Implementing the FrogWatch USA Citizen Science Program as a Versatile Ecological Educational Tool

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ABSTRACT
Citizen science programs, like FrogWatch USA, offer simple training guidelines to collect field data, which provides records across broad geographical locations, allowing for the study of population trends on a large scale. Due to the relative ease of implementing the protocol, this program can easily be used in undergraduate and high school courses to provide an active learning environment and independent research opportunities. Here, we describe how FrogWatch USA call surveys were paired with traditional trapping surveys and conclude that call surveys can be useful in ecological monitoring. We suggest recommendations on how this program can be utilized in different settings and across disciplines.

Key Words: amphibian, biodiversity, ecology, experiential learning, remote learning.

Introduction
As many courses and research projects moved to remote learning with the COVID-19 pandemic, educators had to rethink ways to provide meaningful opportunities to continue field work with their students. Even prior to the pandemic, an interest by academics to provide virtual field trips was on the rise, with a webinar in April 2020 coordinated by Undergraduate Field Experiences Research Network, “Virtually Field Tripping … What Works?”, planned well before many schools shut down. Lessons learned from redesigning coursework to provide remote field experiences may help educators broaden the possibilities for both collaborative and independent research well into the future.

Due to the inclusive nature of citizen science, many of these programs can easily be incorporated into curricula and empower students to collect data independently. Further, many programs are rebranding themselves as community, civic, or neighborhood science in an effort to potentially increase inclusivity. Citizen science programs are valuable to education, monitoring, and research in a variety of capacities (Shah & Martinez, 2016; Krabbenhoft & Kashian, 2020). Specifically, ecological monitoring programs contribute to traditional long-term datasets and fill data gaps while being relatively cost-effective (Bonney et al., 2009; Hadj-Hammou et al., 2017). Volunteers of these programs can gain insight into the scientific process, ecological knowledge and principles, and local species. Additionally, these programs can be incorporated into high school and undergraduate biology courses to promote research skills, quantitative reasoning, and critical thinking. Thousands of programs exist (such as iNaturalist, National Phenology Network, and Journey North) and are easily accessible online (visit scistarter.org). For example, a lab centered around the citizen science program, eBird, at Clemson University exposed undergraduates to data entry and collection via a global database and common avian field methods (Surasinghe & Courter, 2012). Educators should consider implementing citizen science in their classrooms to benefit both students and these programs.

FrogWatch USA, a Model
FrogWatch USA is a citizen science program through the Association of Zoos and Aquariums (AZA), where volunteers are trained to identify and record observations on local wetland conditions and vocalizations of frogs and toads. The program is distributed by a network of chapter coordinators composed of AZA-accredited zoos and aquariums, colleges and universities, and county and state parks and other environmental organizations. Participants follow a standardized protocol and submit data to an online database. The protocol requires participants to register their site and monitor at least 30 minutes after sunset. Following a three-minute listening period, participants record time, weather, species heard, and call intensity (for AZA’s full protocol instructions, visit https://www.aza.org/frogwatch-monitoring-protocols?locale=en). Some benefits of this survey technique are that, generally, regions have a relatively small set of amphibian calls, which are often distinctive and easy to learn; wetlands are relatively ubiquitous, and many are accessible to the public; sampling time takes only five minutes, and no permits are required to handle animals; and the main cost is travel to the field site. Although volunteer certification is not necessary to conduct the protocol, individuals can become certified volunteers through training (to learn how, visit AZA’s volunteer page, ...
https://www.aza.org/frogwatch-usa-volunteers). To better understand the program’s use as an ecological educational tool for undergraduates, we implemented it along with traditional collection techniques during a seasonal amphibian monitoring survey.

○ Methods

We used live trapping techniques, such as pitfalls traps, wooden cover boards, minnow traps, and leaf pack traps (see Wilson & Gibbons, 2009 for a review of trapping methods), twice per wetland and call surveys using the FrogWatch USA protocol weekly from April to July 2013. Four wetlands (one at James H. Barrow Biological Field Station, Portage County, Ohio, and three in Geauga County, Ohio) were surveyed to determine the presence of amphibian species. Handling permits were obtained through the Ohio Department of Natural Resources, and decontamination protocols were used to prevent transmission of amphibian diseases.

