Iowa Science Teachers Journal

Volume 36 | Number 3 Article 6

2009

Earthwatch Expedition: Taking Research Experiences to the Classroom

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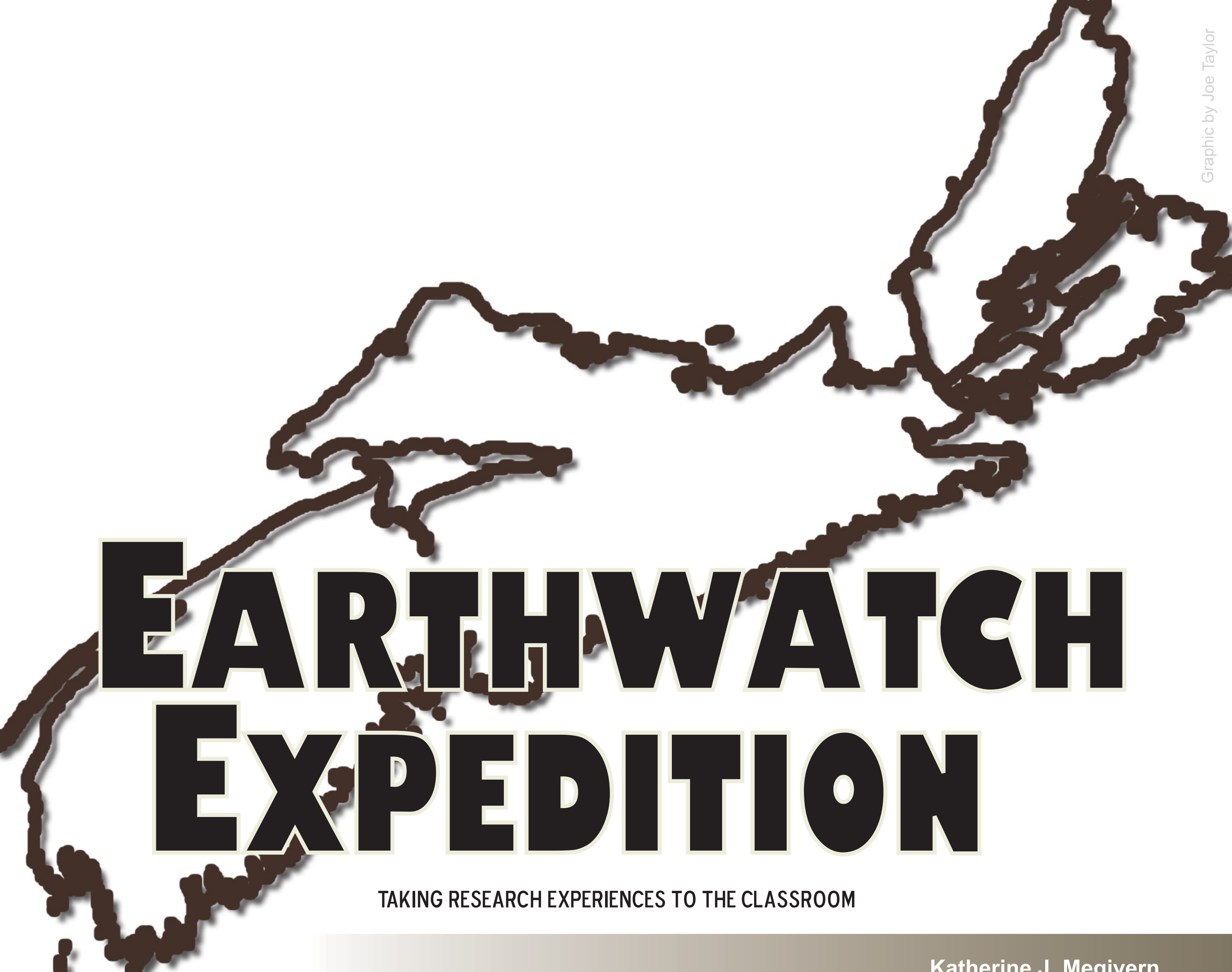

