BIODIVERSITY MONITORING PROJECT—
Insect Monitoring

(This lesson plan was extracted from Smithsonian Migratory Bird Institute)

Background

This classroom lesson centers on using the scientific method to model an actual field experiment to census and monitor insect populations in the local ecosystem, using the same field techniques developed by Smithsonian scientists to census and monitor insect populations world-wide. Because the activity focuses on student teams clearly defining their own protocols as they explore insect diversity, they are engaged—just as Smithsonian research scientists—in science-as-process, using the scientific method. At the same time, this activity allows students to learn species classification skills, just as used by field-based para-taxonomists, even when they do not have the knowledge for specific species identification.

Objective

Students will understand the value of studying and monitoring biodiversity through an interactive lesson that teaches uses elements of the scientific method, including developing and implementing standard protocols, collecting and analyzing data.

Method

By using a simulation of a field research situation, students can practice the scientific method in the classroom, either in preparation or as a substitution for real-world field experience. Students will examine a simulated biodiversity research situation, using a “mini-plot” or sampling square protocol, and will select their sampling parameters, collect data, and classify “species”. Additionally, they will graph their data for species richness and relative abundance, and will interpret their data, based on their protocol parameters. Class discussion will reveal the variety of classification schemes and how methodology must also be consistent in order for data to be comparable. By being involved in every step of the scientific process, students will understand how all of the parts contribute to the overall picture of scientific research.

Materials

- Blank paper for observations and data collection
- Pencils for writing
- Buttons or bingo chips of various colors, some with small circular stickers, some without, representing the insect population within the sample size
- Sampling squares (can be made from 4 wire survey flagging stakes)
- Shredded paper of various colors and widths to simulate leaf litter

Procedure

1. **Divide the class into teams of four to five students each.** Each group needs a sampling square of approximately 30 centimeters that delineates the boundaries of the "sampling area".
To simulate layers of soil where ground-dwelling insects would be sampled (top-leaf litter, middle-decaying leaves and hummus, bottom-soil), layer inside the sampling square shredded paper by color. For example, brown paper on the bottom might represent soil, white paper as the middle layer might represent dead leaves/humus, while red paper on top might represent fresh leaf litter.
Multi-colored bingo chips represent insects. To make it an additional challenge for classifying species, you can including bingo chips that have colored stickers placed on them, which can represent new species, or can represent same species, but male vs. female or young vs. adult. Bingo chips should be added in between each layer of paper.

2. Design a protocol parameters and species classification system (10-15 minutes).
Protocol parameters: Instruct the groups to determine their own protocol parameters for gathering data on the "insects" in their population. They should define their parameters, addressing issues such as how far into the leaf litter they want to go to monitor the insects in their sample, if they want to collect or observe the insects, and the research time frame (how long they have to conduct their census. Make sure everyone knows what each color layer represents so they know which layers they want to sample. Parameters include whether they will conduct a non-invasive census (top layer—leaf litter only), a moderately invasive census (top two layers—leaf litter and decaying matter), or a complete census (including all three layers).

Species classification system: The groups will also need to develop a classification system for counting species on their data sheets. For example, all blue bingo chips could represent a single species, regardless of whether or not they have a dot (perhaps male vs. female, young vs. adult, or subspecies of a single species). Or it could be that bingo chips with dots are all different species. This is actually a fairly critical step in the real world. In most parts of the world, scientists are still discovering new species (see student handout: "The Big, Big World of Insects). Para-taxonomists at remote field stations must sort insects that look alike or don't look alike without the benefit of field guides — since most of the insects have never been described or named by scientists. In this classroom model of an insect census, students will have the chance to debate within their team what constitutes a species — based on appearance alone (color, spot or no spot, etc.). On their data sheets, they will want to have a place to record the number of species a, species b, etc.

