Experimental Field Problems

Activity Overview
Using their schoolyard restoration site, students are given a field problem about which they ask questions and design experiments.

Objectives
Students will:

- Experience inquiry-based science
- Collaborate with peers to plan and implement a research project

Subjects Covered
Science, Math, Language Arts

Grades
6 through 12

Activity Time
Varies (see individual field problems)

Season
Any

Materials
Varies (see individual field problems)

Modified from Earth Partnership for Schools K-12 Curriculum Guide, University of Wisconsin Board of Regents.

Background

A school native habitat garden can provide a much-needed unifying framework for inquiry-based learning across grade levels and subjects. Students involved in building and studying their school site are motivated to understand how science is done and why it works. Since ecological restoration is a young field with more questions than answers, students can share in the excitement of investigating the unknown.

The following inquiry projects reflect current topics in the field of restoration ecology that you can investigate and present in small teams. "Field Problems" are inquiries into plant and animal life of prairies, savannas and woodlands.

Activity Description

To complete your inquiry project, you will need to do the following:

- Form a group of three to four students. The field problem explorations and presentations may need to be adapted to fit available time, needs and interests.
- Meet with your group members to identify the direction of the inquiry. Use group cooperation skills to ensure that all members have input. Your group will need to provide:

1. Question of Interest

As a group, you are welcome to use the sample inquiry questions provided with each project description, modify them, or come up with your own research question related to the topic. It is also useful to reword your question as a prediction. For example, if you are wondering whether there is a greater diversity of plant species in the shade or in the sun, you might predict that diversity is greater in one area or the other, given what you know already.

2. Methods

a) Determine how you will go about answering your question. Your group will need to devise a datasheet to keep track of your findings. If your investigation involves daily data collection, your team may need to plan for that additional time outside the classroom. Remember: "You can do almost anything you want to do, but you certainly can't do everything you want to do." Photos of your project (your study area, equipment, etc.) are very helpful for giving presentations and writing articles.

b) If possible, duplicate your experiment one or more times (these are called replicates) so that you don't mistakenly attribute your results to one factor when, in fact, they were due to something abnormal.

An example of this could be that you think that the plant diversity in sunny areas is ten times higher than in the shade, but the only shady spot you examined was under a walnut tree that, unknown to you, gives off chemicals from its leaves, roots and fruit to inhibit the growth of other species.

c) If you are looking at the influence of a particular factor, such as whether there are more birds nesting in a managed woods or one overgrown with invasive non-native shrubs, as best as you can, keep all other things the same. For example, you should look at areas of similar size, spend the same amount of time looking in both areas, use or don't use binoculars in both areas, etc.

3. Results

Explain what happened. Think about making tables, graphs or charts to illustrate your findings.

4. Discussion

a) Were your findings consistent with your prediction? Were they consistent with the results of similar studies? Can you make any reasonable conclusions based on your findings?

b) What would you do differently in the future to improve the study?

c) Based on your experience with this project, what would be an interesting and worthwhile follow-up study?

5. Article

Prepare a concise written version of your presentation utilizing the scientific article template outlined below.

Scientific Article Template

- Title of research project
- Names of researchers
- Grade level
- Name of school, City, State, Zip Code
- Introduction: Describe what your research is about, including any specific question. Why is this interesting or important to study? Include your predictions/hypotheses.
- Methods: Describe your methods for conducting the research and organizing the data, including locations, size of study plots, equipment and date. Include photos, if appropriate.
- Results: Share your findings—include any graphs or tables, if appropriate.
- Discussion: Were your findings consistent with your predictions? Describe the significance of the results. How do your results compare with similar studies—one quick source of information is the Internet. Mention any factors that may have led to errors in the data and any related future studies that occurred to you during this project.

- Acknowledgements: Make a brief statement that may include funding information, people that provided technical assistance, etc.
- References (if any were used): Use the Internet or the library to look up the *APA Formatting and Style Guide* to learn how to cite texts in a scientific article.
  Note: They are not the same as citing in a literary paper.

Extensions

- Plan and implement a five-to-ten minute presentation on your research project. See the Earth Partnership for schools "Students as Ecological Researchers" activity.
- Present research projects at a student conference.
- Publish findings in a newsletter or journal.
- 💻 Use online research and computer software to investigation a problem not covered during this activity and create a digital presentation that portrays the scope of the problem and all possible solutions.

Additional Resources

- Annenberg Media—Learning Science Through Inquiry: http://www.learner.org/workshops/inquiry/
- Concept to Classroom—Inquiry-Based Learning: http://www.thirteen.org/edonline/concept2class/inquiry/
- Scientific Method Tutorial: http://www.panpipes.net/edit6200/index.html
- Institute for Inquiry. *Examining the art of science education:* http://www.exploratorium.edu/ifi/index.html
- Institute for Inquiry. *Inquiry education information for the classroom:* http://www.exploratorium.edu/ifi/resources/classroom.html
- Institute for Inquiry. *Inquiry bibliography: Professional development design seminar guide to articles:* http://www.exploratorium.edu/ifi/resources/biblio.html
- Institute for Inquiry. *Inquiry education research:* http://www.exploratorium.edu/ifi/resources/research.html
- Institute for Inquiry. *Other publications and web sites of interest:* http://www.exploratorium.edu/ifi/resources/other.html

Assessments

- Conduct a peer evaluation for group members.
- Use a rubric for presentations.

