The following presentations and discussions took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that individual presentations did not originate as formal papers and reflect the more informal, idiosyncratic nature of deliveries prepared specifically for this live event. Participant comments during group discussions are not necessarily exact quotes and may have been paraphrased or edited for clarity.

Documentation of the conference is meant to serve as a resource for those who attended and for others in the field. It does not necessarily reflect the views of the Cornell Lab of Ornithology or individual symposium participants.

These conference proceedings are also available as individual presentations that you may download online. To access those presentations, learn more about citizen science and the Citizen Science Toolkit, or join the ongoing citizen science community, go to:

http://www.citizenscience.org

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Cover photo and above: Conference participants go on a worm walk with Cindy Hale, Program Director of Great Lakes Worm Watch. The worm hunt continues on pages two and three.
Opening Remarks

Welcome

It’s exciting for me to stand in front of a group this distinguished, this exciting, this creative, and this varying, coming from all of the different projects and places represented. Seeing you here at the Lab is a tremendously meaningful moment for me as well as for Rick Bonney, Janis Dickinson, and the other members of the citizen science community here. In the 1990s when this was just beginning, the idea that by the year 2007 so much could be underway in citizen science would have been more than a dream come true for many of us at the Lab.

I do recall a point early in my time here and well into Rick’s time here. We were writing a grant proposal and looking around in the literature for the phrase "citizen science" and couldn’t find it. That was in the mid ‘90s. By now, as everyone in this room knows, it is becoming a household term. You are all engaged in that process and it is a source of enormous pride and gratification to us here that it is where it is now, and you are where you are now. The Lab of Ornithology is a place that has existed in concept, so to speak, for almost a hundred years. Arthur Allen began engaging citizens and thinking about birds way back early in his career at Cornell. He actually had a little sign on his door that said "Laboratory of Ornithology" to distinguish him from all of the bug people he was surrounded by. The garage building that many of you know that was next door here was built in the '50s and we moved into this current building in 2003, and the concept of engaging citizens and doing real world science has been a hallmark of the Lab of Ornithology for many decades.

It was really impressive when I looked through the project Web site (and did as good a job as I could of whipping through all fifty of your bios and project descriptions) to see the range of projects now underway and the potential that those projects have for doing real stuff. I would particularly like to commend those involved for phrasing the mission statement of this project

For the purposes of the initiative, we define citizen science as:

projects in which volunteers partner with scientists to answer real-world questions.

What We Mean by “Citizen Science”

The following is our conceptual understanding and application of this term for the purposes of the Citizen Science Toolkit Project.

The term "citizen science" has been used to describe a range of ideas, from a philosophy of public engagement in scientific discourse to the work of scientists driven by a social conscience.

In North America, citizen science typically refers to research collaborations between scientists and volunteers, particularly (but not exclusively) to expand opportunities for scientific data collection and to provide access to scientific information for community members.

For the purposes of the initiative, we define citizen science as:

projects in which volunteers partner with scientists to answer real-world questions.
as succinctly and as powerfully as you have: “projects in which volunteers partner with scientists to answer real-world questions.” Every one of those words defines something really important: the fact that these are organized projects, that they use volunteers distributed across the landscape, that scientists are engaged in them, that you’re answering questions, and that those questions are in the real world. What a great enterprise! I think it’s a growth industry. I don’t want to take any more of your time this morning, but did want to express that. We carefully chose “citizen science” to be two of the seventeen words in our own mission statement here at the Lab of Ornithology. I couldn’t be more thrilled than to have you all here at this meeting and I hope it is the first of many in which we put our collective heads together. Some of the best in the country are gathered here to address the challenge of making it easy for everybody in the world to participate in this.
Shared Values

I want to share my impressions from the introductory slides that participants shared during the opening reception for this conference, and thank all of you for giving your time in the next few days for this collective effort to develop some guidelines for doing citizen science in the form of a toolkit. It is a form of altruism, and that is what I wanted to talk about based on my impressions during your introductions.

We are not just a group of individuals coming from a diversity of disciplines to do truly ground-breaking, interesting, and interdisciplinary work. We are apparently a group with shared values, and one of those values is great respect for and awe of the natural world, whether we’re talking about birds or worms or stars.

The other major value is education and the idea that education has many forms, only a few of which are represented in the school systems, that it is a lifelong process, and is incredibly important in empowering people to deal with real problems.

The third is that essentially we all believe that the cumulative acts of many represent a powerful vehicle for change. I think that’s also incredibly important in today’s world.
Citizen Science and Critical Thinking Skills

Why are we all here? Last year when I was in Provincetown I saw a T-shirt that said, "We are all here because we are not there." That’s one answer. Another answer has to do with my father, who was one of those very annoying people who usually would not answer my direct questions. How many people had a parent or a mentor like that? For example, if the question was, "How does the sink work?" his response would be, "Well, let’s figure it out." He always did that. He always wanted me and my sisters to engage in critical thinking.

When I look around the world I think to myself, there are an awful lot of people who do not engage in critical thinking. There are a lot of ways to teach critical thinking skills and there are lots of books written on teaching critical thinking skills, but over the past hundred years or so, science education has become a stand-in for teaching about critical thinking because if you can teach people about the process of science, you can help them understand how to think critically. And citizen science is a form of science education that can be very helpful in teaching critical thinking skills.

