Intro to Assessing Biodiversity: Bivalves of the Rio Grande Area

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Learning Objectives:
In this module students will:

- Calculate species richness of an area
- Familiarize themselves with the species identification process and identify selected molluscs of the Rio Grande
- Recognize biodiversity collections as an identification resource and historical data source
- Learn about the importance of specimen labels, how to read a specimen label, and how to extract information from it
- Use distribution data from museum specimens to infer biogeographic patterns
- Describe how humans impact mollusc communities

Importance
No organism lives in isolation, so viewing a group of closely-related organisms allows us to infer more information about an area than just looking at one species. One way to assess biodiversity is by looking at the species richness of communities. Using species richness, we are able to compare the biodiversity of different sites and generate questions about why one area may have higher biodiversity than another. This lab will focus on the community of molluscs in the Rio Grande, and you will be using museum data to primarily assess historical biodiversity data to draw inferences and conclusions.

Guiding Questions
- Why is learning how to identify biological organisms important?
- What can we conclude about species richness by mapping biodiversity data?
- How have humans impacted biological communities?

Vocabulary
1. Biodiversity – the variety of life in an area
2. Binomial Nomenclature – biological system of naming organisms with two names (in Latin). The first word is the genus (always capitalize the first letter); the second word is the specific epithet (all lowercase). The two words taken together are the species name. Names are italicized when typed or underlined when writing by hand
3. Bivalve – a mollusc in the class Bivalvia that has a hard external shell with a hinge surrounding a soft-bodied invertebrate. These organisms breathe and gather food through their gills (filter feeders). They occur in both marine and freshwater environments. Examples include clams, oysters, mussels, and scallops.
4. Community Ecology – the field of study describing interacting groups of organisms in the same area. This can be multiple species and/or multiple populations of the same species. This area of study also addresses environmental factors in which the organisms live.
5. *Invasive species* – an organism that is not native to a given area and that causes harm to native species, property, or the economy.

6. *Landmark* – an object or feature (of any town or landscape) that can be easily seen and recognized; used to help someone establish their location.

7. *Latitude and Longitude* – coordinate system by which the location of any place on the surface of the Earth can be determined and described. Latitudes are horizontal lines that measure distance from north or south of the equator. Longitudes are vertical lines that measure distance to the east or west of the prime meridian. Latitude and longitude can be described in degrees, minutes, seconds, or in decimal degrees.

8. *Locality Data* – information about where an organism is (was) found. Usually includes GPS coordinates and can also include landmarks, description of environment, country/state/county/city/street addresses, and maps.

9. *Map* – a diagrammatic or symbolic depiction of an area or concept depicting features of interest, such as landmarks, and their relationship to one another

10. *Native species* – an organism that is indigenous to a region

11. *Mollusc (can also be spelled “Mollusk”)* – invertebrate animals of the phylum Mollusca. Most live in marine environments, but also occur in freshwater and on land. Examples include snails, clams, squid, oysters, slugs, and octopi.

12. *Species Richness* – the variety of species in an area. Calculated by counting the number of species present in a defined area. This can include all species or a select group of related organisms.

**Introduction/ Background**

**PART 1: BIODIVERSITY AND SPECIES RICHNESS**

There are many ways to quantify the biodiversity of an area. One of the easiest ways is to calculate species richness. It’s basic: just count the number of species (from your taxon of interest). This simple measure can provide a lot of information, as well as a jumping-off point for future research. For example, if you found that the westside of El Paso had 27 species of snails, and the eastside of El Paso had 3 species of snails, you can confidently say that the westside has higher species richness than the eastside assuming that your sampling efforts are equal and thorough (in snails; this is a fictional example). You can then determine if any of the species occur in both areas and generate questions about why the variety of organisms is so much higher on the westside.

**PART 2: THE RIO GRANDE**

The Rio Grande starts from its headwaters in Colorado and travels through the Chihuahuan Desert, where it supplies water for natural ecosystems, agricultural purposes, industrial needs, and domestic uses. It is one of the most endangered river systems in the world, and it does not flow for large parts of the year due, in part, to the megadrought and human extraction of groundwater and surface water. Lack of flow has drastically lowered the biodiversity of the river ecosystem including the loss of many fishes, amphibians, and invertebrates. In addition, man-made alterations of the river including dams, such as Elephant Butte, have resulted in managed flow for irrigation needs and flood control. Furthermore, many cities take water for domestic purposes and return treated effluent to the river. Finally, chemicals from run-off due to storms also decrease the water quality. All of these factors contribute to loss of biodiversity.
PART 3: BIODIVERSITY COLLECTIONS AND SPECIMEN TAGS

