

The Neighborhood Nestwatch Program: Participant Outcomes of a Citizen-Science Ecological Research Project

Introduction

Formal education is not enough to ensure scientific literacy in a world where ideas and technology are changing rapidly (Hacker & Harris 1992). Projects that invite citizens to be involved in ecological research in their own backyards or neighborhoods may provide rich opportunities for community members of all ages to improve their science literacy (Trumbull et al. 2000; Brewer 2002b) and their sense of place. This learning about, and awareness of, the local environment may translate into tangible participant action on a local scale. Yet relatively few data are available regarding science education outcomes of ecological research projects conducted with the help of citizen research assistants in informal settings (Layton et al. 1986). Programs that have been assessed (e.g., several conducted by the Cornell Laboratory of Ornithology; Krasny & Bonney [2005]) have focused on science process and biological knowledge, not on attachment to an ecological "place" and the potential implications of that attachment to conservation behaviors.

The Neighborhood Nestwatch (NN) program engages citizen scientists in the collection of scientific data and fosters scientific literacy and increased attachment to place in their local natural environment. Here, we define science literacy as both an understanding of scientific content and ways of thinking such that citizens

can make better sense of our increasingly technical and scientific world. Skills of a scientifically literate citizen include critical and independent thinking, ability to interpret evidence and data, and understanding the role of uncertainty (AAAS 1993). But scientific literacy alone is not sufficient for understanding the influence of humans on ecological systems. People need to know about the places in which they live. We suggest that a sense of one's place has four primary components: knowledge, skills, awareness, and disposition to care. The first two components are aspects of science literacy. Moreover, there are many feedback loops between these four components.

Neighborhood Nestwatch

Neighborhood Nestwatch was designed to improve knowledge about avian ecology (an element of scientific literacy) and connection to place through citizen research, thereby increasing awareness and interest in local conservation initiatives. Nestwatch has two primary goals: (1) to collect data that can help researchers understand the ecology and population dynamics of eight species of birds along an urban-to-rural gradient in the Washington, D.C., area; and (2) to teach people living in urban/suburban settings about bird biology. Nestwatch began in 2000, and by 2001 approximately 175 households were involved in collecting

data about birds. After joining NN all participants were given a packet of written materials that included a description of participant tasks, background materials, and contact information. Participants also had access to a newly developed Web site, where they could read about many aspects of bird biology and ecology, enter data, and download data forms (<http://sio.si.edu/Nestwatch>). Participants were asked to closely observe and report nesting behavior and nesting success of eight common backyard bird species on their property. They also watched for banded birds returning to their property in subsequent years to provide data on adult survival. Data collection sheets were provided and, in addition, some participants kept journal records of their observations (not analyzed here).

Researchers from the Smithsonian Environmental Research Center (SERC) visited each participating residence annually during the breeding season to mist net and band birds that frequented and nested in participants' yards. Researchers also collected physiological data on banded birds, including blood samples to test for exposure to West Nile virus. Program scientists encouraged email and telephone contact and provided support to participants who had questions. Scientists or science interns would, on occasion, return to a NN participants' property if they were asked to help locate a nest or attempt to band another nesting bird.

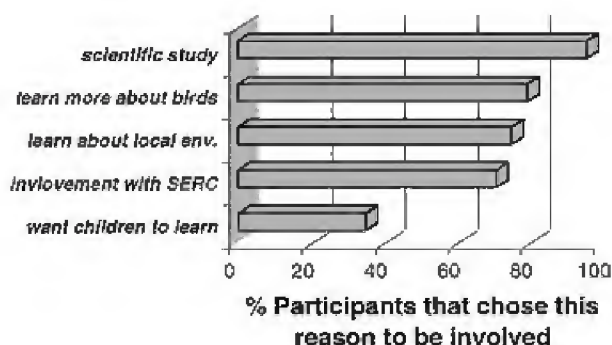


Figure 1. Reasons participants became involved in the Neighborhood Nestwatch program. Because these choices were presented to participants, they possibly represent only a subset of reasons they may have had for involvement in the program. Smithsonian Environmental Research Center is SERC.

Documenting the Impact of Neighborhood Nestwatch

Nestwatch provided an excellent opportunity to assess the impact of an informal education program focused on improving science knowledge for both adults and families. We used surveys, interviews, and participant-initiated email contacts to characterize the typical NN participant and understand the influence of NN on participant's sense of place and science literacy related to avian ecology. Beginning in the second year of the program (2001), we asked participants to complete a survey that included questions about demographics, level of formal education, birding experience and expertise, previous and current participation in environmentally relevant activities, and motivation for getting involved in the program. Nearly all participants completed surveys during banding visits by interns. Survey results were tallied, and participating households were stratified based on age, formal education, and degree of neighborhood urbanization. From survey data we quantified the proportion of NN participants in various demographic categories and their involvement in this and other organizations related to the environment and ecology.

