

A scenic landscape featuring a wide, muddy-brown river winding through a valley. The foreground is filled with tall, dry grasses and some green shrubs. In the middle ground, there is a dense line of trees with vibrant yellow and orange autumn foliage. In the background, a range of rugged, grey mountains stretches across the horizon under a clear blue sky.

# Experimental design

Developing and testing a hypothesis

BEMP workshop 2023



# Why is experimental design important?

A scientist wearing a white visor, glasses, a dark blue jacket, and khaki pants is crouching in a grassy field. They are holding a blue plastic container and looking down at a white quadrat on the ground. The background is a lush green field with some purple flowers in the foreground.

A successful experiment:

- Objective and controlled
- Precise
- Draws specific conclusions

# The Scientific Method

- **Observation**
- Question
- Hypothesis
- Experiment and data collection
- Data analysis
- Conclusion





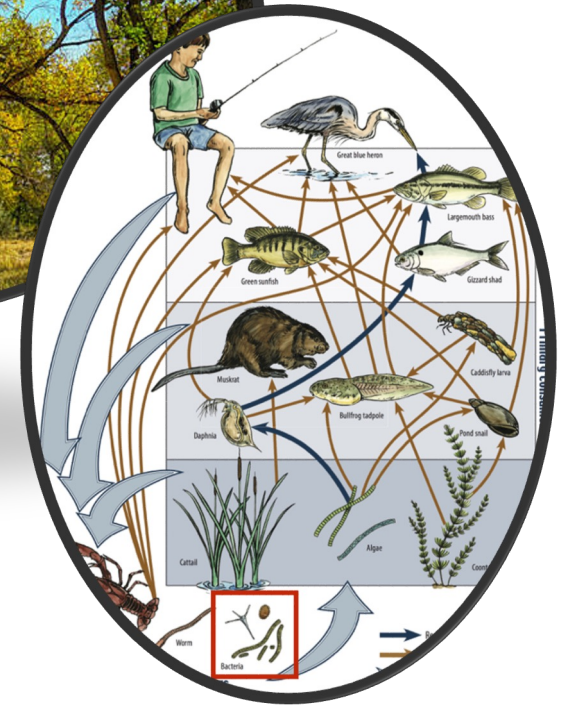
# The Middle Rio Grande Basin





## Define your system:

- A location
- A species
- A food web





The background of the slide is a photograph of a stack of books. The books are of various colors, including red, brown, and white. The pages are visible, and the books are stacked in a slightly messy but organized manner. A semi-transparent white rectangular box is overlaid on the left side of the image, containing the title and a list of bullet points.

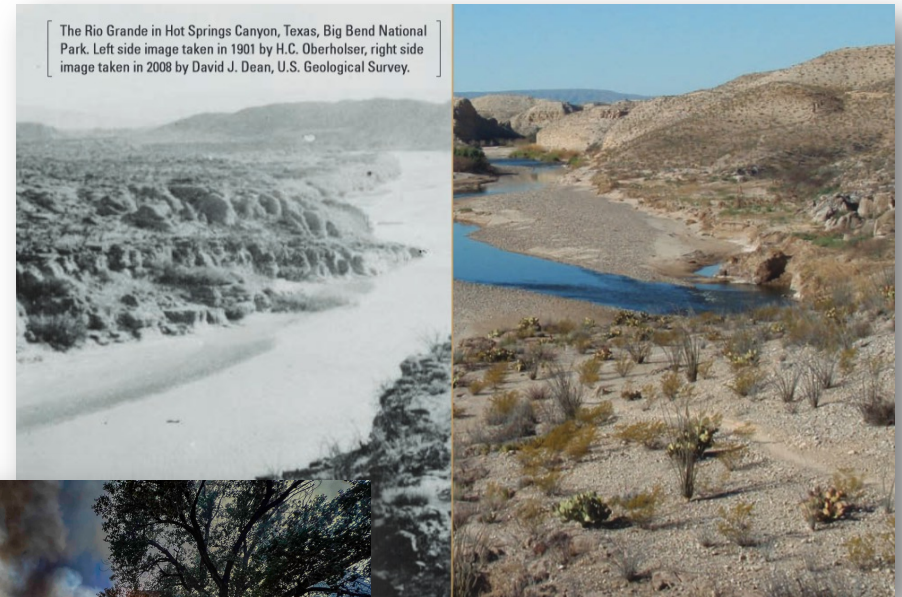
# Background Research

- Google Scholar – Search the literature
  - What's the gap in our knowledge?
  - Are there new techniques?
- Data from previous projects
- Consult available experts



# What's going on in your study system?

- Historically?
- Modern changes?
- What do you find interesting?





