The Dirt Lab: An Open-Ended Investigation Into An Environmental Problem

Charlene M. Waggoner, Dan Wiegmann, and Julia McArthur

Department of Biological Sciences
Bowling Green State University
Bowling Green, OH 43403
(419) 372-2332
cwaggon@bgnet.bgsu.edu

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This laboratory exercise poses a realistic environmental problem with multiple solutions. In seeking to address this problem, students recognize a need to know and therefore learn about soils, techniques for evaluating soils, and how soil composition can affect living systems.

Students are asked to evaluate the soils from the habitat of an endangered species and compare it to other potential habitat sites. They must focus on the features of the soil samples that will have the greatest impact on living systems. They are provided with a set of soil analysis tools and the instructions for the tool use and data interpretation. Additional resource material is available in the room. The laboratory instructor acts as a facilitator.

The summation of the lab is a report on the viability of the various sites as potential habitat. Guidelines for mini-posters are given. Groups present their findings in this format; discussion of conflicting results ensues.

I. Introduction

This lab provides you with a basic scenario for getting students to ask questions, design experiments, analyze data, and discuss their conclusions. It is purposely designed so that there are many interpretations and multiple solutions. Students are asked to make a miniposter and present their results to the rest of the class.

This scenario can be used in its simplest form to introduce students to the process of science at the beginning of the semester. By incorporating the extensions it can be an elaborate capstone research project for advanced students. We use this exercise in Biology 101, Environment of Life, for non-majors. This soil-based exercise follows exercises that introduce students to biodiversity using arthropods. It is followed by a behavioral exercise using live arthropods. Objectives include:

1. Provide students with an opportunity to design an experiment and discuss results.
2. Demonstrate that science is an open-ended process.
3. Expose students to the basic processes of soil analysis.
4. Provide students with an opportunity to present and discuss their findings in a scientific format.
5. Relate the physical concepts of soil composition to the biological concepts of habitat requirements to a personal consideration of habitat destruction.

Our primary focus is on the process of science. Students in our introductory course are not expected to learn a detailed understanding of the specifics of soil composition. They use the tools and techniques that they decide will be most likely to provide them with sufficient information for the comparison of soil samples. The scenario provided is tailored to our local environment in Northwest Ohio. The language of the introduction and the objectives can easily be modified to reflect a more detailed analysis of soils, arthropods, or biodiversity.

II. Student Outline

The members of the Project Find a Home have identified an extremely rare species of arthropod in Wood County. It lives on land that is to be developed as part of the research park project. While this species is rare, it is not yet considered threatened or endangered. The Project Find a Home has given us the job of moving the species to a similar location within the county so that economic development can continue without destroying an entire population of this species. (If you disagree with the development program, you should consult the instructions for your issue analysis project and write a letter to the appropriate set of officials.)

These arthropods are soil dwellers. It has been very difficult to observe them in the field or learn much about their lifestyle. All that is known for sure is that they are found in the soil in this area. In the bucket in the laboratory there is a sample of soil in which they have been found growing. There are also samples of other soils found throughout the county in locations that seem to be an ideal habitat for this organism. The sites are all similar in ground cover, location, rainfall, and other overall characteristics. To select a site, we must do a more detailed comparison of the soils in each area. Project Find a Home needs to find the soil environment that most closely resembles the original habitat if the population is to survive in its new location.

Your task as a member of the Project Find a Home Soil Evaluation Team is to determine which of the soil samples from the other locations most closely resembles the original habitat. You have many tools available to use (see Table 1). Your research station includes a set of instructions for each technique and your project coordinator will help demonstrate them. Be sure to ask if you have questions. Some of the instrumentation is sensitive and expensive.

There are many different soil characteristics you can evaluate. Organize your investigation around those techniques which seem to have the greatest impact on a living organism. To do this, you will have to think about the environmental factors that sustain life and the niche this organism occupies. Make a list of what you believe are essential requirements for a living organism in a soil environment. What techniques will allow you to assess these conditions?

