LESSON 1: URBAN FOREST MINI BIOBLITZ

Lesson at a Glance

Grades
- 9-12

Duration
- Part A: 2 hours.
- Part B: 2 hours sampling time plus travel time to and from site.
- Part C: 2 hours.

Standards
Arizona Science Standards
- Plus HS+B.L4U1.2

All standards listed at end of lesson

Suggested Sites
- Part A and C: Classroom
- Part B: Park or area with diverse natural vegetation. Avoid areas with lawns or extreme vegetation gradients. Some trees and shrubs are okay.

Overview

Students learn about the importance of observing and recording change in the ecosystem over time. They conduct an intensive survey of the biological diversity of a limited area of their urban forest to establish a plant species inventory. Students use a smartphone app to identify species. They plot species densities and evaluate the possible underlying relationships. They analyze their inventory with special attention to previously unrecorded species in the area, and report rare and invasive species to the appropriate local authorities.

Objectives

Students will be able to:
- Identify common plant species in their urban forest and be able to determine the names of unknown species with the use of a smartphone app
- Design and execute a basic vegetation sampling protocol
- Explain the concepts of species density and species-area relationships.

Background Information

A BioBlitz is a biological survey that helps the public learn about their local ecosystems and biodiversity in collaboration with research professionals, naturalists, and other volunteers. Biological surveys are conducted for a range of reasons. They provide baseline and follow-up data for long-term monitoring of general ecosystem trends. Data from surveys can be used to characterize habitat for endangered species and to plan and evaluate management practices.

Background Information (Continued)

Measuring ecosystem biodiversity can be challenging because it requires some expertise in field methodologies and species identification. However, novice surveyors can use a smartphone app (SEEK or iNaturalist) that uses artificial intelligence and allows access to a large dataset for easy species identification. Limiting the scope to a subset of organisms simplifies the complexity and equipment necessary for a survey activity. It is impractical to take a census of all species even on a small site. To collect meaningful data, only a representative sample of the area under investigation is required. Plant communities are commonly sampled with quadrats (plots of a standard size) and/or transects. The area inside a plot delimits the area in which species are measured. Depending on the species of interest, plot size can vary from 0.01–0.1 m2 for the moss layer to 100 m2 for trees (Bonham 2013). A transect is a line marked at regular intervals. It can be laid out in the field and used to record what is directly under the line. Transects are good for sampling a large area relatively fast, but they miss detailed information. The use of quadrats in combination with transects helps with measuring higher levels of complexity.

Preparation

Vocabulary

- **Random sample**: each sample has the same probability of being chosen and is an unbiased representation of the total population.
- **Species-area curve**: represents the number of species found with increasing area sampled; also referred to as species-accumulation curve.
- **Species density**: the number of individuals of a species in an area. It is measured in individuals per unit area. The term “abundance” is often used as a synonym for “density”.
- **Species richness**: the total number of species in an area.
- **Transect**: long, narrow sampling area.
- **Quadrat**: frame with area of known size in which species are measured.

Materials

Part A:

- One 1 square meter sampling plot frame;
- One 30 meter or 100 ft. engineers tape measure;
- Two long nails for securing tape;
- Compass (smart phone compass works well);
- Printout of SITE map for each team, the map needs to have a scale and north arrow;
- Access to random number generator (internet);

- Access to word processing program to make data sheets;
- Access to iNaturalist website.

Part B:

- For each team (2-4 people):
- At least one smartphone fully charged and with the SEEK or iNaturalist app installed.
- Compass (smart phone compass works well).
- 1 square meter sampling plot frame (PVC pipe with 90 degree elbows)
- 30 meter or 100 ft. engineers tape measure. If tape measures are not available, rope with marked intervals can be used.
- 2 long nails for securing tape.
- Map of SITE.
- Data sheet, clipboard, pencils.

Set-Up

- Construct the 1-m2 sampling plot frames in advance (teachers or students can do this)
    - Instructions for making a folding quadrat
- Select a sampling site (SITE) with diverse vegetation that is large enough to accommodate about 5 teams working with 100 ft. tapes. This site can be part of a much larger park or natural site.
- Familiarize yourself with SEEK or iNaturalist and decide which app works best for your class.
- Identify common species in the sampling area with the app. It may be helpful to contact a local naturalist or plant taxonomist to help with species that cannot be identified with the app.

Lesson Procedure

Engagement

Various human activities, climate change, and invasive species slowly change the composition of our urban forest over time.