I originally came to Cornell in 1972 because of the Lab of Ornithology, at least partly. I grew up listening to the Peterson tapes of bird sounds, and I knew they came from the Lab. After I was accepted to Cornell my dad brought me to Ithaca to see what I was getting into. The first place we visited was the Lab of Ornithology. This room we are in, the Fuertes Room, is the only thing that has been preserved from the old building, other than the view. I walked into the Fuertes Room and said, "Dad, I am never leaving this place.” And I never really did.
I started working at the Lab full time in 1983 and was always intrigued by the Lab’s desire to integrate amateurs into the study of ornithology, which started with our founder, Arthur A. Allen, in 1915. Without getting into a full-blown history, I will say that we started our nest record card program in 1965, and Project FeederWatch in 1987. As a result, the Lab is sometimes credited with inventing citizen science. In truth that is ridiculous. Citizen science has been around for as long as people have been studying nature and thinking with curiosity about the world around them. Even organized citizen science really didn’t start here. The Audubon Society’s Christmas Bird Count started in 1900, and I would bet that there are other projects that started even before that time.

What we did do at the Lab of Ornithology was learn how to write successful citizen science proposals for the National Science Foundation. As a result of that we have had some generous funding over the years, and developed many citizen science projects for different audiences. After we started taking FeederWatch to scale in the late 1980s, I began hearing from participants about what they were learning. I would hear things like, “I’ve been watching the birds at my feeder for twenty years, but I never really saw what they were doing until I had to count them for FeederWatch.” You’ve all heard that kind of stuff. I could go on and on and on about how the experience of collecting data, thinking about questions, and observing really helped learning to happen. It’s hard to document, but we know that it has happened.

So, one of the reasons that I am so taken by the citizen science concept is that I believe that by taking people through the entire scientific enterprise, where they think of their own questions and then use their own data to answer those questions, we can help people all around the country and all around the world develop more critical thinking skills. I have never thought of citizen scientists as just citizen data collectors. I realize that in many projects that is what most participants are, but I really would like to see more or even most projects take people all the way through the scientific process from beginning to end.

**The Need for “Citizen Science Central”**

Our success in getting funding to develop citizen science projects also has resulted in a lot of phone calls from people asking how we develop and fund citizen science and how could we help them do it too. I love those calls, especially when they include invitations to places like Puerto Rico
in February, but I started thinking there has to be a more efficient way to help the field grow. Not only that, there are an awful lot of people doing citizen science who are not writing NSF proposals. They are working with other agencies, working with the government, working with schools. There is so much accumulating knowledge about involving the public in science. Has anybody tried Googling “citizen science” lately? You can’t possibly look at all of the listings that are there.

About two years ago we started thinking, how can we begin to aggregate or accumulate this growing wisdom to help all of the people who are trying to start new projects or improve the projects they are already doing; to implement projects; and to evaluate their scientific and educational impact? We thought, well, we need to get everybody together to pool their wisdom. So we wrote another NSF grant—and here we all are, a couple of years later.

Now, the fifty or so people who are here are just a small fraction of the number of people who wanted to be here. I really look forward to figuring out how we can reach out to that greater community with the Web site, with virtual Webcasts, with online conferences, or with whatever it is we decide to do as a group over the next few days.

What I really want to develop is a central location that people can come to when they want to start a project or a group of projects, or get tools for cyberinfrastructure or tools for evaluation, that represents the best thinking of this whole community—everybody in this room, all of the people who applied for this conference who couldn’t come, and all of their connections also.

We did this kind of gathering once before and it really had some success. About two years ago we got funding from NSF to hold a conference called Web Designs for Interactive Learning. That conference, I know for a fact, changed lives. We were talking there about Web 2.0 and nobody even called it that, we were almost inventing it. Some of the people at that conference have gone on to form partnerships, to write successful proposals, and to build new projects as a result of the networking that took place at the conference.

In addition to printed proceedings from that conference, we also created a Web site, Web Designs for Interactive Learning, which is a community-built site that allows people to come in and put up a Web site that they’re working on and get comments. There are all types of resources and reusables. It takes you into code that you can reuse or borrow for your own project. So you get the idea—we were starting to develop a community out of that project.
This is what I really want to do again to create a Citizen Science Central Web site. Probably everybody here has had a chance to look at our early draft. You are all on it, your bios and abstracts are listed under the conference heading. If you click on the Project Gateway, one of the things you will see is a database of all the citizen science projects that we know of. People who just want to know what projects already exist in their area geographically or taxonomically or procedurally or conceptually can go to the Gateway and get that information. We are collecting those data through an online survey and we were up to over 200 projects the last time we looked. If yours isn’t in there, please enter your information.

We are also going to have a Reference database with hundreds of references that we have collected here at the Lab and from all of you so that people can find citizen science related references all in one place.

Along with that we will have the Toolkit. My dream for this Toolkit is a place where you come when you want to know: How do I do it? I’ve heard of citizen science—how do I get started?