3. Conduct census and reevaluate species classification system (20-30 minutes):
Teams collect data, following to their protocol parameters. Two students should do the collecting, with two students assisting with sorting. Teams will need to debate their classification system, and assign species designations as described above. The teams will perhaps need to reevaluate their species classification system.

4. Record, calculate, graph, and analyze data (15-20 minutes): Record keeper records species information using the data sheet. Total the species abundance (the number of individuals per species) in the right hand column. Calculate species richness (how many species are in your sample) at the bottom of the table. On a flip chart, student teams should create a bar graph showing relative abundance (a measure of biodiversity that compares how many individuals are in found for each species). The X-axis will represent the species in your census. The Y-axis will represent the number of individuals found for each species. Students should label their graph appropriately, and provide a legend.

5. Present methods and results (5 minutes each). Each team will be responsible for a short presentation that should include why they selected their protocol parameters, species classification system, and their results.

6. Group discussion and extensions. Discuss as a group the differences in protocols and classification systems. Some questions you may want to ask:

- How easy is it to classify species?
- In what ways could we compare the data collected by different groups (using different protocols)?
- What patterns do you notice in the data?
- In what ways could conducting a census bias the data? (For example, disturbing the upper layers may cause insects typically found in the top layer to move to lower layers to escape. It doesn't mean they typically live in the bottom layer, but they may be found in that location because of the actions of the collector.)
- Species accumulation curve. This type of graph would show how many species you find, based on the number sampling events are conducted. For example, one could predict that if you only put out one small sampling square in a habitat you might miss some (or if you only sampled insects in the top layer of leaf litter). The more sample you collect in a habitat (i.e., the number of sampling squares you collect data in), the more species you will find. You can graph this data with number of NEW species collected in each sample (column 1 has 4 species, column two you found two new species out of 3 collected, so column two has 6 species, and so on). When the curve flattens out, you are likely to have identified all the species present in a habitat. Do you find more if you sample the top through the bottom layer than you would find just sampling the top layer in different sites?
- What research questions would you want to answer next, based on these results?
- Consider conducting an actual field census on or near your school grounds.

Additional Information

Smithsonian's National Zoo biodiversity websites

- h ttp://nationalzoo.si.edu/education/classroompartnerships/biodivmonpro
- http://nationalzoo.si.edu/conservationandscience/MAB/whatisbio.cfm

Smithsonian entomology websites

- http://www.si.edu/resource/faq/nmnh/buginfo
- http://nationalzoo.si.edu/Animals/Invertebrates/News/monarchmigration.cfm
- http://nationalzoo.si.edu/Publications/ZooGoer/2004/4/antfarmers.cfm

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STUDENT DATA SHEET
Ground Insect Census Protocol and Species Classification Data

Date: ________________________ Location: _______________________________________

Habitat type category (forest / field / flowerbed / other): ________________________________

Protocol Assignments:
Field data collector 1:
____

Field data collector 2:
____

Sorter (parataxonomist) 1:
____

Sorter (parataxonomist) 2:
____

Recorder:
____

Instructions:
1. Select a protocol, based on how many soil layers you wish to sample (check one):
    - Minimum disturbance: Fresh leaf litter only (top layer)
    - Moderate disturbance: Leaf litter and humus (top and middle layers)
    - Full census / maximum disturbance: All three layers sampled: leaf, humus, soil

2. Field data collector(s) collect insects from each layer, keeping layers separate from one another.
3. Sorters (para-taxonomists) sort insects using a visual examination. Group works with sorters to determine "what is a species" (i.e., is "blue" a different species than "blue with yellow dot").
4. Record keeper records species information using the data sheet on page two of this protocol sheet.
5. Total the species abundance (the number of individuals per species) in the right hand column. Calculate species richness (how many species are in your sample) at the bottom of the table.
6. On a flip chart, create a bar graph showing relative abundance (a measure of biodiversity that compares how many individuals are in found for each species). The X-axis will represent the species in your census. The Y-axis will represent the number of individuals found for each species. Label your graph appropriately, and provide a legend.