Lizards, iguanas, and snakes! Oh my!
(adapted by K.Kaczynski from Data Nuggets)

Featured scientists: Heather Bateman & Mélanie Banville from Arizona State University

Research Background:

Throughout history people have settled mainly along rivers and streams. Easy access to water provides resources to support many people living in one area. In the United States today, people have settled along 70% of rivers.


Scientist Mélanie searching for reptiles in the Central Arizona-Phoenix LTER.

Today, rivers are very different from what they were like before people settled near them. The land surrounding these rivers, called **riparian habitats**, has been transformed into land for farming, businesses, or housing for people. This **urbanization** has caused the loss of green spaces that provide valuable services, such as water filtration, species diversity, and a connection to nature for people living in cities. Today, people are trying to restore green spaces along the river to bring back these services. Restoration of disturbed riparian habitats will hopefully bring back native species and all the other benefits these habitats provide.

Scientists Heather and Mélanie are researchers with the Central Arizona-Phoenix Long-Term Ecological Research (CAP LTER) project. They want to know how restoration will affect animals living near rivers. They are particularly interested in reptiles, such as lizards. Reptiles play important roles in riparian habitats. Reptiles help energy flow and nutrient cycling. This means that if reptiles live in restored riparian habitats, they could increase the long-term health of those habitats. Reptiles can also offer clues about the condition of an ecosystem. Areas where reptiles are found are usually in better condition than areas where reptiles do not live.

Heather and Mélanie wanted to look at how disturbances in riparian habitats affected reptiles. They wanted to know if reptile **abundance** (number of individuals) and **diversity** (number of species) would be different in areas that were more developed. Some reptile species may be sensitive to urbanization, but if these habitats are restored their diversity and abundance might increase or return to pre-urbanization levels. The scientists collected data along the Salt River in Arizona.

They had three sites: 1) a non-urban site, 2) an urban disturbed site, and 3) an urban rehabilitated site. They counted reptiles that they saw during a survey. At each site, they searched 21 plots that were 10 meters wide and 20 meters long. The sites were located along 7 transects, or paths measured out to collect data. Transects were laid out along the riparian habitat of the stream and there were 3 plots per transect. Each plot was surveyed 5 times. They searched for animals on the ground, under rocks, and in trees and shrubs.

***Scientific Question*:** How do urbanization and riparian rehabilitation impact reptile diversity and abundance?

1. ***What is the hypothesis?*** Find the hypothesis in the Research Background and write it below. Remember, a hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

2. ***What do you predict?*** Given the hypothesis, what are your predictions for lizard abundance and diversity at the three sites?

Scientific Data:

Here are the data the researchers collected. You will also find the data in the "lizard diversity.xlsx" file in the google drive folder.

Reptiles	Non-Urban	Urban Rehabilitated	Urban
Tiger Whiptail Lizard	9	12	0
Common Side-blotched Lizard	8	15	4
Zebra-tailed Lizard	4	2	2
Desert Spiny Lizard	10	0	0
Ornate Tree Lizard	5	7	0
Desert Iguana	2	0	0
Long-tailed Brush Lizard	3	0	0
Western Diamond-backed Rattlesnake	1	0	0

3. **What data will you graph to answer the question?**

Remember, the independent variable is the variable you manipulate, and this variable goes on the x axis. The dependent variable is the variable you measure the outcome of, and this goes on your y axis.

Independent variable	
Dependent variable	


The Common Side-blotched Lizard

Take out a piece of paper and sketch a graph of the abundance data at each of the stream study sites. What type of graph is best to display these types of data? **Take a picture of your graph and paste it below.**

Now open the excel file in either Excel or Google sheets and graph the abundance data at each of the stream study sites. Hint, *you are going to want a graph that shows the three stream site variables on the X axis*. *You are likely going to have to play around in Excel to get this to happen as it's probably not the default. Also, remember what things need to be on a graph!*

4. *Paste your graph (or a large screenshot) from Excel below*:

5. *Describe the data (this is akin to what you would write in a Results section):*

Tell me what the graph is showing. NO INTERPRETATION HERE, just report the data in the graph. Be descriptive here. I am looking for a thorough explanation of the data.

6. *Interpret the data (this is akin to what you would write in a Discussion section):*

Now tell me why you think you see the trends you see in the graph. Connect the data back to what you learned about the impact of urbanization on riparian habitats.

You have just finished examining the differences in lizard abundance among the three sites. While abundance is a fantastic way to measure differences, another way is to look at the **overall diversity**.

There are a couple different ways we can examine diversity. The first is to look at **species richness.** Species richness is the number of different species present in an area. The more species present in a sample the 'richer' the area.

7. When would it be appropriate to use species richness to compare the biodiversity between or among sites?

8. Why might species richness not be the best metric to use? What other information might be important when thinking about overall diversity?

9. Open the Excel File again and write down the species richness for each of the three sites in the table below.

Excel Tip: One easy way to calculate this is to use the '=countif' function. To figure out the species richness of the Nonurban site, click in cell B10. Type '=countif(B2:B9, ">0") and hit enter. You should have gotten 8. What this is telling excel to do is to count the number of times the abundance of the species is greater than 0 (this means that the species was present at the site). Now do this for the two other sites.

Site	Species Richness
Non-urban	
Urban Rehabilitated	
Urban	

<u>Shannon's Diversity Index</u>

Another way to examine diversity is to use a ***diversity index***. There are a number of different biodiversity indices, all used for slightly different purposes. The most common diversity index is the **Shannon's diversity index**. This index utilizes the species richness, but also takes into account the proportion or abundance of each species (ie. a measure of the overall evenness) when calculating the overall diversity.

$$H = \sum_{i=1}^{s} -(P_i * \ln P_i)$$

Where, H = Shannon's Diversity Index, P_i = fraction of the entire population made up of species *i*, S = number of species encountered, and the sum from species 1 to species S.

Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon index increases as both the richness and the evenness of the community increase. The fact that the index incorporates both components of biodiversity can be seen as both a strength and a weakness. It is a strength because it provides a simple, synthetic summary, but it is a weakness because it makes it difficult to compare communities that differ greatly in richness. The most important source of error in this index is failing to include all species from the community in the sample.

Go back to the Excel File and click on the tab *Diversity Indices*. You will see three pre-made tables, one for each stream site. Using the Raw Data, fill in the tables so you can calculate the Shannon Diversity index for each site, to ultimately compare the diversity among sites. I've broken down the Shannon diversity Index calculation into some smaller components to make it easier for you.

hint: for the final part of the equation, in column E, you will want to multiply each row by -1 (this is denoted by the negative sign in the equation), so you'll end up with a positive H value for each row. To get the overall H valle, you will need to sum the entire column. .

10. Fill in the table below with the diversity index values for each site.

Site	**Shannon Diversity Index (H)**
Non-urban	
Urban Rehabilitated	
Urban	

11. Which site has the highest diversity? Which site has the lowest diversity?

12. Using all the data analysis techniques you just did (graphing, calculating species richness and the Shannon Diversity Index) **did the data support Heather and Mélanie's hypothesis**? Use evidence to explain why or why not. If you feel the data was inconclusive, explain why.

13. *Your next step as a scientist:* Science is an ongoing process. What new question(s) should be investigated to build on Heather and Mélanie's research? What future data should be collected to answer your question(s)?
