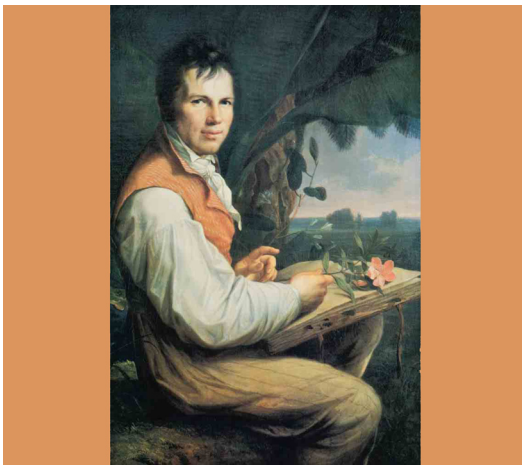

Symposium Reports from the 2008 ESA Annual Meeting

A recurrent complaint of members who attend ESA Annual Meetings is that the large number of concurrent sessions make it impossible to attend all the ones of interest. Symposium Reports from the ESA Annual Meeting is one response to this dilemma. They provide, for those who could not attend, an overview of the symposium presentations and the resulting discussion, as well as a convenient means to identify the presenters. And attendees can review the session! The Editor hopes these Reports are useful, and encourages future Symposium organizers to write Reports for the *Bulletin* when the presentations are given. For detailed instruction for contributions see: ‹http://esapubs.org/esapubs/journals/Bulletin.htm#Typ›.

Symposium 18: Citizen Science in Ecology: the Intersection of Research and Education

The Increasing Acceptance, Role, and Importance of Citizen Science in Ecology

Until recently if one were to ask "who is a scientist?" a common response would be, someone who works at a university or a government agency or in a laboratory. In other words, many of us tend to think of scientists as professionals who have been academically trained and conduct research through the auspices of a research institution, agency, nonprofit organization, or academic institution. Historically, though, individuals from outside this circle of professionals have been instrumental in shaping and contributing to science. In fact, some of the most renowned scientists and ecologists could be considered citizen scientists (e.g., Charles Darwin, Harold Mayfield, Alexander Skutch). But the view that the public could actively contribute to science faded greatly over the course of the 20th century (particularly in the United States) to such an extent that we were left with the view that only someone who was professionally trained could be a scientist. Recently, however, we have witnessed an increase in the extent and acceptability of public participation and engagement in science. In particular, over the past decade we have seen a marked increase in such "citizen science" (Fig. 1). Although explanations of citizen science vary slightly, they converge on this definition: *the involvement of citizens from the nonscientific community in academic research* (Trumbull et al. 2000, Lee et al. 2006).

Because citizen science has seen a dramatic increase in recent years, both in terms of the number of participants and its spread into new disciplines, a symposium was held at the 2008 Ecological Society of