Individual Field Problems

Problem #1: Biodiversity: Invasive Species

An invasive plant is one that can spread rapidly, usually changing the environment by crowding or shading out other plants. Invasive plants can be native or non-native (i.e. originally from Europe or Asia, etc.). Non-natives were often brought intentionally by settlers for ornamental reminders of home, medicinal uses and a variety of other purposes. Among other characteristics, invasive plants often grow rapidly, mature quickly, produce many seeds or vegetative shoots, and lack predators, parasites and diseases that control their numbers. Invasives often form single species stands ("monocultures") that decrease native plant and animal diversity. In contrast, a diversity of native plants provides food and cover for a variety of animals. Private, local, state and federal groups have begun to monitor and control the spread of a number of invasive plants.

Approach

Decide as a group if you want to explore one of the following questions, or a question of your choice:

- Is there an invasive plant problem anywhere in your area?
- Can you document the presence of an aggressive invasive in your area?
- Can you determine any factors that have led to the spread of this invasive throughout your area?

Materials

Specimen of invasive plants, magnifying glass, compass, weed identification guide, data sheet, map of the area, quadrat sticks or hula hoops, and blank paper

Problem #2: Species Competition

One explanation for species diversity is that different species reduce direct competition with one another by living in different areas, eating different foods, etc. For example, cliff swallows nest on cliffs and eat insects in the air, while hairy woodpeckers nest in holes in trees and eat insects found under tree bark. But scientists do not entirely understand how so many plant species can co-exist in some areas. Many theories are related to the way different species avoid growing in the same place and avoid flowering at the same time. Still, more research is needed.

Approach

What questions does your group have involving species competition? Decide as a group if you want to explore one of the following questions, or a question of your choice:

- Are some plant species more abundant under full shade? Are other species more abundant in full sun?
- Are some plants more abundant in high or low moisture areas? High or low wind areas?

Suggestion: You do not need to identify every species, so long as you can distinguish them from one another. Make up fun names for ones that you distinguish, but can not identify. You can take pictures and e-mail them to experts for species identification.

Materials

Map of area, tape measure, quadrat sticks or hula hoop, field guide, data sheet, compass, magnifying glass, and flagging tape

Individual Field Problems

Problem #3: Insect Communities

Did you know that there are more species of insects than all other animals combined? Insects are important because they play a number of vital roles in nature. Some, such as bees, pollinate flowers. Others, such as dragonflies, control the numbers of other insects by eating them. Most insects serve as prey (food) for other animals including fish, frogs, birds, and bats, among others. Many insects are herbivores (plant-eaters) that are specialized to eat certain plants, while other insects are specialized to hunt in a certain way (i.e. ambush bugs hide in flowers that they resemble and wait to snatch bees, wasps, and butterflies with their huge front legs). Consequently, the plants in an area largely determine the insect community found there. Usually, a more diverse plant community will harbor a more diverse insect community.

Approach

What question does your group have regarding insect diversity? Decide as a group if you want to explore one of the following questions, or a question of your choice:

- Are different kinds of insects found in areas with high biodiversity versus areas with lower biodiversity?
- Are certain plants more attractive to a wider number of insects?

Suggestion: In order not to compare apples to oranges, if you choose to compare insect populations in two areas, try to choose two areas that are structurally similar (i.e. both areas lack trees, both areas are forested, etc.).

Materials

Sweep nets, white sheets, pitfall traps and trowels, bug boxes, plastic bags, insect guides, map of area, and data sheets

Problem #4: Bird Populations

Birds live virtually everywhere and play important roles in nature. Each species has requirements for nesting sites, food, water, and shelter. Birds control the populations of other animals, especially insects, but also disperse the seeds of numerous plant species. No doubt, there are birds feeding, if not nesting, somewhere on your school grounds. Finding a nest can lead to other exciting discoveries.

Approach

What question does your group have regarding birds in relation to the area you have chosen to look at? Decide as a group if you want to explore one of the following questions, or a question of your choice:

- Are there more bird nests in the prairie than the lawn?
- Where do adults find food for their young?

Suggestion: As a starting point, your group can search for a bird nest or nests somewhere in your area. Observe the nest. Find out as much as you can about the bird that built it. One way to find a nest is to spot an adult carrying food, then follow the bird to its nest. An agitated adult is a clue that you are near its nest. If you listen carefully, you can often hear nestlings or fledglings (young birds that have left the nest) begging their parents for food.

Materials

Binoculars, bird guides, map of area, stopwatch, data sheet, and blank paper

Problem #5: Mammal Populations

Small mammals, including mice, voles, moles, and shrews, are quite abundant in fields, prairies, and woods, but how many have you seen? Occasionally, we may see a burrow, but which animal made it? Mice and voles are herbivores (plant-eaters) and eat enormous quantities of vegetation. The meadow vole, for example, eats almost its own weight each day in leaves, flowers, seeds, roots, and tubers! By their tunneling, moles aerate the soil and reduce erosion by allowing rain to penetrate the soil. Shrews are voracious predators (animal-eaters), sometimes consuming more than their own weight each day in invertebrates (animals without backbones such as insects and spiders), young mice and fungi.

Approach

We would like to discover an easy and inexpensive, yet effective way that students can record animal tracks in school grounds to determine which species are present. We have tried various techniques (track tubes with homemade ink and store-bought inkpads, sprinkling wet sand and dry flour), but are still not satisfied. Can you hone the method and provide evidence that your method works? If you can determine an effective method, what question does your group have regarding mammals in your chosen area? Decide as a group if you want to explore one of the following questions, or a question of your choice:

- Are there more mammals of a particular species in one area than another or a great diversity of species in one area than another?
- Are certain plants more attractive to a wider number of insects?

Suggestion: It may be interesting to check for the presence of small mammals on your school grounds before you plant your restoration, then continue to monitor the mammals as you implement your restoration.

Materials

Track tubes, ink pads, wooden boards, clay, flour and sifters, mammal identification guides, map of area, and data sheet