I don’t really know yet what the format for this Toolkit is going to be. I hope that by the end of this workshop we’ll have an inkling. Maybe it’s a dichotomous key, maybe it starts out with a question about what it is that you’re trying to do—I’m not really sure. What I do know is that I would like people to be able to go through the Toolkit, click on different links and get examples, Web sites, projects, and references that will help them put together their own projects or improve their project if they’ve already got one going. Or maybe they’ll decide, I don’t really want to build a project, it looks too hard. What I really want to do is partner with somebody who is already doing this. And then they could go look in the Project Gateway section for a partner.
The Conference Process

In order to build this Toolkit, we need information. You guys have all the information. The questions that we have posed for you in the working groups* represent our best thinking on the questions we need to answer to create the Toolkit. At least it was our best thinking as of yesterday. We probably could do a little better now. That is why we gave you those questions, but we also know that they can be answered in different ways. You’re going to come up with different outcomes and different measures and different approaches if you’re really research oriented than you will if you are an evaluation expert or a technologist. We wanted each group to answer the same set of questions, but in their own way. When this is over, we will compile that information into some logical assemblage, maybe a matrix, that can go into the Toolkit, so we really want you to try your best to focus on answering the questions.

Some of you have said you want to answer different questions. We don’t mind if you identify and answer different questions as long as you generate information that is going to help inform the Toolkit. I do hope that you will produce annotated outlines with bullet answers to whatever questions you choose. We are going to pop those outlines right up onto the Web site and they might include, for example: lists of outcomes, lists of measures, Web sites where we can find tools that will help us measure those things, and lists of topics that you think would be really great for citizen science that haven’t been done yet. For example, we all know that it’s easier to do a project in which you’re counting something rather than one in which you’re measuring behavior. It’s possible to have citizen scientists measure behavior, but it’s harder. Those kinds of tips need to be in the Toolkit.

---

Project Advisors

I want to take time to make a couple of acknowledgments. Most if not all National Science Foundation projects have advisory boards, which include people who work pretty hard to help the project staff put something together and pull it off. We have one for this group, and I would like to recognize those people because we really appreciate their help:

- Larry DeBuhr  
  Vice President of Academic Affairs, Chicago Botanic Garden
- Eleanor Ely  
  Editor, The Volunteer Monitor
- Sandra Henderson  
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  Senior Exhibit Developer, Boston Museum of Science
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  Associate Director, LTER Network Office, NEON, University of New Mexico
- Karen Oberhauser  
  Professor of Fisheries, Wildlife and Conservation Biology, Monarch Larva Monitoring Project, University of Minnesota
- Fernando Silva  
  Former Head of Development and Planning, Conservation Trust, Puerto Rico

Bill Michener was unable to attend this workshop because of scheduling difficulties, and Fernando Silva is another person who was unable to make it but gave us a lot of help back in the early stages of the project. I want to thank them and all of the advisors here who helped us pull this off. - Rick Bonney
just because you paid them doesn’t mean their data are better

Sam Droege
Biologist, Native Bees Survey
USGS Patuxent Wildlife Research Center
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that this document did not originate as a formal paper. Rather, it combines an oral presentation with accompanying PowerPoint slides and reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

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The following presentation by Sam Droege was delivered as the opening talk for the Citizen Science Toolkit Conference as a whole and at the first conference session, “Citizen Science Challenges and Opportunities.”

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org
Attitudes about the Validity of Citizen Science

When I talk to my ecology colleagues (you know, the real scientists) about citizen science and some of the things that we’re doing to collect information about population change—which is what we primarily do at Patuxent, and we really have to use volunteers to do that, it’s not a choice, we just can’t afford to do it otherwise—there is this sense that you get. The sense is, “Well, that’s nice, it’s good you’re working with the public. I’m glad somebody is doing that, but it’s not real science. That information you’re collecting isn’t something that you could really use.”

This attitude has shifted, as there are now a lot of publications that use citizen science data as the primary core information, and we’ll see some examples of that, but there is still this sense out there that if you’re working with volunteers and you’re collecting citizen science data, you’re not really right up there on the pedestal. I’m here today to tell you that you are, and that your information is often better than the kinds of information coming from other groups that are paying people.

The Value of Citizen Scientists

An Example of a Citizen Science Volunteer

I’m going to start with an example. Dave Holmes is a birder from the metropolitan Washington, D.C. area, and he has been very active over the years in lots of different kinds of projects. I knew him as a kid when I was growing up. Here is what he has done. This is an example of how citizen science really can make a big impact, much bigger than almost any other kind of program.

David Holmes has worked with the Breeding Bird Survey (BBS). Basically, this is a survey during the breeding season in which you count birds to collect information about population data, and you repeat this over and over as a set route that you travel.

- Has run 10 BBS routes every year for 35 years
- He gets up WAY before dawn each time
- He uses his own car and pays for his own gas
- Each survey is 50 stops and takes about 4.5 hours to run
- He fills out all the forms
- Enters the data online
- His data have NO parallel among any PAID technician or researcher
- Congratulations — Taxpayers just saved $70,000

Sam Droege, Biologist, Native Bees Survey, USGS Patuxent Wildlife Research Center
David Holmes runs ten BBS routes every year. What does he do on these surveys? He has to get up way before dawn, so already we’re talking something like two or three in the morning. He uses his own car, he pays for his own gas, and he gets no reimbursement from the government for any of his expenses. There are fifty stops on these surveys and each stop is three minutes long, and at the end of that four-and-a-half to five hours of doing these surveys, you are really exhausted. You are on that whole time and have to detect and count everything that comes by. You have counted hundreds if not thousands of birds as well as bird flocks and what is going on in those flocks, and you are using all of your skills while you are doing this.