- Ask students for suggestions for how changes over time can be detected and quantified.
- How do we know which species live where, and how this changes over time (conduct a survey of species in a selected area, take photographs, map species distributions, etc.)?
- What are potential challenges when doing species surveys (methods used for stationary species (plants and some animals) probably don't work for species that move (most animals); methods for large species probably don't work for small species;

feasibility of sampling all species in an area; sample time period and period of activity of organism (e.g. nocturnal animals, annual plants), ability to identify species, etc.)?
- Explain to students that the sampling method used depends on the goal of the investigation and the species of interest. Common methods are quadrats and transects. A quadrat consists of a round or rectangular frame of a known area.
- A transect is a long, narrow sampling area that extends over a longer portion of a study area than a plot does, resulting in a larger sample of different plant species.
- However, plot studies are useful for small areas that have a great variety of plant life. Let students know that they will sample vegetation in 1m2 quadrats placed along transects in regular intervals. Students will plan the field study and develop and agree on a consistent sampling protocol to be used in the field.

Exploration

Part A: Planning a vegetation field study.
Here is a step-by-step outline for planning a vegetation field study. Each step is important. The more work students do before starting the fieldwork, the smoother the project will go, and the better the results will be. Divide class into teams of 2-4 students.

What will the project accomplish?
The goal of this project is to conduct a plant species inventory of SITE.

- What are the specific objectives?
  Objectives can come from prior observations, scientific curiosity, or be mandated by management needs e.g. for protecting endangered species. Objectives need to be clear and explicit. Here are some questions that help define objectives:
  - What question are we trying to answer? (What plant species grow on SITE?)
  - What attribute are we trying to measure? (What is the abundance of different plant species on SITE?)
  - For what specific area do we want an answer? (We want an answer for SITE, which is a part of our urban forest.)
- What are the constraints for achieving the objectives?
  - Constraints usually revolve around available resources i.e. money, time, personnel. They can also be related to site access limitations (e.g. protected areas, military sites), or sampling method restrictions (no species removal or destructive sampling).
  - The major constraint for this project should be the ability

    to finish sampling within the allotted time period. Gather existing information about the area.
    - Is there any pertinent information available for your area? Check the iNaturalist website for plant species observations in your area of interest.
- Choose your sampling method.
    - What measurement technique will produce the kind of data you need and can be done within your budget and time frame?
    - Students will count the number of individuals of each plant species in 10 1m2 plots spaced at 3m (9 ft.) intervals along a 30m (100 ft.) transect. They will also count the number of trees and shrubs by species that intercept the line transect. If there is sufficient time, more transects can be sampled.
- Design your field sampling protocol.
- Transect starting points and directions need to be randomly placed. Random placement ensures that each sampling location is equally likely to be selected, and the selection of one location does not influence which is selected next.
    - Ask students for suggestions about how to randomly select locations for transects on their map (possibilities include repeatedly dropping a pin on the map, having a blindfolded student point to locations with a pen, etc.). Introduce students to the grid overlay method (overlay an X,Y coordinate system on the map of your SITE; pick random coordinates for your transects with a random number generator; discard any duplicate locations and locations that fall outside your SITE). As a class, decide on which method to use. Select and mark locations for all transect starting points on the map. Label transect starting points with unique identifiers.
    - Determine transect directions with a random number generator set to Min=1 and Max=360. This will give you an angle for the direction, e.g. 270 will be an angle of 270o from North (0o). The transect will run to the West. Discard angles that result in transects running outside of SITE or overlapping other transects. Note degrees next to unique transect identifiers on the SITE map. Each team should now have a map with all transect names, starting points, and directions.
    - Decide as a class how you will place the plot frame against your transect (bottom left or bottom right corner against

transect). Note decision on back of transect map.
    - Additional notes:
    - Practice setting up a transect and placing sampling quadrats in your schoolyard before you go out to sample in the field.
    - Practice using app for identifying species (scientific names) before you do field work and decide on how to deal with plants that you cannot identify to species level in the field.
    - Plants that are rooted inside the quadrat frame are counted. Plants that overhang the edge of the frame and are not rooted inside the quadrat do not count.
    - Large trees and shrubs are measured along the whole transect. If their canopy overlaps the transect, they are counted. Tree and shrub seedlings are sampled inside quadrats.
- Design and print your data sheets (see example table that could be adapted for this study)
    - Each transect has a separate data sheet.
    - Each data sheet needs to include the following information:
        - Date
        - SITE name and general location
        - Team member names
        - Unique transect ID
        - Measurement units, e.g. number of individuals per plot
        - One column for each sampled quadrat (include quadrat location)
        - One column for large trees and shrubs sampled along transect,
        - One line for each species (scientific names, species names can be abbreviated)
        - Area for special notes

Part B: Conducting a vegetation field study.
Students follow their sample protocol to measure plants along transects in the selected study area. It may be helpful to survey the entire line transect for tree and shrub information first and then return to record quadrats.

Part C: Data summary and interpretation.
- Identify any species that require follow-up work.

