INNOVATIONS

Using eBird to Integrate Citizen Science Into an Undergraduate Ecology Field Laboratory

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Abstract: Encouraging nonprofessionals to participate in ecological research through citizen science programs is a recent innovation and an effective strategy for gathering ecological information across broad geographical areas. In this paper, we demonstrate how reporting field-based observations through eBird, a citizen-based birding and data-recording program, can be used as a lab activity in an undergraduate ecology class. This exercise exposes students to worldwide data collecting networks in which non-scientific communities serve as major stakeholders. This lab activity also introduces basic field techniques in ornithology and allows students to answer inquiry-based research questions using a citizen science database.

Key words: citizen science, ecology teaching, eBird, participatory research

INTRODUCTION

Citizen science provides an opportunity for members of the general public who do not have formal scientific training to contribute to scientific research (Cooper et al., 2007; Bonney et al., 2009). Here, individual volunteers or networks of volunteers perform or manage research-related tasks such as observation, measurement, data compilation and simple computation. The spatial scale of citizen science can be local, regional, national or global (Devictor et al., 2010). Citizen science programs are a venue for professional scientists to interact with non-scientific people who are interested in scientific aspects of nature. Furthermore, such programs allow the public to contribute to scientific research programs and to be an important stakeholder in scientific research studies (Schmeller, 2008). Such programs are an active and effective means of communication between professionals and laypeople, where scientific information is disseminated through educating the public and making them aware of scientific issues (Losey et al., 2007).

During the past few decades, citizen science programs have evolved to have more emphasis on scientifically sound practices and measurable goals for public education (Silvertown, 2009). Recent technologies, particularly the internet, have allowed citizen science data to be collected and accessed more efficiently. Moreover, increasing prevalence and use of user-friendly electronic devices that can record information, such as mobile phones, data loggers, personal digital assistants, and high resolution digital still and video cameras, have made data collection easy for the participants of citizen science programs (Sanford & Rose, 2007).

Applications of citizen science in ecological research and biodiversity conservation

Citizen science programs are being used extensively in global environmental monitoring (such as climate and water resources) and biodiversity monitoring. Such continuous long-term monitoring is essential to understand the causes and effects of biodiversity loss in order to promote conservation efforts and curb species declines. Many citizen-based biodiversity monitoring programs assess the survival and reproductive success of wildlife (Lepczyk, 2005; Ries & Mullen, 2007) with many of these programs focusing on wildlife phenology (e.g., migration of birds, budburst in trees, or flowering of plants). Such investigations are important in assessing the effects of global warming and global climate change on ecosystems and biodiversity in different geographic areas (Lawrence, 2009; Mayer, 2010). Citizen science networks allow scientists to achieve research objectives more feasibly and cost-effectively than would otherwise be possible. For instance, employing well-trained professional scientists or skilled technicians to perform every step of a research project could be economically unfeasible and recruiting an accomplished task force, practically impossible (Ottinger, 2010).

In addition to long-term monitoring, citizen science is also being used as a means of public education and outreach to promote the science-based awareness of natural resources and wildlife (Jordan et al., 2009). Citizen science projects often generate enthusiasm among the general public and encourage the younger generation to be engaged in scientific research (Nerbonne & Nelson, 2008). Some programs may even provide extra benefits to the

community, such as the provision of specific materials specifically for use by primary or secondary school students. As such, citizen science is one form of informal science education. To encompass all these multilateral aspects of citizen science, this field is now frequently referred to as "participatory scientific research" (Raymond et al., 2010).

Limitations of citizen science programs

Data collection in a citizen science program is performed by laypeople who may not have strong scientific backgrounds, training in field survey methods, or strong species identification skills. Therefore, there could be multiple errors in citizen science based datasets including species misidentifications as well as bias with regard to the independence of sampling events in time and space (Wagle, 2000). Moreover, complicated sampling methods and high-tech equipment that require special training cannot be used in citizen science programs. Similarly, citizen science programs are often only effective in monitoring charismatic species that are easily identified by laypeople and are not suitable to study taxonomically and ecologically cryptic species that require specialized skill for identification (Bonney et al., 2009). At times, sampling effort is inconsistent in citizen science programs and may vary within or between years (Ottinger, 2010). Furthermore, high inter-observer variability may exist among participants depending on their experience and science-based training. Therefore, it should be noted that data generated by citizen science programs need to be handled and interpreted carefully.

Examples of citizen science projects

Following are examples of citizen science programs that have been used extensively in wildlife and environmental research that students can explore before conducting this lab activity. We recommend that lab instructors provide a brief introduction about other citizen science programs before the field activity.