Be sure to keep good records while you are collecting your data. You may have to defend your site choice and it will be useful to have the data handy to support it.

After you have collected all of your data, summarize your results and make a decision about the best possible relocation site. Answering the following questions may help with this process.

- What factors do you consider to be most significant?
- What factors do you consider to be least significant?
- Were you able to rule out any sites completely? Why?

Table 1. Soil analysis tools

Tool	Purpose
soil characterization cards	to determine color, particle size, content
magnifying glass	for closer examination of soil
microscope and slides	for closer examination of soil
set of soil sieves	to analyze particle size and soil contents
magnet	for gross determination of iron content
weak acid	to test for limestone and other carbonate compounds
ultraviolet light	to look for fluorescent compounds
pH and moisture meter	to test for soil pH and moisture content
drying oven or ashing oven	to determine dry weight of organic material or determine amount of combustible (presumably) organic material
nutrient agar plates	to culture soil bacteria
Berlese funnel apparatus	to collect mobile soil dwelling organisms
dichotomous keys	for identification of organisms living in soil
soil chemistry test kits	to determine metal and micronutrient content of soils
other	ask your Project Coordinator for help

When you have made your decision as to which soil is most likely to support our arthropod population, report it to the class. Your Coordinator may ask you to write this on the board, or overhead, prepare a written report, or you may be asked to prepare a mini-poster that has your conclusions and supporting data. There is a set of guidelines for the preparation of mini-posters attached to this document. The procedures for preparing the content of the poster are applicable to any presentation format. Be sure to use the proper format.

III. Student Outline: How To Make A Miniposter

1. Assemble your data.

2. Determine your key results and the data that support them.
3. Prepare graphs or charts that clearly summarize and illustrate your key results. (These are your results.)
4. Write clear one or two sentence statements of your conclusions based on your results. These statements constitute your "take home message". They tell your audience what they should learn from your research. (These are your summary statements or your conclusions.)
5. Write one paragraph that explains how your results support your summary statements. (This is your discussion.)
6. Ask yourself, what your audience absolutely **MUST** know about your problem to put your experiment and results in the proper context. Write one paragraph that provides this background. (This is the introduction.)
7. Ask yourself what your audience absolutely **MUST** know about your experiment in order to understand your results. Write one paragraph or design an illustration that explains your experiment. (This is your materials and methods.)
8. Write down all the sources you consulted for background information, procedures, and interpretation of your results. (These are your references and should be properly cited throughout the poster.)
9. Obtain large paper or tape together recycled sheets of paper as needed.
10. Arrange the materials you have collected (introduction, materials and methods, results, discussion, and summary) into a visually pleasing composition in the space allowed. Be sure that your key points are prominent and easy to see.

    Use a large font or write with large block letters.
    Make sure there is high contrast.
    Include a title that clearly describes your work and invites a reader to come closer.
    Include the names and institution of all members of the research team.

11. Check with your instructor for any special instructions.
12. Check with your instructor for the proper time, place, and method to display your poster.
13. Be prepared to answer questions about your poster.
14. Read the posters of other and ask questions about their work.

IV. Materials (Including Sources)

Items Identified with an asterisk (*) are in the field pack for each laboratory group. Other items are available in the laboratory for the groups to share. Instrumentation requiring instruction is clearly labeled and the teaching assistant is available to demonstrate the equipment to the groups individually or the class as a whole. Instruction tags are included in this section following the items.

* Magnifying Glasses Minimum of one per group.

Dissecting Scopes Available in the laboratory.

* Field Scopes
* Geotechinical Gauge or soil charts.