Graphic by Joe Taylor

Earthwatch Expedition

TAKING RESEARCH EXPERIENCES TO THE CLASSROOM

Katherine J. Megivern

ABSTRACT: I participated in the *Live from the Field* Earthwatch Expedition - Mammals of Nova Scotia, through a fellowship awarded by Wells Fargo. During this experience I participated in research to study the abundance of mammals in Nova Scotia and determine the effect of climate change on natural systems. After this experience I developed an inquiry project for my students in which they study the populations of insects. The students develop their own questions, collect data and make sense of their research. By investigating populations, students are encouraged to see the wonderful biodiversity right in their backyard! *This article promotes National Science Education Content Standards 1, 2, 4, 6, 7, and 8, and Iowa Teaching Standards 1, 2, 3, 4, 5, and 6.*

Drs. Christina Buesching and Chris Newman, both of Oxford University's Wildlife Conservation Research Unit, study the distribution and abundance of mammals in the ecologically vulnerable area of Nova Scotia. Their goal is to determine the impact of climate change and other environmental changes on natural systems. They also evaluate the quality of the large amount of volunteer data generated in this project to establish protocols that can be used effectively by volunteers.

I was able to work with these researchers as a volunteer while participating in the Live From the Field program of Earthwatch. Returning home, I used my experiences to improve a related conservation class project. I know I will apply my new skills and knowledge to the classroom for years to come.

Ecology of Nova Scotia

One of the most critical reasons to monitor mammals is to establish baseline population data. Newman emphasizes this importance with the story of the water vole in England, where he and Buesching have also conducted mammal research. As the voles' numbers dwindled perilously, no one could be sure of the extent of the problem because no one had established their numbers in previous years. These numbers are critical in gaining legal status for endangered species. Data are also important, of course, in monitoring biodiversity, managing endangered ecosystems, and informing decisions involving human activities such as hunting and forestry.

Nova Scotia provides a valuable baseline for determining the impact of human activities because of its relatively undegraded, diverse fauna and its sensitivity to environmental changes. Nova Scotia's sensitive position is due to its location near the January 0^{O} frigid isotherm and the Gulf Stream current which, as they shift, can affect mammal populations.

The scientists' webpage at http://www.wildspirits.ca/ describes some recently documented changes in Nova Scotia, including

- an increase in snow-free winter months
- later spring thaw
- increased spring flooding
- dryer, hotter summers

Scientists have documented many examples of how these changes have affected wildlife. Non-native white-tailed deer are outcompeting native moose due to climate change and parasites. The Eastern coyote has returned and is competing for small mammals as food. With seasons delayed, the snowshoe hare is often turning white before snow season and turning brown before snowmelt in the spring, increasing their visibility to predators twice a year. While volunteering on this project, my research group saw low numbers of mouse populations that Buesching and Newman attribute to asynchronous resource acquisition and availability.

The Volunteer Experience – Stories to Share

The experience of collecting data as a real scientist was extremely valuable for my classroom teaching. I learned nuances concerning how science works and how scientists make sense of both direct and indirect evidence. I knew the skills and stories that I took back to my classroom would benefit student learning and enthusiasm for science. My experience on this expedition was characterized by immense consolidation of ecological principles, learning of new skills, excellent food and accommodations, and entertaining as well as informative scientists.

On this expedition, we focused especially on the mark and recapture of small mammals and feces quadrants for larger mammals. Two main areas were sampled. One was at an inland site, Cook's Lake, near Lunenberg, and the other was near East Port Medway, adjacent to the coast. Buesching and Newman expected that the coastal site would provide a chance to observe and trap different types of animals, such as the flying squirrel and rock vole. Indeed, on the final day of trapping, the first rock vole recorded in Nova Scotia was found in one of my traps! Buesching would report this important finding to the Mersey Tobeatic Research Institute (MTRI) at the end of the trapping season.