This is the kind of thing that volunteers can do that you really can’t find in circumstances in which people are paid. The value of that, setting the uniqueness of the data set aside and counting just the number of hours, we calculate to be $70,000.

And then we have lots of forms that have to be filled out. He fills out all of the forms, he enters the data online, and what do we have? He has been doing this for thirty-five years. You have a data set of ten routes times thirty-five years with the same observer, a consistent, absolutely perfect data set that cannot be replicated by anyone, including researchers that were paid. This is the kind of thing that volunteers can do that you really can’t find in circumstances in which people are paid. The value of that, setting the uniqueness of the data set aside and counting just the number of hours, we calculate to be $70,000. So he has made a contribution to taxpayers of $70,000. That’s an example of the kinds of things that can happen with citizen science and of the kinds of contributions that are being made, which are worth a lot of money.

**Volunteer Data Quality**

- Many studies showing comparability to professionals
- Apply same standards to paid and volunteer
- Data you throw away do not negate the data that remain

**Volunteers Can Be Better than Technicians**

- They stay around for years
- Mature
- Careful
- Dedicated

I’m not going to go into a lot of detail about these things, it is mostly about ideas, but we have a lot of studies now that have shown in a range of circumstances—counting frogs, counting birds—that in terms of data quality, volunteers can do just as good a job as professionals. There are nuances to that, and I think we will be hearing a number of examples of how it works and how it doesn’t over the course of this conference. However, in a lot of cases there is really no difference in data quality between volunteers and technicians.

When you are doing a citizen science program, one of the things to do is apply the same sort of standards to your volunteers in terms of the kind of quality and types of information you want that you would to a paid technician. At that point, if you’re applying the same standards of what you accept and what you don’t accept, then the only difference that you have is, hey, you are paying people for the same quality of data that you
FrogWatch is an interesting example. It involves people counting frogs. There, we very much liberalized who could participate. We said that anyone can participate: You can take these tests and validate the information you’re producing, or you can just go out. The objective there was twofold. In addition to collecting good information for us on a subset of those areas, we wanted families to get out there and actually experience nature at night, to move away from the television and realize that they themselves can actually engage in nature. If the data aren’t up to our standard that’s fine, we get rid of it. The fact that some of those data need to be expunged because they don’t meet our quality standards does not negate the fact that the remaining data are of high quality and usable. You get this sort of notion sometimes that—“Well, I can show you where your data are bad.” If you get rid of that bad data, the remaining data aren’t besmirched by the fact that you had to get rid of some of the data.

In a lot of ways, as I said before, volunteers are better than technicians. First of all they stay around for years, whereas with data collection for a lot of operations, the paid technicians are often college students who are there for a few years and have to move on. Particularly when you are involved in monitoring information, which is what I am interested in, there is a big impact of changes in observers. Depending on what they’re counting, observers often bring in their particular skills and biases in how they estimate things. It’s nice in something like the Breeding Bird Survey if you have a consistent person who can model the impact of changes in observers. If you have high turnover in paid technicians then you don’t have that consistency.

A lot of times, paid observers tend to be college students while volunteers tend to be older. There is a maturity issue involved. Volunteers often take their job collecting data more seriously, and they bring a lot to the collection of information that you often don’t see with students. Volunteers came there because they wanted to, not because it was a job or would look good on a resume.

Volunteer Recruitment, Training, and Retention

If the information that is being collected for your program is of high interest to the volunteers, that is attractive. If there are low training requirements so they don’t have to spend a lot of time just to get up to speed to be able to participate in the program, that is attractive. And it is attractive if they feel there is a mission, if there is passion behind the reasons that they are doing this, and you are showing that passion. When you started a program you had some reason for doing so, and you need to transmit that to your volunteers and not rely on some dry formula posted on a couple of Web sites or that kind of thing. They like to feel that you think it’s important and you’re passionate about your role in it.
It’s also important that in critter-based projects, they get to see the critters. This translates to other types of projects also. It’s important that they get to see things. It’s not like: "Okay, you’re going to sit here, and at some point the coyote’s going to come by and sniff the station and then you take the picture." It helps if there’s a lot of action, if there are a lot of things going on, if they’re counting things, if they see wildlife. Again, because a lot of times they don’t have much direct experience themselves, they may not have the patience. That’s an important aspect to a successful program. And because a lot of people aren’t the “climbing-the-highest-peaks” kind of folks, physical conditions become important so that they don’t feel they’re getting eaten alive by mosquitos or that they’re going to be bitten by snakes. Physical conditions need to be attended to in terms of designing and developing successful programs.

In terms of your job in setting up a volunteer program, we tend to come from backgrounds and training in academia. We really feel like our job is analyzing results and using our special expertise. In reality, our number one job is feedback and training and interaction with the volunteers. If we are too remote or inaccessible and are not giving the strokes to our volunteers, and again, these are unpaid volunteers, they are going to leave. If they’re leaving, that means no more data for you to collect and do the thing that you’re interested in, which is analyzing the results.