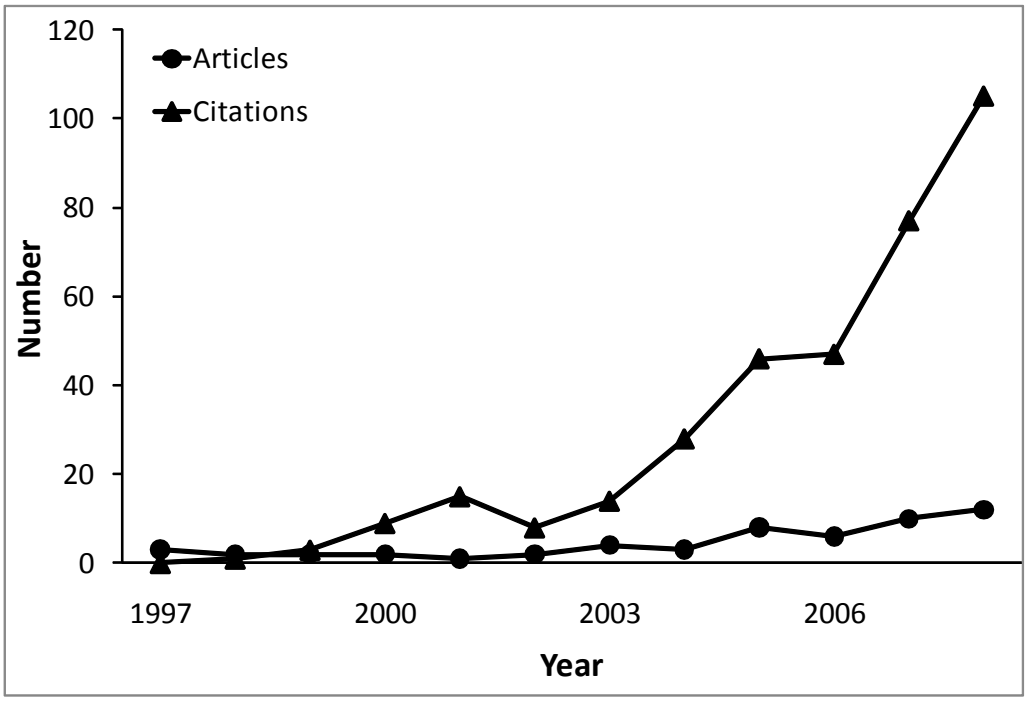

Fig. 1. Historical trend of citizen science articles. Data represent peer-reviewed articles as identified in ISI Web of Science using the search term "citizen science" from 1980 through 2008. The number of unique articles (n = 55) published is indicated by "articles," and the number of unique citations (n = 353) is indicated by "citations."

America Annual Meeting to address the role of such activity in ecology. Eleven speakers from around the world converged in Milwaukee, Wisconsin, to share their work in "Citizen Science in Ecology: The Intersection of Research and Education," a symposium organized by Christopher Lepczyk, Owen Boyle, and Timothy Vargo. The goals of the symposium were to explore the following questions: (1) Is citizen science a new discipline, subdiscipline, or tool, relative to ecology? (2) Are data collected by citizen scientists valid, and if so, comparable to data collected by professional ecologists or their assistants? (3) Can citizen science be an effective tool to help bridge the gap between ecological research, communities, and education, both for the public and students? (4) Is citizen science the same as or different from ecological monitoring, or is one a subset of the other? (5) Are citizen scientists actively participating in the scientific process as ecologists, thus increasing their ecological literacy? To address these questions, speakers discussed citizen science both in general conceptual terms and in case-specific contexts from around the world.

Rick Bonney of Cornell University opened the symposium with an overview of the history and evolution of citizen science in academic research. He explained that citizen science began as a series of monitoring projects designed to put the findings of hobbyists, such as bird watchers and star gazers, to meaningful scientific use. Following these early monitoring projects were ones designed with educational goals and even some set up as experiments. Eventually citizen science started to become an accepted technique for data collection in several scientific disciplines. Today, new citizen science efforts are