Christmas Bird Count: A citizen science program implemented by the Audubon Society. This program aims to capture a snapshot of bird populations over many decades and to provide insight on the dynamics of bird populations across North America during the early winter. Volunteers gather information on birds over a three-week period at the turn of the year (December-January), and submit their observations to a review panel. Afterward, cumulative data are made available to the public and researchers for review and scientific study. Website: www.audubon.org/bird/cbc

NestWatch: A nest-monitoring project developed by the Cornell Lab of Ornithology in collaboration with the Smithsonian Migratory Bird Center. NestWatch serves as a nest-monitoring scheme to record reproductive success for all North American breeding birds and provides useful information to the general public about nesting biology. Website: http://watch.birds.cornell.edu/nest/home/index

Monarch Watch: An educational outreach program run by the University of Kansas that monitors the abundance, habitat use and migration of the Monarch butterfly. The Monarch Watch website provides detailed information on the biology and conservation of Monarch butterflies. This project involves capturing Monarch butterflies during the migratory season, tagging them, and attempting to recover the tags or to recapture tagged butterflies. The tagging program provides a great deal of information regarding Monarchs, their migration, and geographical range (Wells, 2010).
Website: http://monarchwatch.org/

Journey North: An internet-based citizen science database that tracks annual biological events, particularly how seasonality and climate change affect wildlife migration and ecosystem dynamics. Through field observations, participants record the migration patterns of wildlife in response to seasonality. Species of interest include Monarch butterflies, robins, hummingbirds, whooping cranes, gray whales, and bald eagles, along with other birds, animals, and plants. Using the nationwide data generated by participants, migration maps can be generated. Website: www.learner.org/jnorth

THE ACTIVITY

Background information

One of the largest and fastest growing global biodiversity data resources available is eBird. eBird is a real-time, online, freely-accessible, citizen science program coordinated by the Cornell Lab of Ornithology and the National Audubon Society (http://ebird.org/content/ebird). Launched in 2002, eBird has evolved a long way to enhance public participation, improve data validity, and widen data access to the research community. eBird is a rich database for bird abundance and distribution data on a variety of spatial and temporal scales. One strength of eBird is that it utilizes data collected by both professional and recreational bird watchers to generate enormous amounts of data.

eBird compiles bird sightings and abundance data from an international network of users and makes them available to the global community of educators, ecologists, land managers, landscape biologists, ornithologists, and conservation biologists. These data are currently being used in scientific analyses of global bird distribution and abundance (http://ebird.org/content/ebird/about/ebird-publications). Utilizing a user-friendly and intuitive website, eBird makes it easy for bird watchers to submit their observations and visualize all submitted eBird data via maps, graphs, charts and tables. eBird also provides users opportunities to network with other birders in their areas, search for the best places to see birds, and generate and catalogue bird lists.

The eBird database collects the following information: year/month/day/time of birding, the location of birding, data collection mechanism (i.e. point counts, transects, and area searches), and a checklist of all the birds seen or heard during the birding event. Automated data quality filters developed by regional bird experts review all submissions before they are entered into the database. Local experts review unusual records that are flagged by the filters. This review process enhances the validity and reliability of the information generated.

Given the increasing popularity of citizen science programs, our intention was to introduce the concept of citizen science to undergraduate students in a field-based ecology lab. Our lab demonstrates how students can contribute to citizen science efforts by collecting meaningful ecological data and provides students an opportunity to develop and answer inquiry-based research questions.

Student field observations

We conducted this activity in a single 3-hour session of an undergraduate ecology lab during the Fall of 2010 and 2011. We repeated this activity in eight classes, with class size ranging from 10-12 students. We took each class to two previously scouted locations where high levels of bird activity were expected. Suitable birding areas can be identified using the eBird website or by consulting local bird clubs. We provided students with colored pictorial identification guides for regional birds likely encountered. In addition, we used the following field guides for bird identification: *Birds of Eastern and Central North America* (Peterson and Peterson, 2002) and *National Geographic Field Guide to the Birds of Eastern North America* (Dunn and Alderfer, 2008). We also provided each student with a pair of binoculars.

At each location, a student (or groups of students) geo-referenced the birding site with latitude and longitude using a GPS reader and made notes about the surrounding habitat and general survey area. In addition, students noted the start time and the number of people involved in birding. Surveys of each location took approximately 1 hour. The instructors (or regional bird experts) led the walk and each student was instructed to document the number and type of species encountered and, if possible, record the sex, age, and health/body condition of each bird. Records were collected from visual encounters as well as recognizable vocalizations. Students also noted whether they identified every bird they encountered in the area or just some of the birds (when entering data, it is essential to know whether you have a complete checklist or not). The attached survey form (Figure 1) was used to record information. Students reported information using the traveling count method (recommended by eBird) because it allows participants to observe a good proportion of the birds in a given area (for more information on survey types, refer to supplemental materials or consult the eBird website: http://ebird.org/content/ebird/news/are-you-really-making-casual-observations). Students returned to the classroom for the final hour of the lab period, registered as eBird users, and submitted their checklists according to the instructions provided on the eBird website.

