree
27. In general, I am interested to learn to use mathematics and statistics in biology.
28. Strongly disagree
29. Disagree
30. Agree
31. Strongly agree
32. I feel confident that I can learn mathematics and statistics.
33. Strongly disagree
34. Disagree
35. Agree
36. Strongly agree
37. I am more interested to learn to use mathematics and statistics in biology after completing the leafcutter ant image analysis lab.
38. Strongly disagree
39. Disagree
40. Agree
41. Strongly agree