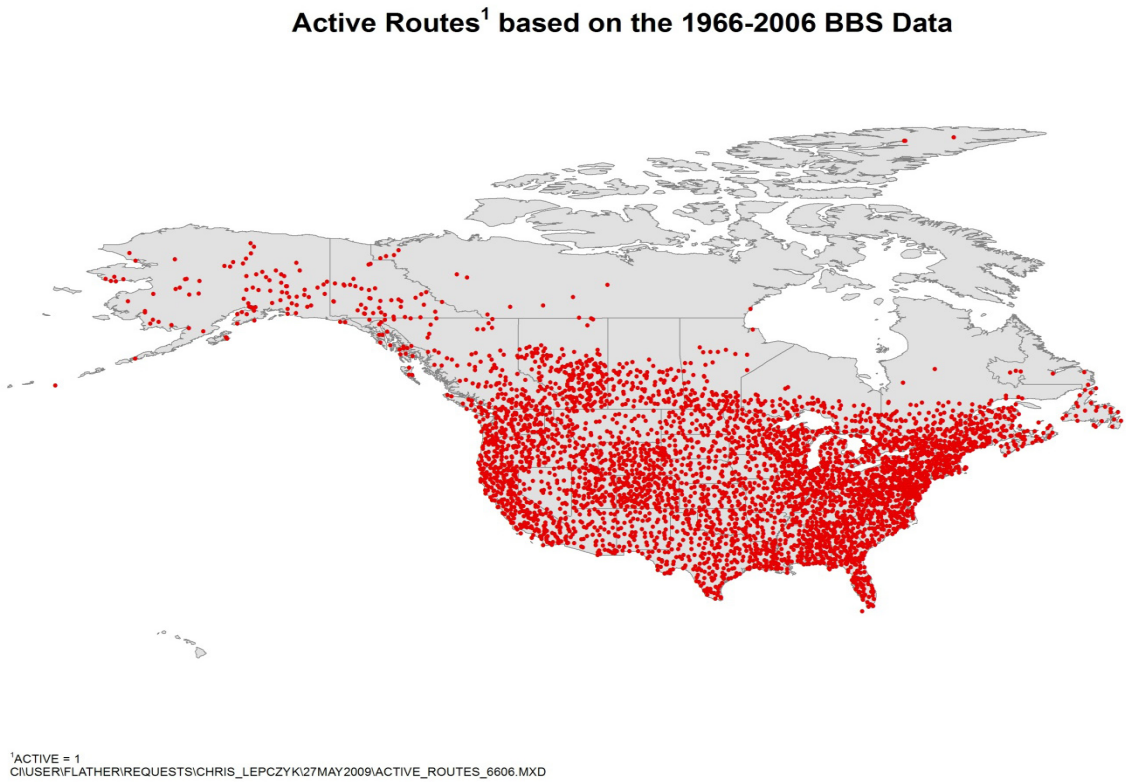

Fig. 2. Locations of breeding bird survey routes. Figure credit: Curtis Flahter and Mike Knowles.

involving participants in data analysis as well as data collection, and some are even starting to collect data from online images such as nestcams (readouts from recorders aimed at birds' nests).

Following on the heels of the history of citizen science was a series of four case studies describing ecological research and monitoring projects that rely upon volunteers for their success. These case studies were arranged along a continuum from large-scale national projects with thousands of volunteers to regional and local projects. In addition, each case study represented varying degrees of interaction between researchers and volunteers.

Leading off the case studies was David Ziolkowski of Patuxent Wildlife Refuge, who discussed how citizens drive the North American Breeding Bird Survey (BBS). Specifically, the BBS protocol conducts annual bird surveys along >4000 routes (Fig. 2) across the United States, Canada, and Mexico, using a highly skilled volunteer workforce. Part of the success of the BBS program has been its relatively straightforward field protocol and standardized design. Moreover, the BBS program has resulted in over 400 bird species being surveyed annually at a cost of less than $900 per species per year. Without citizen scientists, such accomplishments could not be achieved. Similarly, in the United Kingdom, a long-running insect monitoring project has been led by citizen scientists in conjunction with Rothamsted Research, the oldest agricultural research station in the world. Philip Gould highlighted

how the Rothamsted Insect Survey has used light traps (Fig. 3) to capture insects across 460 sites in the UK for the past 50 years. This survey takes about five minutes each day to collect insects, which are then sent to Rothamsted Research for sorting and identification of the macro-moth fraction of the catch. To ensure a robust monitoring project, volunteers are reimbursed for any trap maintenance and provided with annual summaries of the moths collected from their trap. The success of the program has been built upon: (1) keeping the monitoring system simple; (2) ensuring that the volunteers are trained; (3) knowing when to discontinue sites; and (4) providing all volunteers with feedback on their work. The value of the insect survey was demonstrated in recent findings that two-thirds of common moth species across the UK have declined over the last 35 years, with 20% declining so fast that they should be considered threatened. As a result, several more species have now been added to Biodiversity Action Plans in the UK. Both the BBS and the Rothamsted Insect Survey demonstrate how large-scale monitoring can be used to denote changes in diversity and abundance over time. Furthermore, they both use protocols to filter data, thereby allowing for robust data set production.