From mid-June to late August 2001, we conducted open-ended interviews with willing participants who represented different age and educa-

tion categories across the urban to rural land-use gradient in the Washington, D.C., area ($n = 45$ participants; selected based on time available to participant). Participants living in urban settings were underrepresented ($n = 5$ interviews), whereas participants in suburban settings were overrepresented ($n = 21$ interviews), reflecting the bias within the suburban portion of the gradient. Our interview questions were designed to encourage participants to (1) share their knowledge of bird behavior and habitat requirements at local, landscape, and global spatial scales; (2) express their understanding of individual bird behaviors and intraspecific, interspecific, and community interactions; and (3) address the four components of sense of place (knowledge, awareness, skills, disposition to care). A complete list of questions is available from the NN Web site (<http://sio.si.edu/Nestwatch>). Interviews typically lasted for 30 to 80 minutes, with the majority lasting toward the longer end of the range. Finally, we compiled all the email messages ($n = 57$) initiated by participants to evaluate the nature of their comments and questions throughout the breeding season. Interviews and email communications were transcribed and analyzed with NUDIST 5 (QSR International) software to extract and quantify concepts, phrases, and ideas that emerged from participants' answers to the categories of open-ended questions.

Participants in Neighborhood Nestwatch

Nestwatch participants were evenly distributed among three groups that comprised senior citizens (either individuals or couples), couples or singles in their late 30s to 50s, and families with young children. The level of education ranged from completing high school to doctoral degrees (Ph.D., M.D.), and more than 80% had completed bachelor's or master's degrees (not necessarily in ecological sciences). Many of the participants were long-time birdwatchers and enthusiasts (particularly the older participants), but our survey and interview results suggested that their depth of knowledge of birds and related ecology varied greatly. Family groups (typically one parent and one child were most active) were more likely to be new to birding and know less about the ecology of their backyards. Although many reasons were cited for participating in NN, everyone completing the survey selected "the desire to help out in an authentic research project" as a reason for participating. Many participants liked the association with the Smithsonian Institution and cited a general desire to know more about their backyard birds. Families tended to comment that they wanted their children to learn about the environment through participation in the program (Fig. 1). One lesson from the survey is that as

Table 1. Percentage of participants in Neighborhood Nestwatch that reported increasing their knowledge in particular aspects of ecology.*

Outcome	Knowledge area	Increased knowledge (%)
Science literacy	bird biology and behavior	87
	identify a new bird species	43
	wildlife knowledge (nonbird)	20
Sense of place	increased awareness	83
	perception of property	59
	changed behavior	56

*Because participants may have reported multiple areas of learning, values add to >100%.

NN expands its outreach to families it would be worthwhile to examine the value of shared learning between parents and children for both improving science literacy and increasing communication in the home (e.g., Genaro et al. 1980).

Improving Science Knowledge and Thinking

Data from interviews and analyses of email and telephone communications between participants and NN research staff suggested that there is a great potential for increasing knowledge about science among participants. Two of the most important factors influencing increased science knowledge in this study were the initial motivation and interest of the participants (self-selected), and the interactions between research staff and participants. These interactions could have occurred during the banding visit, over the phone, by email (if a computer was available to the participant), or during the initial public meeting where participants learned about NN. The following excerpt from an interview is an example of a common sentiment and suggests, not surprisingly, that the face-to-face meetings between citizen and science staff were the most valuable from the perspective of participants: "The fact that the Nestwatch folks came and spent time working makes a big difference. I don't think I would do it if it were all on my own because I wouldn't know where to start." By simply being present while research staff conducted the banding visit, par-

ticipants said they learned about territorial behavior, nesting and feeding behaviors, habitat preferences, and subtle behavioral characteristics of different species.

Despite the fairly specialized research focus on avian population dynamics, opportunities for learning in this program were many and varied. As a result of their participation, Nestwatchers reported learning about new species they had not noticed previously in their yards, nest predators, and development time from egg to fledgling. Ninety percent of participants reported learning from participating in the project (Table 1), and even the most experienced birders we interviewed reported learning something new about birds.