No method used in monitoring distribution and abundance is completely comprehensive. Using a variety of methods produces the most accurate estimates of the mammals in the area. Methods used on this expedition included direct methods, such as sightings, and indirect methods, which help evaluate distribution and abundance of “shy” species. These indirect methods include field sign transects and quadrats, vocalizations, footprints, and droppings. Live trapping was used for those species for which it was humane and effective. Wildlife cameras and bat echolocators were engaged but not effective so early in the season.

Our daily schedule generally consisted of checking traps in the morning and in the late afternoon. In between, we reinforced, expanded, and consolidated our knowledge. We also spent time discussing our “big picture” of ecology. Information gained and activities from the experience included:

- learning to use statistical tests to determine population estimates from random sampling of feces via the quadrats and the mark and recapture data drawn from trapping.

- learning humane ways to trap and mark mammals using fur-clipping as well as which animals are less likely to be stressed by trapping.

- reviewing the geologic setting and history of Nova Scotia and how they relate to mammal distributions.

- learning how human activities such as logging had changed the habitats of Nova Scotia. The original white pine and hemlock forests have been replaced by secondary forests with thick undergrowth because the white pine and hemlock that was logged no longer maintains the high acidity soil environment. The dense undergrowth has likely affected animal populations and makes monitoring species more difficult.

- cutting trees to build trails used by researchers to limit trampling of habitat, by land owners to explore and enjoy their land, and by animals to more quickly move through their habitat.

Back to Iowa – Student Investigations

The Wells Fargo fellowship I was awarded to help fund my research experience included 300 dollars to be used for conservation project equipment and allowed me to expand my current unit on ecology. This expansion and my focus on inquiry-based instruction helps students come to deeper understandings of ecology and the process of science. Through evaluation of real data, students gain an understanding of biomes, animals' requirements for life, interrelationships among animals and between animals and other parts of the environment, diversity of animal structures, classification, documentation and scientific writing, and change and consequences. There are interdisciplinary components including art (drawing maps, at minimum), computer graphics, technology (computers, digital photography, GPS, weather units), language arts (writing, public speaking), and statistics.

I knew my high school students would benefit greatly from conducting their own population and biodiversity studies like I had done in Nova Scotia. Yet, I would have to adjust the scope and scale to what is available. Before my Earthwatch experience, my students' inquiry projects were limited to insect biodiversity. Since then, I have added a trail camera, Berlese apparatus, tracking tube equipment, bird call identifier, and guidebooks. Now, each group of students still samples insect populations (because insects will usually provide the numbers needed for conducting statistical tests) as well as one other animal group and records relevant data on weather using a Kestrel weather unit, and location using a GPS unit.

ONLINE RESOURCES

A copy of the student handouts are available at https://sites.google.com/site/whyoutdoors or by contacting the author via e-mail.

Getting Started

Students will be investigating organism populations in an area or several areas over time. Importantly, I do not just hand out a packet and expect students to fend for themselves. Inquiry-based projects require much from students and the teacher. As groups plan and conduct their study, I am constantly walking around listening to conversations and asking questions or making suggestions as needed. For example, I ask questions such as:

- "What kinds of data could we collect?"
- "How will you document your data?"
- "If you want to have your data by _________, what things might you have to do outside of class?"
- "How will you prevent excess disturbance of your site?"
- "How will you ensure the safety of others who might come across your site?"
- "How will you divide up the work so that you maximize your productivity while we are outside?"

I check the study area for hazards before beginning the project and set area boundaries that will allow constant monitoring of the students. I also remind students to dress for the range of weather conditions possible. Depending on your site, you may need to secure proper permission to use the site. Because many study areas are accessible to other people, the safety of passersby during the project must be addressed. For example, if pitfall traps are dug, the holes must be marked, perhaps with flags.

Before starting the inquiry project, my students have already learned basic ecological principles such as food chains, food webs, dichotomous keys, biodiversity, trophic levels, energy transfer between these levels, photosynthesis and respiration.

While these authentic inquiry experiences are wrought with ambiguity, their open-ended nature makes each day a new, exciting experience for me and the students! A rough time line and description of the inquiry project follows, but don't be afraid to spend a few extra days on various portions of the project.