A

B

Fig. 3. Examples of (A) a light trap station in use, and (B) placement in a back yard. Photo credits: (A) Syd Wright MBE, and (B) Philip Gould.

At the regional scale, Susanne Masi, manager of Chicago Botanic Garden's Plants of Concern Program, presented an overview and findings from the garden's rare plant monitoring project. The Chicago Botanic Garden established this program to monitor listed and rare plants in the greater Chicago metropolitan area. Initiated in 2001, the program involves ~250 trained volunteers each year in collecting plant data (Fig. 4), and has now accumulated 8+ years of standardized data on 205 plant species at 245 sites. Aside from simply monitoring rare plants, the program has demonstrated several key findings related to using citizen scientists. First, a two-year volunteer data validation study comparing randomly selected

Fig. 4A

volunteer data to professional data showed a high degree of correlation between the two groups. For example, there was >80% correspondence between the two groups in critical data fields such as population numbers and presence of threats. Second, the results of a Plants of Concern citizen science focus group showed that volunteers participated actively in, and understood critical elements of, the scientific process. Furthermore, participants unanimously experienced an increase of their involvement in stewardship and conservation activities as a result of the program, and reported sharing this scientific understanding and enhanced conservation commitment with the broader public.

Fig. 4B

Fig. 4. Volunteers (A) determining plot locations and conducting rare and listed plant inventories (B–D) as part of the Chicago Botanic Garden's Plants of Concern Program. Photo credits: (A) Peter Jacobs, (B) Robin Carlson, (C) Emily Kapler, and (D) Dani Drekich.

Fig. 4C

Fig. 4D

Fig. 5. Bushmen in Africa using CyberTracker. Photo credit: Louis Liebenberg.

Capping off the case studies was a presentation by Bill Mueller, who introduced the Milwaukee County Avian Migration Monitoring Partnership (MCAMMP), an avian monitoring study focused on migratory bird stopover ecology in the urban parks of Milwaukee County, Wisconsin. To date the project has utilized the assistance of >140 citizen scientists over six migrations (three years) to help address the major goals of assessing habitat use and quality in both riparian and upland sites, and quantifying habitat use by migratory birds. Citizen science volunteers involvement includes training for transect counts, assistance with bird-banding operations, vegetation sampling and analysis, and recording of data. One major aim of training the citizen scientists is that they will be able to establish a long-term, urban avian monitoring project that can expand in the future.

The second main portion of the symposium was devoted to a set of talks on the issues of the philosophy, policy, and technology of citizen science. Rebecca Jordan began this second portion with a discussion of a framework for promoting ecological literacy within the context of citizen science programs. She stressed that program design must balance both the scientific goals, which include ensuring data accuracy, and educational goals. Together these goals promote conceptual knowledge about the system of study, epistemological knowledge about science processes, and behavioral change with respect to environmental and civic action. While there is much evidence to support the promotion