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# Narrow your focus

How much grass do grasshoppers actually eat?

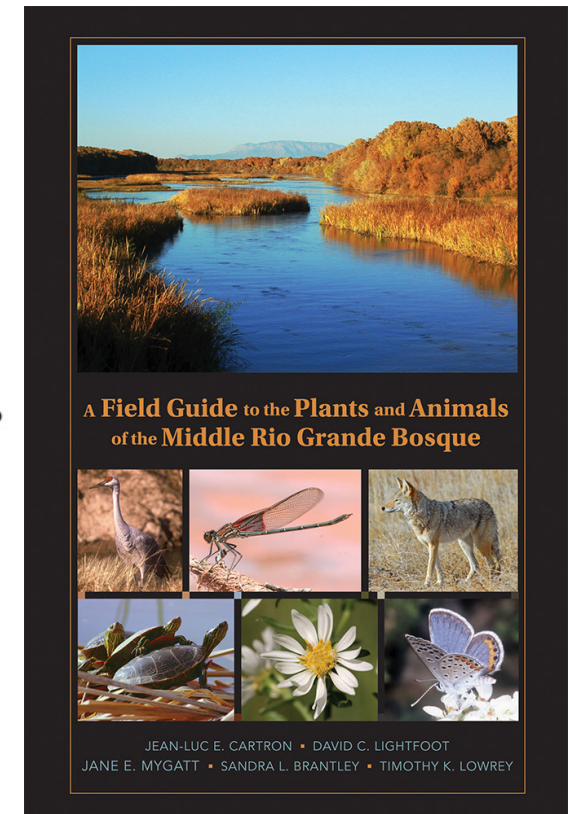
Do all ants that live in the same nest eat the same thing?

How much trash do coyotes in the Bosque eat?

Do the two turtle species in the Bosque School pond compete for the same resources?

Which Bosque tree species do porcupines prefer to eat?

~2 Hours of field time



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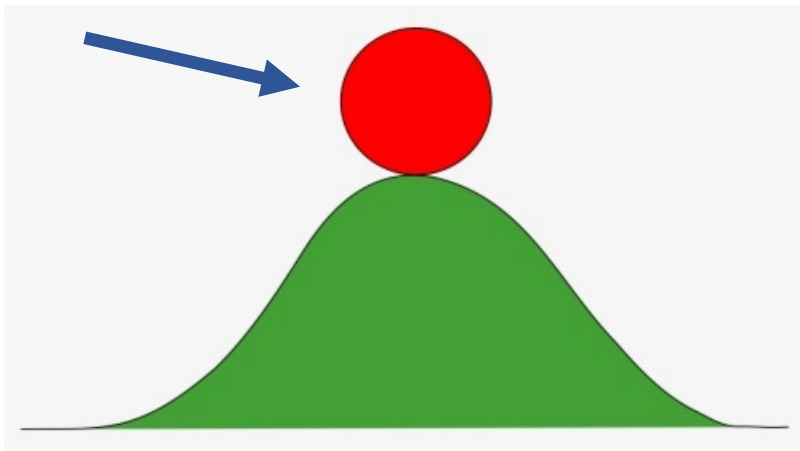




# Make a Prediction (educated guess)

Must specify the direction and/or type of change  
(don't just say something will change)

Must be Testable (null hypothesis=no relationship)





I eat roots, stems, leaves, and seeds from a wide variety of plants

What do you predict the hispid cotton rats will eat after the fire?