There were some clear examples of scientific thinking related to the population study that emerged from our interviews. After considering the goals of the program, a number of participants expressed reasonable concerns about the quantity and quality of the data they (and other participants) would collect. Some participants were also concerned about the effect their birdfeeders might have on the outcome of the study. Additional insights about the extent of scientific thinking emerged from our analysis of email communications. For example, some participants brought up issues related to the scientific methodology of the research, including asking questions (28%), reporting observations (60%), and drawing conclusions (15%). Questions asked by NN citizen scientists were mostly about bird behavior (36%), methods clarifications (32%), and bird identifica-

tion (21%). Behavioral questions suggested that participants were making observations beyond the bird feeder by noting predation and nesting activities that occurred throughout their backyards. These results are similar to those of Trumbull et al. (2000) when they analyzed email communications from participants in a bird-based project developed by the Cornell Laboratory of Ornithology.

In contrast to the email communications, our analysis of interview transcripts detected strong gains in understanding elements of bird ecology. Participants did not tend to comment on the scientific process during interviews. A similar observation was made of participants in the Cornell lab's Birdhouse Network in pre- and post-test data (Krasny & Bonney 2005).

Although we documented a number of positive outcomes, NN has not reached its full educational potential. For example, many participants (44%) did not understand the overall goals of NN and were not sure exactly how researchers at SERC would use the data they were collecting. Methodologies are related to the research questions and goals for data collection; thus, this is an area deserving greater attention in future offerings of the NN program.

Even after just 1 year of participation, the NN program influenced participants' sense of place. Nearly all the participants noted an increase in their "awareness" of the birds and relationships between birds and habitat in their backyards (Table 1). One participant reported a totally new level of attention to birds in his yard: "I've

been here 12 years and I never really heard the birds the way I hear them now. I don't know what that is—what happened. The light switch went on.” In particular there was increased awareness of the value of a backyard as a habitat for plants and animals. More than half of the Nestwatchers (56%) changed some aspect of their behavior in relationship to their yard. A few participants were inspired to study further on a subject of interest (7%) or suggested that they were planning on changing behavior (7%). Planting shrubs that would act as shelter or food resources was a behavioral change mentioned by more than one participant.

Fostering stronger connections to the ecology of a location may be one strategy to change behavior in a way that benefits habitats and species. In a related study, Main (2004) reported that participants in the Florida Master Naturalist Program (FMNP) made changes in their behavior (e.g., recycling, lawn care, increased involvement as volunteers, and in local environmental issues) following completion of one of three 40-hour courses introducing participants to primary habitat types in Florida. This indicates that very different models may be used to reach similar goals for increasing conservation awareness and behavior. The key is identifying the critical program components that inspire people to change their behavior. One important component common to Main's study and ours is personal contact with a scientist or expert. The FMNP participants spent approximately 40 hours with experts in the field, which likely facilitates the one-on-one discussions we found so valuable in NN.

Neighborhood Nestwatch encouraged people to observe animals in new ways. Nestwatchers were encouraged to note behaviors and activities that linked birds to their habitat, to other birds, and to populations of predators (birds or other mammals and amphibians) that may have influenced nest success. It was ap-

parent from interviews that by making such detailed observations, participants felt more connected to their backyard birds, and their levels of concern about the welfare of the birds and their nestlings increased. Here is an example of a typical quote suggesting increased connection to the backyard habitat “. . . it's made me aware because before. . . I always thought I was doing my part because I was feeding them and providing water for them.” Many Nestwatchers reported changing their own behaviors to accommodate birds (e.g., building wren houses, planting shrub habitat for nesting, planting food sources in their yards, not cutting trees with nesting birds, keeping domestic cats inside during the time when birds were likely to be fledging young). One Nestwatcher reported “I've got a tree that I want to cut down but. . . I just can't. It's at a 45 degree angle; my things aren't growing in its shade in my vegetable patch. That tree is driving me nuts, but I think, I've seen things live in there. I don't think I can cut it down.”

The program was also a topic of conversation with neighbors, friends, family, and community groups for most participants. By sharing what they were doing in their conversations and newsletters they were actively recruiting new volunteers. One person said “I was very disappointed at my birds because I couldn't find very many this year. My neighbors had a nest. . . They had a nest in a bush outside the den, which we could look into. They watched a blue jay, and the blue jay was amazing. They were amazed. They had never done this before. She just retired. They were amazed at how fast they grew.” We would expect that talking about their NN citizen-science experiences reinforces participant learning and may expand the impact of the program in the greater community.

Regardless of their level of education, community members who participated in NN gained ecological knowledge and came to view their

property differently as a result of the program. Moreover, increased awareness, in combination with new knowledge, appeared to motivate some participants to engage in activities that improved the habitat value of their yards, suggesting an improved sense of place and relationship with the local landscape. These outcomes highlight the value of community science programs that allow citizens access to practicing scientists in the context of a shared project.