This study was carried out by six undergraduate students as a senior capstone research project and included 14 trips into the field for trapping and 12 trips into the field for call surveys. Traps were set in early evening the day before a sampling event and took approximately 30 minutes per site to set and 15–30 minutes to collect, while call surveys took 5 minutes per site. Data from this study were submitted to FrogWatch USA each week and were also used for research experiences and capstone projects for students.

○ Results

Several species were detected only during call surveys or only during trapping surveys (Table 1). Each sampling technique had constraints and was biased toward certain species. In this study, some species tended to avoid traps, trap size limited the ability to capture species across all size ranges and life stages, traps worked properly only if a wetland was adequately inundated, salamanders and tadpoles/larvae do not vocalize, some species vocalized louder, and many species had a distinct time of year that they vocalized. For example, tadpoles of various species and American bullfrog adults were captured in minnow traps but no other trap types. Wood frog froglets were captured in pitfalls traps and under cover boards but not in minnow or leaf traps. Gray treefrog adults were not live-trapped, likely because successful trapping typically requires an arboreal trap that was not used in this study. Since species vary in size, behavior, and activity patterns, a combination of trap types can be helpful to maximize diversity caught. Further, some species may have been present but not heard during call surveys because species like spring peepers and gray treefrogs, when vocalizing at a high intensity, may muffle the vocalizations of species with fewer individuals present, like American bullfrogs.

Although results from this study show call surveys using FrogWatch USA can be effective, more validation studies need to be done to confirm whether data collected from this program can be a true complement to visual surveys that are typically done by professionals. Depending on the learning outcomes of the class activity and the time that can be allotted, call surveys are a way to collect data and provide a meaningful field experience. However, biases in the data should be discussed with students.

○ Further Considerations

In addition to promoting scientific inquiry, research skills, and surveying techniques (Oberhauser & LeBuhn, 2012; Shah & Martinez, 2016), FrogWatch USA along with other ecological monitoring citizen science programs can be incorporated into high school and undergraduate ecology courses. Educators can adopt elements of citizen science or entire programs to fulfill goals of traditional field-based ecology labs for online learning (Richter et al., 2020). FrogWatch USA’s infrastructure (online database and virtual trainings) and minimal equipment allows it to be ideal for this type of learning environment. Since the protocol includes evening sampling and will most likely be done independently by students, this can be used in both a small and large classroom setting and can include a single trip to the field or multiple trips, depending on the classroom objectives.

Another way FrogWatch USA can be incorporated is by using it across different disciplines or courses. For example, a field ecology course can use the program to teach students how to collect data and identify certain species of frogs and toads. This data then can be used by a remote sensing and geographical information system (GIS) course to learn how to map and visualize species distribution. Also, since the program uses locations (sites) that are always associated with a wetland type, it might have crossover with elements in a hydrology course. For example, simple analyses can be used in the classroom to compare species presence/absence and diversity within or across regions, or call intensity can be compared across wetland types and rural vs. urban environments.

Further, FrogWatch USA can be used in tandem with other citizen science programs. These programs might consider other factors that are connected to the amphibian life cycle, such as water quality and rainfall data or larger ecosystem processes such as phenology. For example, an assignment could compare presence/absence data or call intensity with temperature and precipitation data to address potential shifts in phenology patterns associated with breeding and climate change. This pairing of citizen science programs in the classroom may have an impact on students’ learning outcomes in the field of ecology and should be further assessed.

Table 1. Amphibian species detected by each technique are indicated by X.

| Common Name          | Scientific Name         | Call Surveys | Live-Trapping |
|----------------------|-------------------------|--------------|---------------|
| Green frog           | Lithobates clamitans    | X            | X             |
| Spring peeper        | Pseudacris crucifer     | X            | X             |
| Gray treefrog        | Hyla versicolor         | X            |               |
| American bullfrog    | Lithobates catesbeianus |              | X             |
| Wood frog            | Lithobates sylvaticus   | X            | X             |
| Western chorus frog  | Pseudacris triseriata   | X            | X             |
| Spotted salamander   | Ambystoma maculatum     | X            |               |
In this study, we also implemented chytrid fungus testing (a major amphibian disease) to determine if amphibians at sampling sites were infected and to provide an opportunity to teach students how to collect this type of data. The Amphibian Disease Laboratory (https://science.sandiegozoo.org/resources/amphibian-disease-laboratory) sends free swab kits on request and processes samples for a fee. Results are sent back to researchers indicating positive or negative results. Although this is not a component of the FrogWatch USA protocol, this provided a valuable learning experience for students, as disease can be a major contributor to amphibian declines and is important to safe handling of animals in the field.