- Prepare a list of all species recorded. This will give you species richness. It is the total number of species in an area.
- Calculate average species density/m2 and rank species by density. Which species are most common (highest density), which species are rare (low density)? What are possible reasons (habitat type, disturbance, animal grazing e.g. rabbits, deer, sampling season, etc.)?

Explanation

A key concept for students to grasp is that in most ecosystems, there are dominant and rare species.

- To demonstrate this for the sampled SITE, ask students to plot average species density/m2 (y-axis) against species density rank (x-axis). This means that the species with the highest density will be 1 one the x-axis, the second most dense species will be 2 etc. See Figure 1 for an example of how this graph could look. This graph is referred to as a rank-abundance curve or Whittaker plot.

Elaboration

Ask students how they could use the information from their rank abundance curve and other available online information to determine if they found any rare, endangered, "first records", or invasive species on their SITE.

- Students can watch "ENDANGERED SPECIES - How to find them near you!". This video focuses on birds.
- However, iNaturalist can be used similarly to eBird: here is a list of Arizona rare plants. This assignment can be done as a homework project and used for student evaluation.
- Rare, protected, or invasive species may be of interest to local and state conservation and resource management organizations. If students find any such species, report them to relevant organizations.

Evaluation

Species-area curves are a common tool to evaluate the sampling effectiveness at capturing biodiversity.

- Ask each student team to graph the species-area curve for their transect. The number of quadrats sampled will be the x-coordinates. Y-axis values will range from zero to the total number of species observed along the transect. Each point will correspond to the cumulative number of unique species found within quadrats as the number of sampled quadrats increases. For example, if the first quadrant contains 4 different plant species, the (x,y) coordinates will be (1,4). If the second quadrant contains 3 different plant species, but 1 is the same as in the first quadrant, the second (x,y) coordinates will be (2,6). For an example of a species-area curve, see Figure 2.

- What is the relationship between the number of species and the size of the area sampled (the number of species found increases with the area sampled; the number of new species found in each additional quadrat should decrease with each additional quadrat sampled)?
- Next, plot a species-area curve for all transects sampled.
- Compare the shape of the individual species-area curves to that of all transects combined. Initially, each additional sampled quadrant will add several new species. After substantial sampling, the species-area curve should level off. Graphs for individual transects may not level off because the number of quadrats sampled per transect was insufficient to capture all common species of the area. The graph prepared for all sampled quadrats should exhibit the leveling-off pattern.
- How can species-area curves be used to determine how many quadrats/transects need to be sampled in a community to adequately characterize species numbers of that community? This can be done by plotting the species-area curve, and estimating the area after which sampling additional quadrats/transects adds only a few more species.
- How big of an area (quadrats/transects) needs to be sampled to adequately describe the vegetation of the SITE where the class worked?

Additional Resources

Educator Resources and References

- Arizona Native Plant Society. 2000. Rare Plant Guide. https://aznps.com/rare-plants/
- Heard, M.J. 2016. Using a Problem-Based Learning Approach to Teach Students about Biodiversity, Species Distributions & the Impact of Habitat Loss. The American Biology Teacher 78 (9): 733–738.
- Wilson, M. 2009. Field Methods in Vegetation Sampling. https://oregonstate.edu/instruct/bot440/wilsomar/Content/Index.htm
- Bonham, C.D. 2013. Measurements of Terrestrial Vegetation. Wiley-Blackwell, Hoboken, NJ.

Field Trip Sites and

- Forester
- Conservation Biologist

Career Exploration

Arizona State Science Standards

Disciplinary Core Ideas	Crosscutting Concepts	Science and Engineering Practices
L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms. L4: The unity and diversity of organisms, living and extinct, is the result of evolution. Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms. U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.	Patterns Cause and Effect Stability and Change Scale, Proportion, and Quantity	Ask Questions and Define Problems Develop and Use Models Plan and Carry Out Investigations Analyze and Interpret Data Use Mathematics and Computational Thinking Engage in Argument from Evidence

Standard Codes	• Plus HS+B.L4U1.2

Next Generation Science Standards

Disciplinary Core Ideas	Crosscutting Concepts	Science and Engineering Practices
Text	Text	Text

Standard Codes	• Here

Arizona English and Language Arts Standards

Reading: Literature	Reading: Informational Text	Writing	Speaking & Listening	Language
Text	Text	Text	Text	Text

Standard Codes	• Here

Arizona History and Social Science Standards

Civics	Economics	Geography	History
Text	Text	Text	Text

Standard Codes	• Here

Arizona Mathematics Standards

Operations & Algebraic Thinking (OA)	Number & Operations in Base Ten (NBT)	Number & Operations —Fractions (NF)	Measure-ment & Data (MD)	Geometry (G)	Standards for Math-ematical Practices (MP)
Text	Text	Text	Text	Text	Text

Standard Codes	• Here