Only small grasses and forbs (flowers) have grown back quickly



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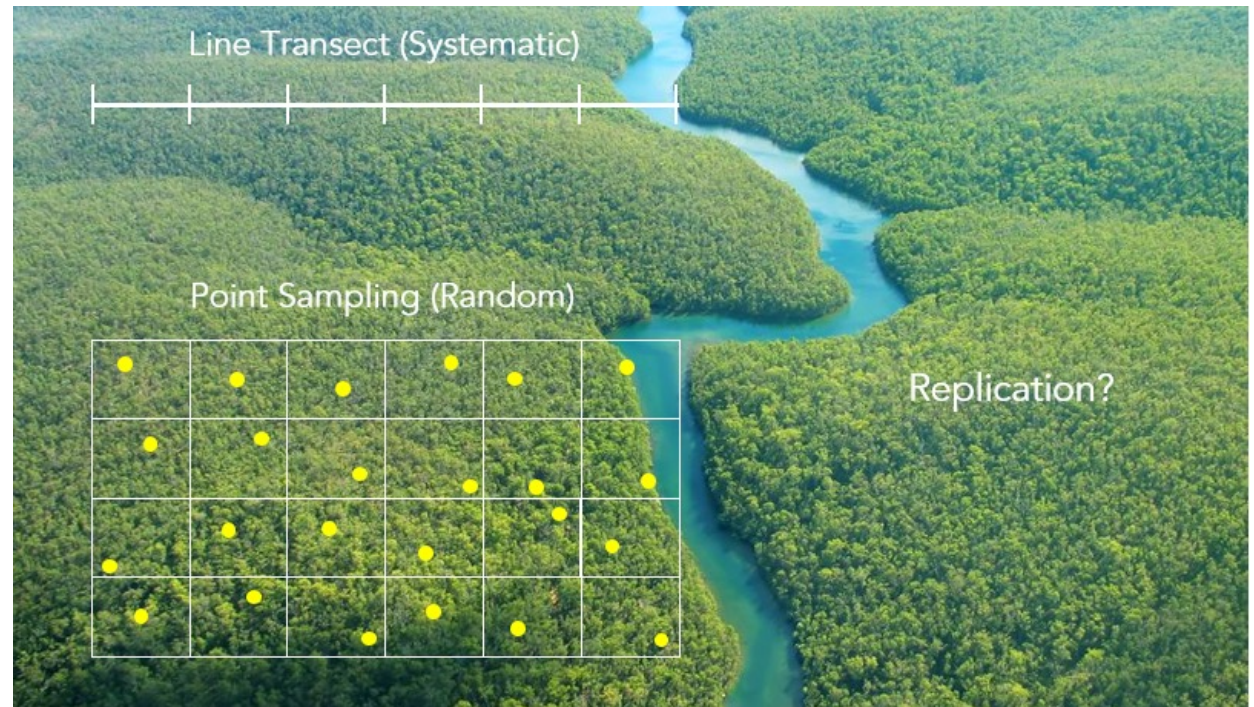
# Experiment