○ Conclusion
Citizen science programs are beneficial to educators, students, involved partners, and the science community. We believe FrogWatch USA can be used in high school and undergraduate biology courses of any size, due to the program’s infrastructure and minimal equipment requirements. Also, the program’s ability to be used across disciplines and courses along with the potential to be paired with similar citizen science programs makes it ideal for teachers and higher education faculty to incorporate in ecology courses.

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Dougherty Valley High School, San Ramon, CA
Eastern Mennonite High School, Harrisonburg, VA
El Centro College, Dallas, TX
Elkhart High School, Elkhart, IN
Emmett High School, Emmett, ID
Fairhaven High School, Fairhaven, MA
Florida SouthWestern State College, Naples, FL
Freedom High School, Freedom, WI
George Washington High, Charleston, WV
Gillette College, Gillette, WY
Grafton High School, Grafton, WI
Grand View University, Des Moines, IA
Grandview High School, Grandville, MI
Greater Lowell Technical High School, Tyngsborough, MA
Greater New Bedford Regional Vocational Technical High School, New Bedford, MA
Greensburg Salem High School, Greensburg, PA
Harmony School in Innovation, Katy, TX
Hearthwood Hall Episcopal School, Columbia, SC
Hillsboro High School, Hillsboro, OR
Hilltop High School, Chula Vista, CA
Holt High School, Holt, MI
The Independent School, Wichita, KS
Interboro High School, Prospect Park, PA
Kenmore West High School, Buffalo, NY
Kent County High School, Worton, MD
Kettle Run High School, Nokesville, VA
Lake Metroparks, Concord, OH
Lakeville North High School, Lakeville, MN
Lexington High School, Mansfield, OH
Los Fresnos High School, Los Fresnos, TX
Martin Luther College, New Ulm, MN
Mary Persons High School, Forsyth, GA
Marysville High School, Marysville, KS
McDowell Intermediate High School, Erie, PA
Metropolitan Community College, Omaha, NE
Midland Park High School, Midland Park, NJ
Minnetonka High School, Minnetonka, MN
Morgan, NC West Mifflin Area High School, West Mifflin, PA
Moscow High School, Moscow, ID
Mount Abraham Union High School, Bristol, VT
Nassau Community College, Garden City, NY
Northampton Area High School, Northampton, PA
Olivet Nazarene University, Bourbonnais, IL
Palm Tree School, Fairfax, VA
Panorama High School, Panora, IA
Perkins High School, Sandusky, OH
Pike High School Freshman Center, Indianapolis, IN
Pikeview High School, Princeton, WV
Putnam City High School, Oklahoma City, OK
Riverside City College, Riverside, CA
Salem High School, Salem, IN
Saltsburg High School, Saltsburg, PA
Seabury Hall, Makawao, HI
Seneca East High School, Attica, OH
Sherando High School, Winchester, VA
Skyline High School, Sammamish, WA
Snow College, Ephraim, UT
Southeast Community College, Lincoln, NE
South Central Jr Sr High School, Elizabeth, IN
Southern Wells High School, Poneto, IN
Spague High School, Salem, OR
St. Andrew’s Episcopal School, Potomac, MD
St. Clair High School, St. Clair, MI
State Library of PA, Lykens, PA
Stillwater High School, Stillwater, OK
Stouffville District Secondary School, Whitby-Stouffville, ON, Canada
The Summit County Day School, Cincinnati, OH
Sunlake High School, Land O’ Lakes, FL
Tiffin Columbian High School, Tiffin, OH
Unionville High School, Kennett Square, PA
University Christian High School, Hickory, NC
Ursuline Academy, Dedham, MA
Valley View High School, Archbold, PA
Vincennes University, Vincennes, IN
Visitation Academy – Saint Louis, St. Louis, MO
 Walters State Community College, Morristown, TN
Western Piedmont Community College, Morganton, NC
West Mifflin Area High School, West Mifflin, PA
Wheeling Park High School, Wheeling, WV
Worthington Christian High School, Worthington, OH
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