You can use e-mail listserves or a lot of announcements saying "Hi" and communicating the notion that you are there. It doesn’t have to be a whole lot, but you need to let them know that you haven’t forgotten about them, and that you are communicating to them in particular. The more you can bring it down to, "I am talking to you, not to the global ‘you’ of all volunteers," the better. Again, a lot of times they came in because of some personal contact with someone, so they like to feel this connection with you.

When papers come out you may say to yourself, "Well, our volunteers don’t want to see these because these deal with all kinds of high-level information."

Send it to them. You can do it via PDF files. They don’t have to read it, but they can say, "Look, it’s being used. Great! I’m not going to read it, but I can see where I’m important because it’s generating these kinds of things." That leaves an impression.

Summarize the results. Here is another thing: sometimes we are overwhelmed by the amount of volunteer data. Even if it is cursory (e.g.,
1,500 reports came in and here’s a list of the species) and you know from your perspective that’s a very shallow summarization of that information, it doesn’t matter. They want to see that you have used the data at some level, even if you don’t feel it’s a good analysis. Some kind of feedback regarding results in a timely way is important. Additionally, if there is a way to give them feedback on their particular results, like “Thank you for bringing in those five Cerulean Warblers,” it shows that type of one-to-one connection that retains people.

Data Management

We will be hearing a lot more about data management during this conference, but we have found that online data management is the way to go. It forces compliance. You don’t get, “I tend to modify things a little bit,” or “I didn’t count these because I didn’t feel I needed to.” We’ve heard these kinds of things. If they don’t get to submit their data until every single form is filled out, and there are double-checks, that will save a lot of headaches. In submitting paper forms, as I’m sure a lot of you can attest to, there is always a need to check back with the person—they forgot this, they omitted that—and that adds a lot of time to your management of people.

Online data entry allows uniformity, standardization, quality control, and one and only one data source. Everything goes into one database and it ends up being very nice because you’re not trying to make several different things compatible, and you don’t have data entry issues from several different groups providing you with information. If it’s all online it really brings a lot of issues together, particularly if you’re doing large-scale work. If you’re working with several different volunteer groups that collect turtle information, having one data entry port rather than having three and trying to compile them later is the kind of thing that can help you avoid potential problems.

Contributions and Lessons Learned from Past and Current Citizen Science Projects

Early Citizen Science Projects

The Christmas Bird Count is often cited as the first citizen science project, but I have to say that is not the case. The projects I’m going to talk about were started in the 1800s, but I have a feeling that the weather people have been collecting volunteer data for a lot longer than that. In terms of birds, the first two surveys both started in the 1800s and have some residues that we can look at to this day.

The lighthouse surveys are interesting. One of the first acts of the American Ornithologists’ Union (AOU), which I believe was formed in the 1880s,
was to deal with one of the blazing issues of the day, which was that large numbers of birds whacked into lighthouses and died. Their solution was to start a volunteer effort that involved contacting all of the lighthouse keepers up and down the coast and all over the Caribbean. They said, “Could you count the birds that strike the lighthouse?” They had a form and it went back to the AOU. The interesting thing is that all of the interesting issues that we deal with now show up there. These still exist. You can go to the archives in Philadelphia and read them, they’re all on display. There are letters like, “This is the dumbest thing I’ve ever heard of. Why am I counting birds?”

Then you get the problem of uneven data quality. Some of them are talking about Storm Petrels and others are talking about Mother Carey’s chickens. You have terms like “yellow bird,” and problems with taxonomic issues. I can’t say that I’ve ever seen a publication come from that information, but apparently it was useful enough that they extended it for quite a number of years. Maybe they decided that birds striking lighthouses weren’t that big a deal. I don’t know what happened.

That was probably the second volunteer survey. The first one was started by one of my heroes, Wells Cook. He was from the Midwest, traveled around, was a school teacher, and then later became a college professor. He was very interested in bird migration and probably got this idea from Germany and Great Britain, where they were starting to have an interest in bird migration. He organized people and asked them to collect information about when birds first arrive, when they become most abundant, and when they leave in the spring and the fall. The program ran from the 1880s and was picked up by a series of organizations and ultimately the government, and continued through at least World War II and petered out in the ’50s. Maybe it continued a bit through the ’70s. Over the years of that program there were 6,000,000 records, with thousands of volunteers collecting this kind of information.

We’ve used it because sometimes we want to talk about whether a species was common or not common. Though this stopped in the ’fifties,
a few places collect first migration dates still. Maryland is one of them and we did a little paper looking at these data in an exploratory way in terms of what they can tell us.

This data set is still appropriate for analysis and retention right now. You can look at the curve in terms of issues like global warming, for example. The data that were collected a long time ago are still valuable, and I’ll bring this theme up again a little bit later. That datum point from that person in 1880 who wrote down that first time that Bobolinks arrived in Iowa is still used today, over and over and over again. It’s a permanent contribution.

Hunter Success Surveys
Another interesting example is hunters. If you’re a hunter and you want to go out and shoot ducks, you have to get a special permit for that. When you get that permit, you get registered and your address goes into an information bank, and a set of hunters are sent a letter by the federal government. It says, “Please fill out a diary of what ducks you shoot and when.”