Museums are a place where specimens of the past can be viewed and studied. Some museums do not have public exhibits but still collect and house specimens and data that are used by researchers. For example, the UTEP Biodiversity Collections, located in the Biology Building, is a regional museum collection that focuses on organisms of the southwestern United States and Mexico. Occasionally, the UTEP Biodiversity Collections makes museum displays for the public, but the majority of specimens (an estimated 600,000 individual specimens including plants, insects, molluscs, reptiles, mammals, fossils, and more) are stored and available to researchers for study. The locations and dates of collection, along with their identifications, are published in ARCTOS, a free online portal: https://arctos.database.museum/SpecimenSearch.cfm. Museums (including the UTEP Biodiversity Collections) are a valuable source of data in the field of environmental science and are aggregated through larger data portals. The biodiversity data used in this lab was downloaded from the Global Biodiversity Information Facility database (GBIF)

When locality and collection date of specimens are added to a map, the value of collecting data through space and time becomes apparent. Researchers can ask many questions related to historical and present-day distributions of particular species, along with other associated data such as size and diet. For example, they can investigate potential routes that invasive species took to get from one country to another or assess whether species that were found in Texas in the 1960s still occupy the same habitats. The data can also be used to make predictions about where species might occur in the future with climate change or other environmental alterations.

Data associated with museum specimens can be used in a multitude of ways, but biases occur in every dataset (recruiting volunteers for a medical trial, conducting a phone survey, etc.), and environmental science data is not immune to this. Therefore, learning about how a dataset was generated is essential to understanding the limitations of the conclusions that can be drawn. Most museum data have been generated by researchers archiving samples in the process of doing their research and are biased toward a specific research interest. Therefore, the absence of a data point in a particular locality does not necessarily mean a species does not or has not occur(ed) there. Biologists in the field are more likely to document something rare (such as the threatened Texas Hornshell) than something common (such as the invasive Asian Clam). In addition, place-based bias exists in biological observations. For example, many specimens are found along roadways simply because people travel along them. Certain areas may have no biological data due to privacy issues (in El Paso, most data for Ft. Bliss is not publicly available because it is a military installation). Some of these limitations to the dataset are mitigated by doing further research and using several sources of data, such as present day observations using application-based tools such as iNaturalist. Regardless, acknowledging bias will make you a better scientist and citizen.

In this lab, you will be working with museum specimens from the UTEP Biodiversity Collections and learning how to use this resource for identification. Every museum specimen has a “tag.” This is normally a piece of paper tied to the actual specimen, but can also be taped/glued to the outside of a jar. Some museum specimens have their own tag; some were collected in a group and have a tag that only identifies the place of collection. Most museum specimen tags will have:

- Scientific (Latin) name of the specimen
- Location of where specimen was collected (GPS coordinates)
- Name of the collection/museum
- Number indicating what specimen is accessioned into the collections (often letters and numbers, such as UTEP1301)
Some museum specimen tags will have:
- Name of the collector
- Specific locality descriptors (Country, state, county, river, nearby landmarks, elevation, depth, associated organisms)
- Sex of the organism
- Brief notes (organism collected alive/deceased, weather at time of collection, etc.)
- Higher taxonomy (such as class, order, family)

The entirety of information about every organism is not expected to appear on the museum specimen tag. It should provide basic information, with enough detail to allow future researchers to look up the specimen to gain more insight.

PART 4: IDENTIFYING ORGANISMS

The ability to identify organisms is essential to our survival. As a child, you probably learned the difference between a tree, a bush, a bird, a fish, a turtle, and a snake. You were already using identification techniques. Historically, the ability to identify organisms that could be harmful was of great importance (don’t eat that berry, that snake is venomous, etc.). Currently, we still need the basic knowledge of how to identify an organism (even if it’s not a life-or-death scenario). If you were comparing communities to see if an invasive species has shown up in an area, can you tell the difference between similar-looking native species? If you were sampling molluscs, how would you know which ones were endangered/protected?

All characteristics of an organism can help with identification (behavior, habitat, distribution, DNA, morphology, etc.). Identification starts with whatever existing knowledge you have on hand to determine what group you may be looking at. For instance, you may recognize a bug that has six legs as an insect (Class: Insecta). When you are first learning, your identifications will often start at a higher classification rank, but as you recognize more traits and learn more information about a group, you will be able to further classify it (i.e., you may recognize that an insect has very colorful wings and decide it is a butterfly (Order: Lepidoptera)). Using a variety of resources, such as field guides, dichotomous keys, online search tools, and museum specimens, you’ll be able to eliminate possible choices and use distinguishing characteristics to make a more confident identification. This process is slow at first but will become faster as you become more familiar with a particular taxonomic group.