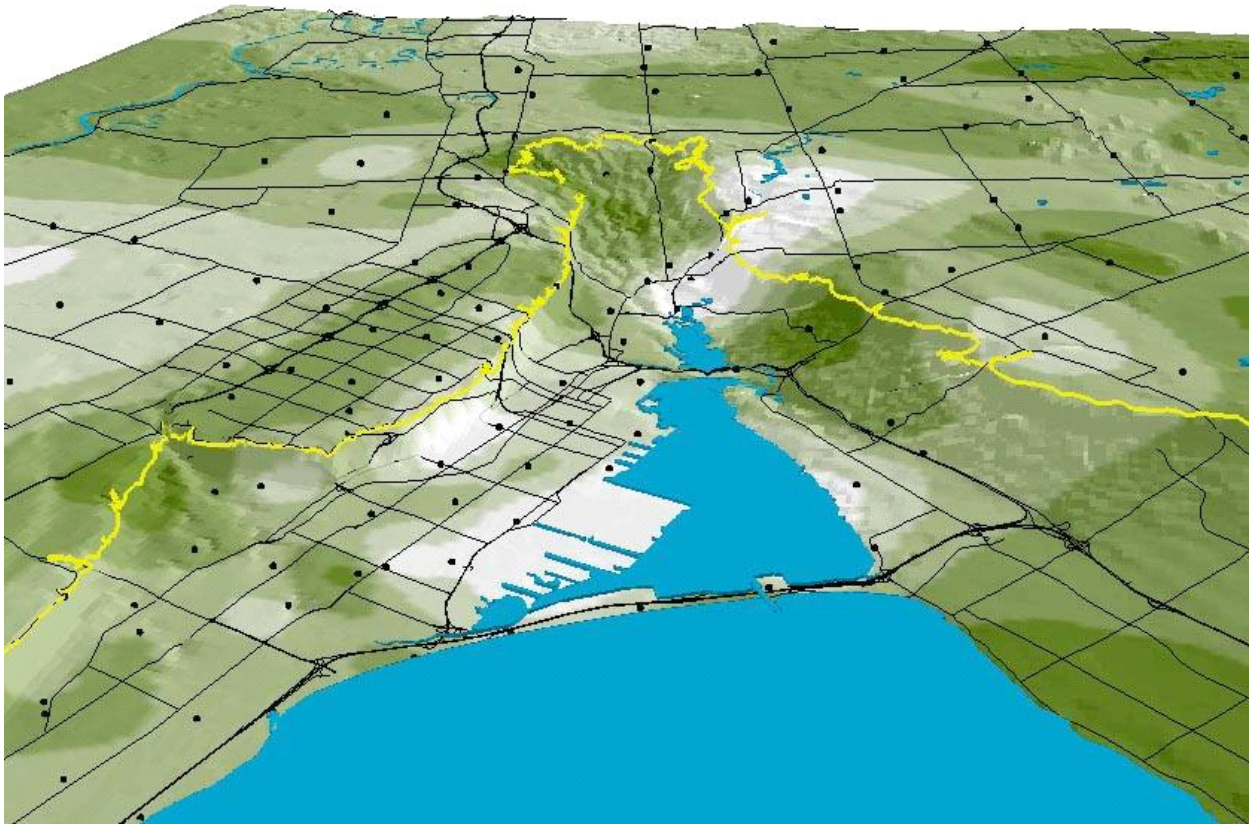

Fig. 6. A map of arboreal lichens in Hamilton, Ontario, Canada, based upon citizen science data. Darker green locations represent greater numbers of lichens, and points represent sampling locations.

of conceptual knowledge, the latter two areas warrant further investigation. Integrating cognitive and environmental action theory will likely prove useful as practitioners seek to broaden program impact.

David Bonter of Cornell's Laboratory of Ornithology next discussed the issue of data validation processes for large citizen science databases, such as Project FeederWatch. Currently, Project FeederWatch receives >100,000 checklists from >14,000 citizen scientists annually, yielding over 5,000,000 bird observations of ~500 individual species. Thus, it is critical that such large volumes of data be inspected for any problems; this requirement has led to the development of a quality control and quality assurance protocol. This protocol uses a review system, whereby unusual observations or potential errors are flagged and sent to experts for follow-up with the citizen scientists. Unverified reports remain flagged and are excluded from data analyses and web-based data output. The system also allows researchers to identify volunteers who are in need of support and to focus educational efforts accordingly, ultimately improving data quality and integrity.