Student learning objectives

The primary objective of this lab was to introduce the concept of citizen science to students and help them understand the importance and limitations of such efforts. Citizen science databases possess immense scientific value by providing long-term data on distribution of species and occurrence of ecological phenomena across different broad spatial scales. Students were able to understand this, firsthand, as they developed their own inquiry-based research questions at various locations using the eBird database.

This lab activity also exposed students to the

eBird Survey form

Location: _____

Date: _____ Starting/ending Time: _____

Latitude: _____ Longitude: _____

Survey method: _____ No of observers: _____

Area: _____ Length: _____

	Abundance of species (delineate with hatch marks)			
Species	Males	Females	Juveniles	Unsexed
Additional Notes				

Fig. 1. Sample eBird survey form for students.

world of recreational birding. An important goal of biology education is to allow students to interact with nature and assist them in understanding key elements of ecosystems; and in this lab students identified both birds and their associated habitats. Students performed traveling counts, a commonly used avian survey technique. We also used this opportunity to describe other survey techniques used to count wildlife such as transect surveys, aerial counts, and point counts.

Assessment questions

Students were given the following assignment to reflect on their experience with citizen science:

1. Print the dataset and email it to yourself using eBird.
2. What are the advantages of citizen science programs to the public and the scientific communities? Limit your answer to two advantages to the general public and three advantages to the scientific community. List three potential limitations, drawbacks, or challenges of citizen science programs and briefly discuss them.
3. What kinds of biological studies could be developed using the eBird database? What kind of ornithological or ecological questions could be answered by analyzing information from the eBird database? Limit your answer to three different ecological questions/biological studies. Provide examples in your answer. Hint: climate change.
4. Think about one key ecological or environmental question that can be investigated using the eBird database. Then, through statistical and graphical analysis of eBird data, answer your question. Some sample questions are: "How are the distributions/abundances of common/rare birds changing in your home state/college town?" "Has intensification of the land-use activities in your home state affected the abundance of birds?" Use appropriate graphical and statistical analyses. Your answer should contain at least one graph/plot and the text should be limited to 200 words.
5. Briefly describe two additional citizen science programs that are not listed in this handout. Include program objectives, type of data collected, and inferences made with data collected.
6. It was emphasized that scrutinizing citizen science databases for accuracy of species identification is of high importance. Assume that you are in charge managing the eBird database. Discuss how you could test the validity of certain doubtful records such as isolated records of rare birds or species being recorded outside their natural ranges. Discuss how the scientific community can improve the accuracy of data collected by citizen volunteers. Limit your answer to 200 words.
7. Write a brief reflection of your experience doing citizen science. What is your opinion about being a "citizen scientist" in an ecology lab?

Student opinions about the lab

Citizen science turned out to be a completely new concept to most students. The majority of students were unaware of citizen science. The few who had heard about citizen science programs had never participated in them. For all the students, this was the first time that they realized how large-scale ecological information collected by citizen volunteers could be used to address global environmental issues. Overall, students found this activity informative, enjoyable, relevant to their lives, and they strongly recommended that this lab be continued in the future. This exercise made students feel that they were actually making a difference and contributing to something larger than themselves; this seemed to provide students with additional incentive (beyond simply earning a grade) to successfully complete this lab activity.

The following comments summarize student feedback from the lab:

"No one in our lab section had ever had any experience in birding, but with the species guide and binoculars, we were able to correctly identify about eight different species of birds. This gave us greater insight into the diversity of the bird populations in Clemson. Citizen science, in my opinion, is a great opportunity that I would be unaware of without this lab."

"In my opinion, this is a good lab for introducing students to citizen science programs. It is important for a class to relate to real life, and this lab definitely relates to realistic research. Before this lab, I had never heard about citizen science programs, and I was surprised at how often they are used."

"It really made me feel that I was actually making a difference and that there was more of a reason for me to be performing this lab rather than just for my educational gain. I really felt like I was benefitting a program and that there was more of a purpose for my actions and work. I almost feel as if citizen science should be taught more to the public and advertised more than what it already is."

The student feedback we received indicated that our lab effectively introduced students to citizen science and conveyed the importance of student participation in citizen science programs. It also demonstrated to students how they could contribute to an understanding of global ecological processes and use citizen science databases to develop and address research questions that were relevant to their lives. Based on our experience presented here, we strongly recommend using this lab in undergraduate ecology or general biology classes.

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