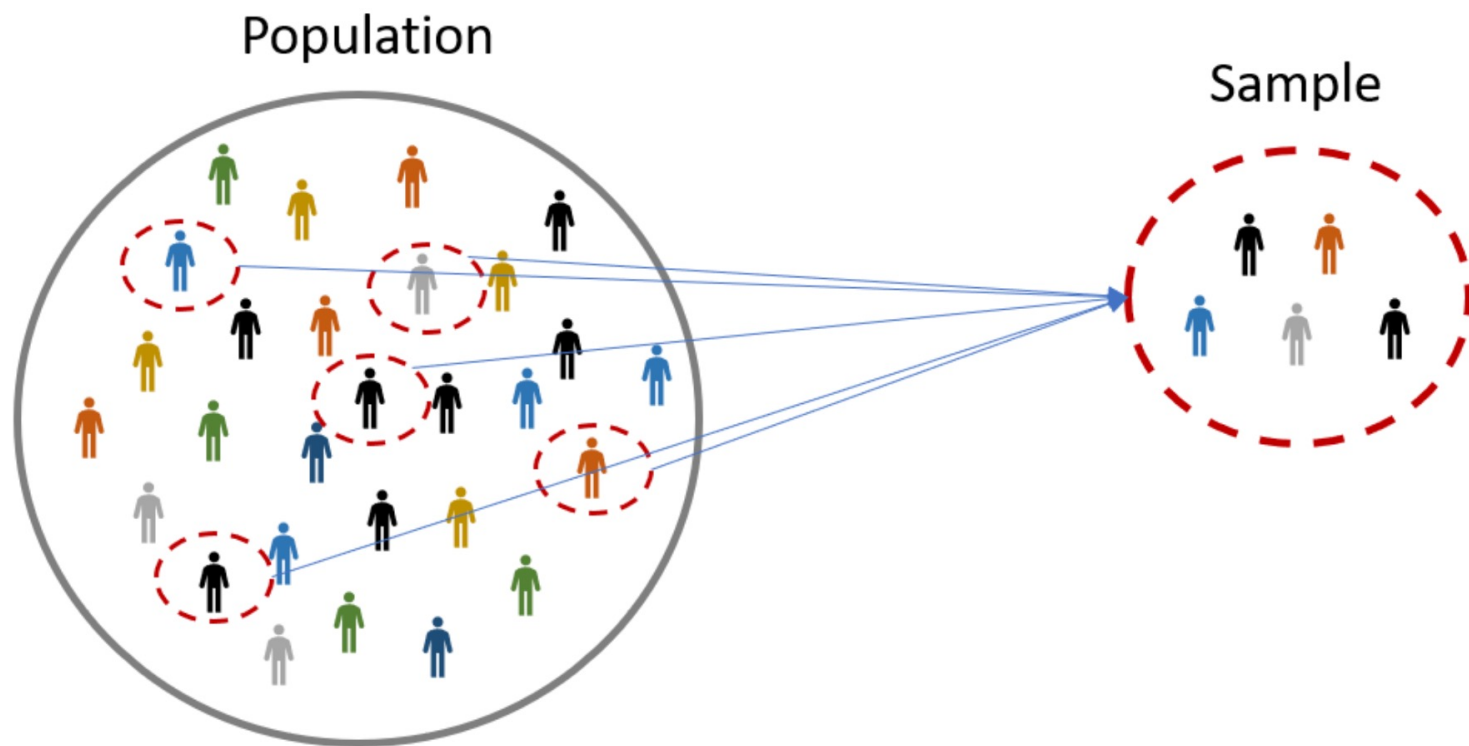
# Collection

- Sample types?
  - 15/20 proteins
  - 10 plants
  - Mix of both
- Sampling method
  - Transect
  - Random
  - Other?



Needs to be replicable, write everything down

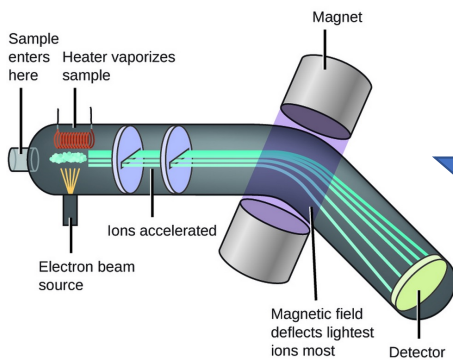
What should you think about when sampling?





# Sample Preparation and Analysis

- Dry samples
- Isolate desired compounds
- Isotopic analysis using mass spectrometer



Get Data!