Moving from data editing to data collecting, Louis Liebenberg, founder of CyberTracker Conservation, presented a talk on how technology can be used to get people back in touch with nature. Specifically, Louis has developed the free software program CyberTracker (available at ‹http://www.cybertracker.org/›), which enables volunteers of all ages to collect biodiversity data on simple portable devices, such

as smartphones and PDAs (Fig. 5). CyberTracker is already in active use for both citizen science projects and environmental education around the world. For instance, in the United States, NatureMapping, BioKIDS, and BioBlitz are using PDAs with CyberTracker software to enable volunteers of all ages to collect biodiversity data. Similarly, in South Africa, the NaturalWorld web site allows participants to share and view bird sightings, and in the Kalahari trackers from local communities are being employed to survey wildlife conservation corridors. Finally, the WhaleForce project involves yachtsmen around the world using CyberTracker to monitor whales. Ultimately, the software allows for easy data collection by citizen scientists and helps to promote people who engage the outdoors by collecting field data.

Michelle Prysby next discussed more efficient ways for interested citizens to find a project, and for projects to find interested volunteers. One partnership for scientists and educators interested in reaching trained citizen scientists consists of the Master Naturalist programs. These programs are volunteer training and service programs that involve the public in natural resource education, citizen science, and stewardship. Currently there are >25 Master Naturalist programs in the United States that represent a ready pool of volunteers who have been trained in core citizen science skills, such as recording field observations and using taxonomic keys to identify organisms. These volunteers are well connected to their local environments, and are part of an existing infrastructure that can support their citizen science volunteer activities. (For more information on natural resource education and stewardship programs such as Master Naturalists, Watershed Stewards, and Conservation Stewards, please see the Alliance of Natural Resource Outreach and Service Programs ‹http://www.anrosp.org›).

The final presentation of the morning was by Hague Vaughan, of Canada's Ecological Monitoring and Assessment Network (EMAN), who wove together the themes of the morning's talks. He described how citizen science fosters a desperately needed means to better link ecological monitoring to policy development and decision-making. His argument was that the emphasis on certainty in ecological monitoring leaves decision-makers lacking sentinel and feedback information where timeliness is a key factor. If focused on outcomes, complementary citizen science can be a means of enhancing effectiveness. To illustrate how to integrate citizen science into policy, Vaughan discussed a project that combined citizen data with targeted research and air quality monitoring stations in Hamilton, Ontario, Canada to identify pollution and lichen hot-spots that was used to deliver feedback on municipal and industrial choices (Fig. 6).

The symposium concluded with a round table discussion of the morning's talks. Following the symposium, an additional workshop on citizen science was held over the weekend at the Urban Ecology Center of Milwaukee. At this workshop many of the symposium speakers gave an additional talk during the morning portion, with an afternoon of hands-on activities designed to train and educate citizen scientists.

Overall, the symposium sought to address five major goals related to citizen science. In reflecting upon these five goals it is clear that there was progress made on all, but not necessarily agreement. For instance, the general view was that citizen science has new elements to offer ecology, but there was no definitive agreement among the speakers that it was a new discipline or subdiscipline. Whether or not this will change remains to be seen; citizen science is still very much an area of new ideas and growth. On the other hand, several speakers presented data from their research illustrating that the quality of data collected by citizen scientists is of the same or better quality than that collected by professional

ecologists. Such quality is enhanced further with the aid of both software (e.g., Project FeederWatch and CyberTracker) and expert assistance. Similarly, there was strong evidence that citizen science can be an effective tool to help bridge the gap between ecologists and the public. In terms of the overlap with monitoring, it is clear that they share a number of similarities and will likely continue to do so in the future. However, many of the citizen science projects were much broader than monitoring alone, because they engaged the public in the scientific process or served to enhance ecological literacy. Based upon the talks and concluding discussions, citizen science is an increasing part of ecology, and has great promise for contributing knowledge, improving ecological literacy, training scientists to work with the public, and providing information for policy-makers.

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