If you were hired to see if construction of a new bridge would affect local invertebrates, you would not have the time or resources to get DNA from every organism in the vicinity. You would rely on your own knowledge of identification, plus other resources, to help you determine the range and vulnerability of each species. One person can never have the knowledge to identify every organism in the world (or even in one city), but you will learn how to identify key characteristics and learn how to use tools that will aid in your ability to identify animals.

As a reminder, when we identify an animal, we use binomial nomenclature for every organism on Earth. For example, humans are *Homo sapiens*. This formatting is important to quickly identify that someone is talking about a species. The first word is the genus, and the second word is the specific epithet (or species name). When using the Latin name of an organism, remember that the genus should always be capitalized, the specific epithet is lowercase, and the name should be italicized (when typing) or underlined (when writing by hand). An example using the Marsh Rams-horn (a snail living near the Rio Grande):

Genus: *Helisoma*
Specific epithet: *trivolvis*
Correct way to write the scientific name: *Helisoma trivolvis*
Some incorrect ways: *Helisoma trivolvis, helisoma Trivolvis, helisoma trivolvis, Helisoma Trivolvis*

Natural history museums are an important resource for biodiversity. As archives of preserved organisms, natural history museums organize specimens by both taxonomy and locality to facilitate data management and the research process. Specimens are often identified by experts, therefore the identifications can be trusted (keep in mind that experts can still make mistakes). Many museums now have images, with several views, of their specimens online with several views that you can access through data portals like the Global Biodiversity Information Facility (GBIF). Additionally, museums will typically have more than one specimen of a species, allowing you to compare your unidentified specimen to several verified reference specimens so that you can make more accurate identifications. Researchers often make appointments at natural history museums for specimen comparison. In this lab, you are the researchers that have “made an appointment” and borrowed museum research specimens to study the biodiversity of molluscs in the Rio Grande and its associated wetlands and canals.

**Activities**

Please read the instructions below and complete each exercise. Your lab assignment/homework is to answer all of the *questions in italics*. Please write your answers on the worksheet provided in the lab.

**Pre-lab Activity:**

   - Your instructor may show this is your lecture class; you can rewatch it on your own.
   - If it is difficult to understand, there is a transcript of the video on the webpage.

   Q1. Write a two-sentence summary of the video.

**Activity 1: Intro to Identification**

2. Each group will be given 2-3 molluscs from the UTEP Biodiversity Collections that were collected in the Rio Grande. These are research specimens, so please handle them carefully! **ALWAYS** hold the specimens over the lab bench. **Do not** separate the label from the specimens. If you are conducting this activity online, your instructor will assign you three randomized record links from the UTEP Rio Grande Mollusc Archive: [https://arctos.database.museum/archive/riograndemollusc](https://arctos.database.museum/archive/riograndemollusc) After clicking through to the record, examine the media of each record.

   Q2. Describe your three specimens:
   - *General description of color, size, shape*
   - *Compare and contrast the three specimens*

3. You will attempt to identify an unknown mollusc specimen using comparative anatomy. These are research specimens as well, so please handle them carefully. Use the following links and look for photographs similar to your mollusc. You can also use the identified specimens in front of you or specimens from other groups as references for your identification. Don’t forget that the locality information can help narrow your search.
iNaturalist checklist of Texas Freshwater Mussels:  
https://www.inaturalist.org/lists/66510-Texas-Freshwater-Musselss-Check-List?page=1  
Livers of the Rivers Freshwater Mussels of Texas:  

If there are multiple photos that look like your mollusc, click on the species links (iNaturalist) or read the species description and species range maps (from the freshwater mussels of Texas). Your TA can help you with vocabulary.

Q3. What species of mollusc do you have?  
   a. Common name (in English)  
   b. Scientific name (use correct binomial nomenclature)

Q4. What features/traits did you use to identify your specimen?

Activity 2: Reading a Museum Specimen Tag

4. Read the label of the specimen. Identify the parts of the label that list the species name, the catalog number, the locality, the collector and the date. Write these data into the data sheet. Note: Some museum tags/labels will not have all of the information asked for below; that is OK! If you’re doing this remotely, make sure to read the specimen label in the media image and not the record.

Q5. Fill in the following table to the best of your ability:

<table>
<thead>
<tr>
<th>Organism</th>
<th>Scientific (Latin) Name</th>
<th>Catalog Number</th>
<th>Locality</th>
<th>Collector</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tr>
</tbody>
</table>

Activity 3: Describing localities

Now that you’ve read a few example labels and locality descriptions, you will practice describing localities for your own collecting and research projects. In a later lab, we will visit two sites along the Rio Grande (on the westside of El Paso) to sample molluscs. As a field biologist, it is important to document the research process in a way that can be replicated by others.