The interesting thing is that sixty percent of the hunters who get that request do it. We heard earlier that there are something like ninety million gardeners. Do we get sixty percent of ninety million gardeners doing any kind of monitoring? Do we get sixty percent of the bird watchers doing anything? We get sixty percent of hunters. People may make remarks about hunters, but hey, they’re ponying up here.

Also, they didn’t go onto the Web and say, “Gosh, I like to count ducks, I’m going to sign up for a survey counting ducks.” They were simply asked. That is another point. If hunters will respond to a simple request by the federal government to give them some information, that tells you that there is a huge untapped pool of people who have not been asked. I think the important thing is that they were directly contacted and asked to do something rather than: Oh, you know I’ve built this structure here and now I’m waiting for people to come and find me.

I found this when I was managing the Breeding Bird Survey. If I needed more people in an area, I didn’t put an ad somewhere in the bird watching journal of the state. That has a very low response. I would get in contact with people and I would just start making phone calls: “Who do you know?” And then I would call that person up and say, “Will you run this for me?” The success was very high and we were able to build up the program, so keep
that in mind when you are trying to build up your constituency. That is, if you need to build your constituency. Sometimes there are too many people involved.

**Waterfowl Parts Collection Survey**

We asked the same group of people, hunters, to do another task in addition to the diaries, and we again got a sixty-percent response.

We don’t actually tell them that we don’t trust that they can identify a Gadwall correctly. What we ask them to do is send in a wing from the fowl (and in some cases with geese, the tail) and then we can do the identification as well as gain a variety of other information. We get the same sixty-percent response rate and in general, hunters are the crowd that would be more conservative and mistrust the government. They’re an interesting group to work with.

**Breeding Bird Survey**

Below this line are the primary places from which data are generated for the Breeding Bird Survey. It’s very extensive. Many, many people are now involved and it is comparable to the migration surveys done in the 1880s. There are lots of people involved, all volunteers. Cormorants are not one of the more common species. The BBS can look at abundance, they can look at trends, and they can do lots of analysis.

Thousands and thousands of analyses have been done each year on this data set, and many, many hundreds of publications have come out of this.

Let’s look at what is going on at the core of this, at who is paying for this. It’s a federal government program with no donations. It costs about $900 per species, per year, to generate that data. There are now 4.2 million records in the data system and notice that we haven’t actually
gotten around to the records that were generated in the 1800s. It has been going for forty years and about ten thousand observers have been involved in the project.

In terms of contributions, if you tally up who is doing what, there are about 29,000 hours of volunteer effort. That yields the equivalent of fifteen federal full-time employees. We would be paying fifteen bodies for the entire year as well as taxes and benefits. I would bet that not one of you has a staff of fifteen. We have an effective staff of fifteen that we don’t pay. I think people tend to not highlight this, that the people who are doing things for you as volunteers are people who should be paid in a perfect world. When you bring up your program, you should be calculating those contributions because they are very impressive most of the time. We could not afford this, so we would not have a Breeding Bird Survey if we were paying people—there is no way.

The people who run Breeding Bird Surveys stay a long time and we have very good retention of people. And I have to say, referring to what I recommended earlier, that we didn’t give them a lot of feedback either. We didn’t stroke them as much as we do now. I don’t know why they stayed in some of those middle years.

When we look at why people leave the Breeding Bird Survey it turns out that a lot of times they leave because they have to. They move, their hearing is going bad. Sometimes we have a situation in which a volunteer wants to continue doing the survey but their hearing should actually be disqualifying, so we’re gently putting off the fact they should go.

Why do volunteers leave?

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<th>Percent of volunteers</th>
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<td>Hearing Loss</td>
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The Breeding Bird Survey

System
- $900/species/year
- 4.2 million records
- 40 years
- 10,500 observers

Annual Contributions
- 29,000 hours - 15 FTEs
- 150,000 miles

BBS Observer Demographics
- Observer retention averages a tenth of a lifetime
- The average observer volunteers for 8 years
- 10% remain active past 25 years
- 75% remain after their 1st year
North American Amphibian Monitoring Program:
Training and Testing Volunteers

There is something that we are now moving into with the North American Amphibian Monitoring Program, which is similar to FrogWatch, and I know the Lab of Ornithology parallels us in this. Instead of passively recruiting people who already know everything about birds or frogs, we now have training programs and testing programs, so we’re interacting in a more direct and educational way. You want to volunteer? Hey, we will also train you and we’ll test you to meet these skill standards. I think there will be a lot more of that in the future, with volunteer training occurring within the context of programs.

Two Examples of What Not to Do

Here are two examples of how not to do things. One is the Colonial Waterbird Surveys, one of the first efforts by the federal government, which traditionally just looked at game birds. They had responsibility for non-game birds, but because people weren’t shooting them, they didn’t really start working on their population status and conservation until they became endangered. One of the first sort of proactive events was to look at colonial waterbirds—terns, herons, egrets, seabirds, those kinds of things—because these were species groups that were in trouble or about which issues were raised. The first part of the refuge system surrounded issues having to do with colonial waterbirds. This was in the ’sixties or ’seventies.

People would count how many terns or herons, so people were doing things, but the whole notion of statistical approaches lagged behind. What they did was get a pile of money and then handed it out to different groups and said, “Count colonial waterbirds for us and then give us your report.” They would do this every ten years, and they did this several times.