Day 1

I first introduce students to the project by telling them that they will be researching populations of insects and other organisms in an area. Many students wonder why scientists might do something like this, so we brainstorm the relevance of insects as environmental indicators. Think-Ink-Pair-Share works well here. While students write and discuss their ideas, I walk around to get a sense for what connections students are making. Some questions I use to guide student thinking include

- "If we catch insects in an area, how can we use them to draw conclusions about the ecology of the area?"
- "Consider the pyramids of energy, mass, and numbers. If we count the insects and find different numbers in two different areas, what conclusions could we draw about the ecology of the two areas?"
- "If we find different numbers of species (or orders) in two areas, what could this tell us about the ecology of the two areas?"
- "If there is one main food item on the menu at the producer level, what biodiversity levels would you expect at consumer levels?"

For increased relevance, I sometimes introduce an extension plan in which students consider a more applicable purpose for the study such as:

- Conducting baseline surveys for a site to be developed in some way, such as commercially or into a natural area/outdoor learning center.
- Compare school grounds with natural areas through a field trip or students sampling natural areas off-site for extra credit (with parent approval).
- Compare insect biodiversity data with plant biodiversity data for the same area.

Day 2

Now that we have developed a purpose and relevance for the study, we begin brainstorming methods to track insects. Again, I have found Think-Ink-Pair-Share to be useful to get students actively bouncing ideas off one another.

After some brainstorming, I demonstrate one or more sampling methods used by ecologists or have students

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research ecological population sampling within their groups online. I am sure to discuss random sampling and mark-recapture as methods of estimating populations.

For more advanced students I introduce statistical tests to determine diversity and significant differences in numbers between sites. The Simpson Diversity Index, a measure of diversity, and the Chi-square test, to determine significance of differences, are recommended for students. I often use M&M color populations as a fun way to introduce these statistical tests. Unless students have had a statistics class, they are likely to require help throughout the project on manipulating and interpreting their data. I introduce students to the statistical tests to demonstrate how scientists use various tools when making sense of their data/observations.

Day 3
As a class, we go outside to examine the study area. Student tasks are to:

1. Sketch a map of the area on which to later mark their project locations.
2. Think about and record answers to: What questions could be answered by trapping/sampling insects?

I remind students that they must be able to explain why their question is important or interesting. For example, it could be important to know where insect populations and biodiversity are highest when deciding where to locate a picnic table in a yard. A parameter that can also help generate ideas is to require questions that will involve the comparisons of numbers of individual insects and numbers of different orders of insects.

By being outside and contemplating activities or purposes of various spaces, the students are better able to create meaningful questions. Of course, some groups struggle with this task, so I sometimes have to ask some leading questions such as

- "What do you want to know about the insects in this place?"
- "Why would you want to know that?"
- "What things might humans do in a space like this?"
- "What would we want to know about insect populations before we do those things?"

Days 4-5
Next, students pair and share, generating a class list of questions. As a class, we decide which questions are testable, and refine others so that they are testable on school grounds and in the time available. Examples of testable questions include

- "How does insect biodiversity compare between areas of tall grass and areas of short grass?"
- "How does the biodiversity of flying insects compare under a maple tree and under a pine tree?" (This could be important in deciding what kind of tree to plant in a certain area.)
- "What color attracts the greatest numbers of species (or orders) of insects?" (What color should you wear if you don't want to attract insects?)

An example of a student question that is not testable as written is

Which insects prefer more insulation in their habitat?

One possible rewrite is

How does the number of insects and numbers of different orders of insects compare between a more-insulated brushy area and a less-insulated lawn of short grass?

Some questions may be interesting but unusable for testing, such as

What insects are native to the area?

I assign groups of no more than four students. Each group chooses one question to investigate and decides on methods and materials needed. I ask students to determine responsibilities of individuals and the group.