# The Scientific Method

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- Conclusion





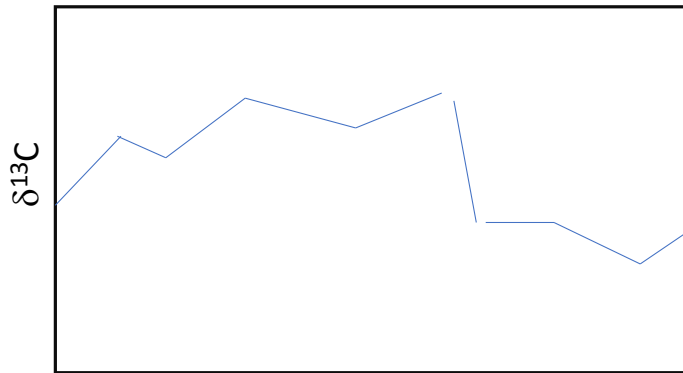
# Data analysis and results



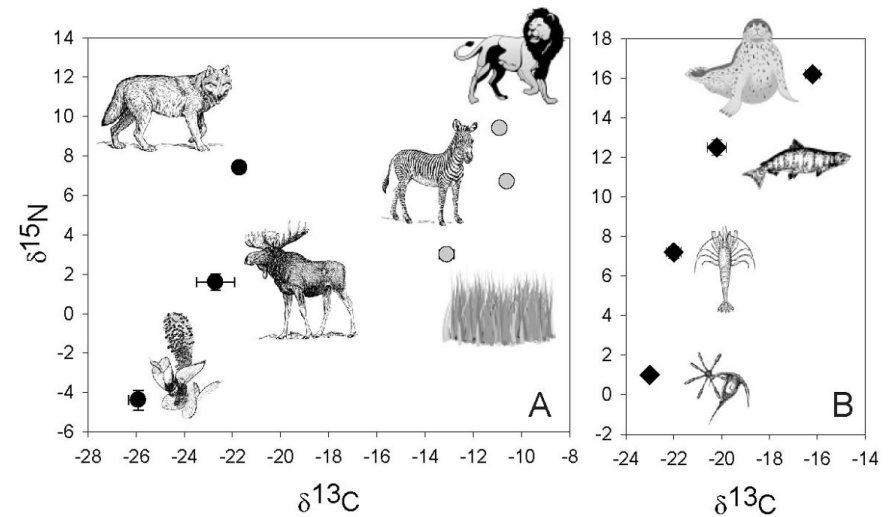
Sample ID	Plant	Collection Date	d13C	d15N	Location
Algae#2 BP 11/28	algae	11/28/2018	-23.7	1.5	Bosque School Pond
BP Algae #1 11/28	algae	11/28/2018	-16.4	-0.7	Bosque School Pond
BP Algae #3 11/28	algae	11/28/2018	-27.8	0.2	Bosque School Pond
Chokecherry - A	Chokecherry	Fall 2020	-26.4	2.4	Sandia Mountains
CWB2	Cottonwood	Fall 2018	-29.0	-3.5	Albuquerque Bosque
#1 Cotton Wood Buds	Cottonwood	9/24/2019	-31.8	-3.5	Bosque School
Cottonwood Bark	Cottonwood	9/24/2019	-29.9	-3.5	Bosque School
CW1	Coyote Willow	Fall 2018	-30.2	-2.9	Albuquerque Bosque
CWBU1	Coyote Willow	Fall 2018	-31.4	-2.7	Albuquerque Bosque
CW2	Coyote Willow	Fall 2018	-29.5	-4.1	Albuquerque Bosque
Coyote Willow Leaves	Coyote Willow	9/24/2019	-30.3	-0.9	Bosque School

# Preview of Saturday

Sample ID	Plant	Collection Date	d13C	d15N	Location
Algae#2 BP 11/28	algae	11/28/2018	-23.7	1.5	Bosque School Pond
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Distance from river (m)



Ben-David et al, 2012



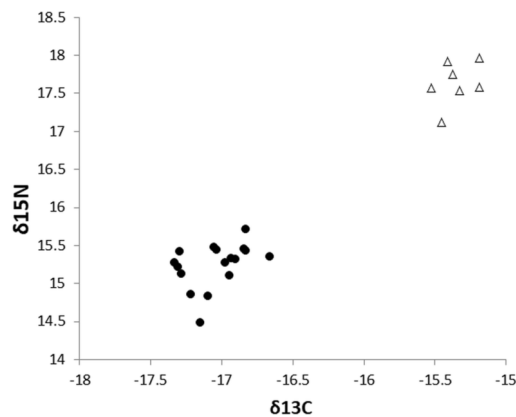
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# Present data – Draw conclusions

- Do the results support our hypothesis?
- If not, what might help explain the results?
- Does this fill a gap in knowledge?
- How might this inform future research?





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## Stable Isotope Workshop: *Experimental Design Worksheet*

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### Instructions: Fill out the worksheet with your group

1. Define the research question(s) for your project

- Must be In the bosque
- Within the constraints of the workshop

2. List specific hypothesis/hypotheses you will test to answer those questions

- Specific, testable, related to your question, relevant

3. Sketch out an experimental design that will allow you to test those hypotheses

- Come up with a plan for your experiment, think about your variables, and how to obtain accurate results which can answer your hypothesis

4. What isotopes will you analyze to test these hypotheses (think about which isotopes give you what ecological inferences).

Carbon, Nitrogen, Hydrogen, Oxygen?

5. List specifics on:

a. What you will collect? (e.g. – seeds, leaves, fruit)

b. How many samples will you collect? 15-20 proteins, 10 plants

c. How will you conduct your sampling (e.g. – transect, random, etc.)

d. How will you transport materials from field to lab for stable isotope analysis? Create a comprehensive supply list here.

Falcon tubes, coin envelopes, MCF tubes, tweezers, Tupperware

# Final thoughts

- Take detailed notes of your experiment
- How will you conduct your sampling?
- What will you collect and how many?
- What tools will you need to collect them?
- How much time will it take?
- Enjoy learning new stuff!