It turns out that after tons of money and tons of ways of looking at it, none of it is usable. Basically, all of that earlier information, from a statistical status monitoring point of view (though there are other things you could do with it), was a waste of time. The reason was that each group decided to do it in a little bit different way, and they all kept it in a slightly different database, and when they tried to put it all together, after spending millions of dollars, there were a lot of incompatibilities. They weren’t getting a lot of feedback from a coordinator saying, “This is how we want the data, this is our requirement.” Instead, people would modify their survey techniques, and it turned out a death of a thousand
cuts occurred in that the accumulation of all the errors and all of these little discrepancies made the whole system fall apart.

Now we still don’t, in some sections of the country, have quality data on colonial waterbirds. In other cases, such as the Great Lakes, they had to start from the beginning and reorganize along the lines we talked about previously, so that they have good statistical techniques, everyone is collecting the data in the same way, there is one organizing force, and they work out the system.

The Salamander Monitoring Program was one of my programs. I still like it a lot, but it was one of my several failures. What you would do is put out squares of wood on the ground in the woods, and sometimes streamside, and then you go back later and you look under them, and there are salamanders and you count them. And it’s very nice, kids can take part in this, it’s something you can do during the day, it’s attractive, it’s not very difficult. We worked out the statistical details of how you do it, and they’re great because you have low annual variation and you can calculate trends easily.

We gave it to a person who was very interested, a total salamander-head who also likes running Web design, and he never followed through with some of the kinds of things we’re talking about here. He didn’t give people feedback, he wouldn’t accumulate their data, his Web site was half there and half not. It fell apart not because it was a poor idea, I think, or because of the volunteers, but because the management of the system didn’t work out. I’d be happy to talk to you more about those kinds of things, but I still think that particular program is good enough to be rebuilt.

**Recommendations and Next Steps**

**Where Do You Put Your Money?**

When you look at collecting information or a monitoring program, one of the general questions is, where do you put your money. I would argue that if it’s appropriate for volunteers, and in a lot of cases it is, it’s almost always more financially efficient to spend that money on managing and working with volunteers. Even though there’s an effort involved, the gain is much greater than working with paid technicians.

**Monitoring versus Research**

Monitoring versus research is a little bit of an aside, but I brought this up earlier and I think it’s a point that often gets missed by groups. It’s a point that can be used to help attract attention and help get funding in particular. Research in the broadest terms is answering a question, a question that can, in most cases, be answered at any point. The issue with monitoring is that if we don’t collect monitoring data this year, that can never be recollected again. Once a year’s worth of monitoring or a
place’s worth of monitoring is missed, it’s never recollected, so we lose every year we wait or every time we don’t involve someone who could do a particular sighting.

This is something to emphasize to people who are participating in monitoring types of questions and programs: If your data do not come in, we will never know what the frog populations for that year were. The other thing is that once those data are in, just like those migration data from hundreds of years ago, these data are always there and will be used over and over again. That you saw bluebirds on your Breeding Bird Survey route in 1978 means that bluebird point for that one route is used over and over again, thousands of times by now, each year in creating information about population change or status or maps or the many other kinds of programs. So once they’ve made their contribution, it’s not like a one-off, like we answered that question now, here’s a little paper, then we put it away and it disappears.

This is something that builds, and monitoring information, as many of you know, only gets better with age because you’re able to detect more trends the more years you have in. And it’s all a mathematical situation—the longer you’ve been there, the better the information gets. The difficult thing for a lot of people dealing with these kinds of data, and it doesn’t matter what species or what kind of thing it is, is the first year or two. People want results. What is the status of worms? What is going on with Cerulean Warblers? Mathematically, it’s very difficult to detect those kinds of changes over the first few years, but once you have ten years in, then it starts getting to be gravy. Then you really have the ability to detect changes, to analyze the data and to look at things. So for a lot of these efforts, from just a mathematical point of view, you’re in a difficult place in the first few years to offer quick results. This comes up so often I think it needs to be emphasized.

Where to Next?

In terms of citizen science monitoring projects, we have been doing the kinds of things that make sense to us. We look at birds, we look at bird lists because traditionally those are things that people and metrics have looked at a lot. We haven’t looked at it from an ecological information point of view in terms of what information we need. So right now we have a lot of programs working on vertebrates, and that’s good. We’re getting the kind of information that informs conservation efforts. When we talk about changes in bird populations and why we’re looking at this versus that, we are looking at the data first and then saying, “Because we can see that species declining, as we can see in the Christmas Bird Count and the Breeding Bird Survey, we are working on these.”

When we look at some of these other groups, we don’t have that information. I’m looking at native bee species now and I can tell you that there are no data sets. We have no way to look back on them. We have
Little dead bodies in museums from pre-World War II. I can’t tell you what the status of bees is despite the newspaper articles saying they’ve all disappeared.

It would make some sense in the largest of large pictures to look at what other groups we want information on that would give us an idea of the health of the world. Because I’m a critter-based person I have a few examples here. This goes for “what is your place in the scheme of things and how am I unique or not,” in that I’m getting a new measurement of world health. For example, crickets and katydids are processing the environment in a very fundamentally different way than birds. They are, in fact, bird food. They are processing health identification issues that are cricket and katydid issues, so if we have measures of crickets and katydids, we have a new way of talking about the health of the earth.