5. Maps of the two water bodies, which we will sample (and have been sampled before), are shown below. In this activity, you will generate textual descriptions for both localities that can be used in your semester biodiversity project (details will be provided in later labs and on BlackBoard).

Q6. Using the maps below, give a brief description of Site 1 and Site 2 where the pin icon is placed. Use landmarks, intersections, and/or headings (i.e. N, S, E, W).
6. Compare your locality descriptions to those in ARCTOS.
   Site 1: https://arctos.database.museum/guid/UTEP:Bird:3020
   Site 2: https://arctos.database.museum/guid/UTEP:Inv:13586
The collector’s description might not be perfect, but usually is a good model. Now, generate more detailed locality descriptions that you can use for your biodiversity project. Aim to write
your locality descriptions in a way people unfamiliar with the area will be able to understand. Include nearby road intersections, distance and direction from intersections, coordinates, and any other information that thoroughly describes your sampling sites.

Q7. Write detailed descriptions (you can use these for your semester project):
   a. Site 1
   b. Site 2

Activity 4: Mapping molluscs from the UTEP Biodiversity Collections
Over time, natural history museums collect a lot of biodiversity data. By using collections from multiple institutions, and collaborating with other scientists, we can create a holistic picture of patterns in biogeographic distribution (where organisms occur). By mapping this data, we can begin to see patterns, and create new hypotheses about where organisms are found and why. We will draw on a large printed map as a class (each group will show the localities of their three specimens).

7. As a class, you will map your mollusc specimens from the UTEP Biodiversity Collections. (Reminder: do not separate the labels from the specimens). Find the catalog numbers that are on your specimens on the map (Hint: Use the locality data to help narrow down your search). Write the scientific name on the sticky notes given to you and place the sticky note on the map next to your record.

Q8. Once your class has finished, take a look at the map. Write two (2) observations of the map that you can make regarding the presence of bivalve species along the Rio Grande. Any observations are valid, but if you are stuck, try answering the following: Do you see any patterns? Are there species that occur in one place and not another?

Activity 5: Species Richness
From this information, we can calculate species richness and begin to draw conclusions. Your TA will place three points on the map along the Rio Grande (A, B, and C)

- Point A is located in New Mexico
- Point B is located near Big Bend National Park in Texas
- Point C is located at the mouth of the river in the Gulf of Mexico
8. Calculate the species richness of the “upper half of the Rio Grande” (Point A to Point B) and the “lower half of the Rio Grande” (Point B to Point C). Remember that species richness is the number of different species occurring in an area. Be sure to include the species from your sticky notes AND the species that have already been labeled (from other museums).

You can do this by creating a list of unique species and tallying duplicate names.

Q9. Answer the following questions regarding species richness:
   a. What is the species richness of the “upper half of the Rio Grande” (Point A to Point B)?
   b. What is the species richness of the “lower half of the Rio Grande” (Point B to Point C)?
   c. Which of the above areas of the river have higher species richness?
   d. Think about what you’ve read about the Rio Grande area so far. What do you think are some possible explanations for these patterns in species richness?
   e. For the “upper Rio Grande” (Point A to Point B), choose the most common species. Do some research on this species (look it up online, use the available field guides, etc.) and address the following questions:
      i. What is the most common species in this segment of the Rio Grande? (Please give the common name and scientific name)
      ii. Look up this species online. Is this species native or invasive in the Rio Grande?
      iii. Although you will be sampling many types of molluscs, we have only looked at Bivalves today. Make a prediction about what you expect to find in terms of Bivalves when sampling Country Club Road near the Rio Grande and Crossroads Pond.

9. Now that you have some tools to assess biodiversity, you can begin to create your own questions for future research. Spend 5 minutes on your own brainstorming questions that could be answered with today’s tools and or data (don’t worry about questions being too simple, complex, or ‘stupid’. It’s a brainstorm!). Share your list of questions with the group.

Q10. With your group, develop a question that could be answered using the tools and data discussed in this lab.
   a. As a group, choose the most interesting question (Vote if necessary).
   b. Determine if the question is answerable with today’s tools. If you would need additional data, what data would you need? If you have all the data to answer the question, describe a method of how you might answer your question.

Assessments
Your lab assignment/homework is to answer all of the questions in italics above. Please write your answers on the worksheet provided during the lab.

References and Resources
ArcGIS online: https://www.arcgis.com/home/index.html
ARCTOS database: https://arctos.database.museum/SpecimenSearch.cfm
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