The Value of Collaborating with Scientists

The importance of personal, sustained communication between staff scientists (or interns) and participants was a critical element of the success of NN. Previous research suggests that this phenomenon is not unique to NN. Both quality and quantity of the interactions, however, are important. Feinsinger et al. (1997) reported that a single, brief workshop for volunteer park interpreters in South America was not enough to maintain the level of collaboration they desired or to reinforce the inquiry approach they were promoting. Intense interaction between researchers and nonscientist partners is also important in student and scientist partnerships with schools (Evans et al. 2001; Brewer 2002a).

There are trade-offs between the time available for scientists to be physically out in the community and the ability to engage large numbers of participants. For example, Cornell's Laboratory of Ornithology has developed many excellent citizen-science programs. Although they reach more people in the United States than NN (more than 100,000 students and citizens), they do not emphasize face-to-face interaction between scientists and participants (R. Boney, personal communication). Especially for larger-scale programs, such as Project Feederwatch at Cornell,

scientists can greatly improve their two-way communications with participants in schools and communities without large amounts of time spent in the field by using email and interactive Internet discussion sites. Indeed, the results of our analysis of email correspondence suggest that this form of communication between participants and science staff does engage participants in the "process of science."

The rest of the story is told by our interview data, which illustrate the value of face-to-face interactions with scientists (and science interns). These meetings were very important in improving participants' knowledge about birds through shared observations and, occasionally, data collection. Through real-time communication, scientists and nonscientists make personal connections. Further, our results show that face-to-face meetings promote discussions during which scientists can better address questions and interpret observations being made by the community participant, and they allow participants to observe how the scientist makes decisions during the implementation of a research project. Of course scientists need to approach citizens respectfully as partners when their research programs depend on citizens to provide research access to their private property. Beyond this access issue, direct interactions with scientists seemed to empower citizens by making them feel like they were important partners in the research process. Another frequently unrecognized benefit may be the collegiality developed through these kinds of partnerships that can help to reduce the power differentials that can exist between experienced scientists and novice or lay people working together in the community (Hogan 2002).

Implications for the Future of Nestwatch and Other Programs

One of the biggest challenges facing the scientific community is de-

mystifying the process of science and translating the process and results for nonscientist citizens (Brewer 2001). Many programs have been developed to address this challenge. Although the backyard citizen-scientist model appeared to motivate interest and ownership in the NN project, it did present some demographic challenges. Well-educated, affluent volunteers are likely to outnumber other groups in bird-oriented programs (e.g., Trumbull et al. 2000; this study). Urban dwellers involved in NN tended to be underrepresented and less familiar with the ecology of their yards. Increasing participants in these underrepresented demographics will enrich the program and provide one avenue for sharing science with people who may be underserved by informal science education programs. Recruiting more families to programs such as NN appears to be a rich avenue for improving knowledge of science and influencing the ecological sense of place in participants who are initially less experienced in birding and backyard ecology. Presentations at civic organization meetings may be additional venues to increase community interest. Many urban families, however, may not have backyard habitats for watching birds, and this may represent a substantial challenge as well. Adding a data-collection component for civic clubs and youth groups that takes place on public land (e.g., parks, schoolyards) could address the inherent limitation of backyard-type programs that tend to be most popular with people who are property owners.

We also identified new avenues for keeping citizen scientists interested in continued participation. In the second year of the program, scientists conducted nest predation experiments on a subset of participants' properties. Although we did not assess the educational value of this activity, it seems likely that activities like these could be future opportunities to explicitly educate participants about aspects of the scientific process (e.g., experimental

design and hypothesis development and testing) through new written program materials and conversations during research visits. Ideally, a citizen ecological/conservation science effort should be infused into multiple aspects of the community and include not only homeowners but also school and civic groups working toward a common goal.

By fostering collection of long-term ecological data and facilitating constructive dialogue between citizen scientists and researchers (e.g., Brewer 2002b), NN has become a model of an effective small-scale community conservation partnership that has increased the knowledge base of participants. Participation in the program encouraged awareness of and appreciation for the value of backyards as habitat for birds and other organisms. Moreover, for many NN participants, knowledge, awareness, and appreciation were translated into tangible activities to preserve or enhance the habitat value of the property for birds. Valuing yards as wildlife habitats is, perhaps, the most exciting and hopeful outcome of NN. At a time when many species are threatened and endangered because alarming rates of habitat loss, motivating knowledgeable citizens to take personal action within their realm of control should be the highest aim of ecological and conservation partnerships.

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