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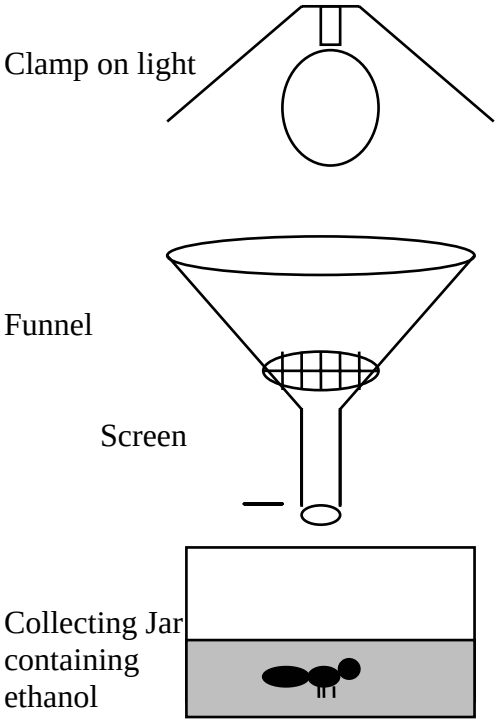
* Soil Test Kits For small classes, many varieties of these can be purchased at a local garden store. Consumable costs can be substantial. Meters may be more economical than chemical tests for large classes.
  (S04446 Frey) Complete Soil Test Set.
  (S02080 Frey/ 77181 Forestry Suppliers, Inc) pH Test Kit
  (S02082 Frey) Soil Nitrogen Test Kit
  (S08240 Frey) Potassium Test Kit
  (S08241 Frey) Soil Phosphorous Test Kit
* Soil pH And Moisture Meter We use these meters in place of chemical pH testing. pH paper could be used. Students could test relative moisture by placing a known amount of soil from each sample on a stack of paper towels, waiting an hour or so, and then counting the numbers of layers that became damp. They could also weigh known volumes of soil, let them air dry or put them in an oven, weigh again, and calculate the % of weight due to water.
  94302 Forestry Suppliers Inc.

Hubbard #3076 Screen Four Sieve Kit This is a stack of screens that are used to separate particle size. Purchase a standard set or make your own by stapling various sizes of screen into wooden frames.

53716 Forestry Suppliers, Inc.

Berlese Funnel Used for collecting insects from soil samples.



65-4148 Carolina

* Magnet Used to check for presence of iron.
  S16132 Frey.

* Petri Plates Any plastic lid or small dish will work.
* Soil Scoops Plastic spoons work in the lab. Garden trowels work outside.

Ultraviolet Light We use a DNA UV Illumination system. You can use a hand-held source with appropriate UV eye protection. You could try the black light bulbs sold with the fluorescent paints.

21-3690 Carolina. Illumination system
21-3695 Carlolina. safety glasses.

Drying Oven We use an incubator already in the lab. We have also created mock samples where we show a "dry" sample and provide the wet weight. Students must weigh the dry sample and make the calculations.

Supplies For Soil Samples

To do this experiment in the laboratory, we collect soil samples from the field. We have also used a bag of potting soil and used some of the following procedures to create samples. The important thing to keep in mind while making soil samples is that you do not want them to be so unique that there is a single, obvious match.

Fluorescent Paint Pour some paint on the surface of the soil samples. Allow it to dry. shake or stir it into the soil.

Poster paints are found in almost any office or art aisle at the grocery store. These can also be found in any art supply store or children's toy department.

Baking Soda Mix varying amounts of baking soda into the samples.

Iron Filings

75-8322 Carolina
or check with your campus shop or Technology department.

Addresses For Sources

Carolina Biological Supply Company
2700 York Road
Burlington NC 27215
or
PO Box 187
Gladstone OR 97027
Phone 1-800-334-5551
Fax 1-800-584-3399

Frey Scientific
Beckley Cardy Group
100 Paragon Parkway
Mansfield, Ohio 44903
Phone 1-888-888-1332
Fax 1-888-454-1417

Forestry Suppliers, Inc.
P.O. Box 8397
Jackson, MS. 39284-8397
Phone 1-(800)-647-5368
Fax 1-(800)-543-4203