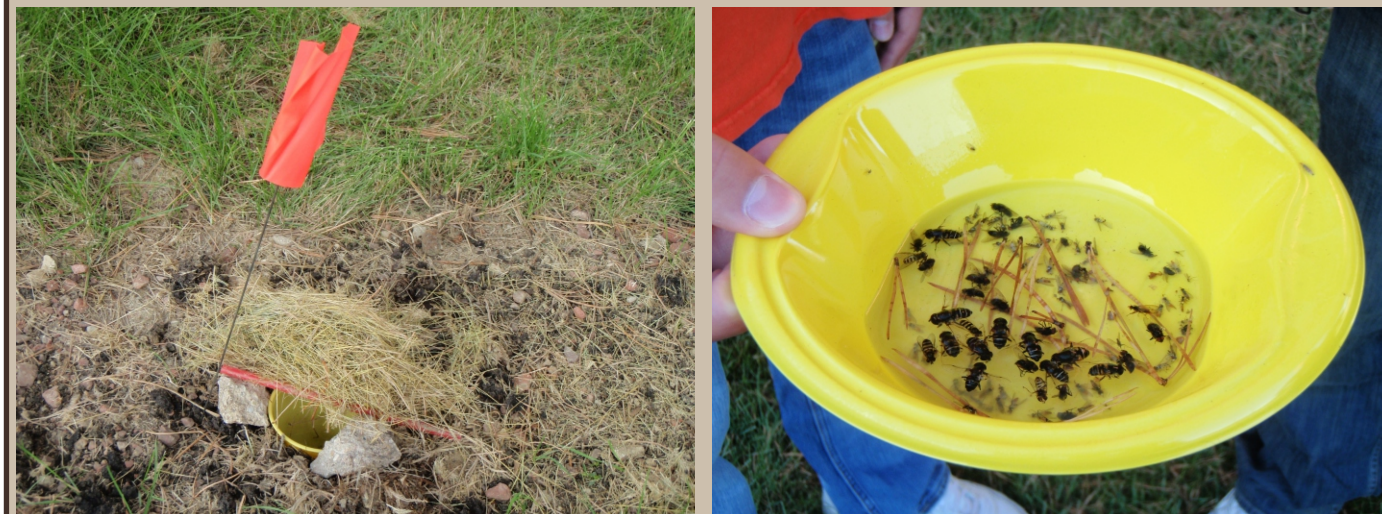
I have each group discuss their strategies with me so that I can provide guidance and help. Once students have met with me, they begin designing and gathering data collection tools.

Day 6
We head outside to set up our data collection devices (Figure 1).

Days 7+
Students collect trapped insects and reset traps as needed unless it is the last day of collection. The number of days for collection can be adjusted as needed. Collection of over 10 insects is needed for a reliable Chi-square test. If insects are to be killed, which may allow for easier identification and checking of identifications by the teacher, they can be killed humanely and without the use of even moderately hazardous chemicals by freezing them in zipper bags.

I recommend that students identify insects to order level. The order level can substitute for the species level when using the Simpson Diversity Index. A simple key to main insect orders and an example insect to key out may be found at http://www.backyardnature.net/in_order.htm. For a key to all insect orders, go to
http://www.projects.ex.ac.uk/bugclub/bugid.html

FIGURE 1
Collection devices used by students.



Pitfall trap for crawling insects, complete with marker flag and a cover that's inviting to insects.

Bowl trap for flying insects – water in insects' favorite-colored bowl with a drop of soap to break surface tension and allow sinking.

Final Days

As students finalize their collections they need to restore the land to how they first found it. Once students have their data collected, they turn their attention to completing identifications, statistics, lab reports, presentations, peer evaluations, and assessment questions. As students work to make meaning of their data, I engage groups in discussions about what their data might mean, alternative interpretations, and ways they could have improved their investigation. These reflective discussions encourage students to see science as more than data collection.

Conclusion

My experience in Nova Scotia not only improved my understanding of scientific concepts, but of how science works. By collecting, analyzing and discussing data, I was having to apply knowledge and think deeply about concepts. When students are faced with similar challenges they also gain valuable knowledge about science and the scientific process as well as develop critical and creative thinking skills applicable in any field.

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