The same with ladybugs, or mushrooms, or worms. John Losey, who is here, is starting a ladybug program, which is great. The question is, what information would be nice to have from an ecological perspective?

The Eighty-Percent Rule

The eighty-percent rule is something I’ve thought about a lot. Maybe this doesn’t translate to other people, but eighty percent of everything that I do fails. Sometimes it just doesn’t work out. Say eighty percent of the people who come with me to work on a project disappear, but the thing is that twenty percent of them work out really well. The argument is that if you have tried something or tried certain aspects and have just totally failed, it’s really not about you. You have to make a lot of attempts at doing citizen science or other new ideas in order to get successes. So if you say these things just don’t work, it’s never going to work because you haven’t tried it all. A good chunk of them don’t work out, and again that might be my personal experience, but by doing what you guys are doing, we are gaining an awful lot.

Web Sites

The Monitoring Manual site is based on the idea that you’re developing something where you’re attracting change, and that you need to think about how you set that up so that the results ten-plus years down the road, when it really starts getting juicy, are as usable as possible. This is a philosophical Web site. It goes through all of the steps that you need to do when you are considering how and what and how many, what kind of information you’re going to get out of it, goal setting, and what area—things that have tripped people up over and over again. I’ve tried to write it in a way that is understandable. Then you can take that to a statistician and say, “Help me calculate sample size.”

There are various forms that you can fill out, and you can also document your program so that when you leave and someone else comes along and says, “What in the world were they doing?” there is documen-
I put the discoverlife.org Web site up because it’s a good Web site for geographic information and online identification guides. I haven’t talked about those, but we use them a lot and I like their approach. It’s free and they work with different people all the time.
NestWatch & Virtual NestWatch: an InterSECTion of

Science
Education
Conservation
Technology

Tina Phillips
Project Leader, NestWatch, Cornell Lab of Ornithology
www.nestwatch.org
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that this document did not originate as a formal paper. Rather, it combines an oral presentation with accompanying PowerPoint slides and reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

Documentation of the conference is meant to serve as a resource for those who attended and for others in the field. It does not necessarily reflect the views of the Cornell Lab of Ornithology or individual symposium participants.

The following is one of three focus point presentations delivered on day one of the Citizen Science Toolkit Conference as part of the opening session titled “Citizen Science Challenges and Opportunities.”

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org
Introduction

I am presenting NestWatch and Virtual NestWatch, two projects born from the same NSF grant. Someone asked me as I was developing this talk, “What is it that you want people to know?” Basically, it is that this project is really trying to push the envelope, creating intersections between these four very important pathways: science, education, conservation, and technology. I would like to acknowledge that this project could not have been developed without the incredible support at the Lab of Ornithology and the collaboration of the Smithsonian Migratory Bird Center, and most important, the funding from NSF.

...these animals and their behaviors are fascinating and they’re a hook; they can get people interested in animals and from that you can build their interest in science.

This is a view from one of our NestWatch cams, and these are the things that have really captivated people. During the individual introductions, so many of you said that you are now scientists or science educators. For many of you, your love of science began when you were children, going out with your mother or father and watching birds in real life. Or, as was the case for me, growing up in Long Island, watching Wild Kingdom with my dad on the couch. Either way, these animals and their behaviors are fascinating and they’re a hook; they can get people interested in animals and from that you can build their interest in science. That is what we are trying to do here with Virtual NestWatch and NestWatch—enabling people to look at these images and getting people to wonder and develop that interest in science.
Cornell’s Model of Citizen Science:
A partnership between the public and professional scientists that relies on large-scale observations collected across time and space.

Science
Gather meaningful data to answer large-scale research questions

Education
Promote environmental awareness and scientific literacy

Conservation
Apply results to science-based conservation efforts

Lab of Ornithology Citizen Science Model

I’d like to bring you back to the beginning for this project, which is the Cornell Lab of Ornithology’s model of citizen science. Essentially, we define it as a partnership between the public and professional scientists that relies on large-scale observations collected across time and space. It comes very much from a researcher-driven perspective. You’re going to hear about other perspectives during this conference, but ours is what we call researcher-driven. It is large-scale and there are a lot of volunteer networks that we’ve built.

With that definition in mind, all of the citizen science projects at the Lab have three major goals. One is science and research, gathering meaningful data to answer large-scale and relevant questions. These manifest themselves in our publications. We’ve had over forty publications that are based on citizen science-collected data in peer reviewed journals. Our educational mission is to promote environmental awareness and scientific literacy. We can see this in all of the online resources that we have, in our printed materials, and in our outreach efforts. Our conservation goal is to apply these results to real science-based conservation efforts and things like management guidelines.

NestWatch & Virtual NestWatch

Project Overview

These are two projects and I’m going to define them separately so that you can understand how they differ and complement each other. NestWatch is a nest-monitoring scheme that relies on observations of all North American breeding birds across time and space. There are two ways to participate in NestWatch. You can do it on your own, as is the case for most of our citizen science projects, or you can have mentored participation. I just want to underscore that it is all North American breeding birds. This is really important because NestWatch...
comes out of the Birdhouse Network, which is a project that collects data on cavity-nesting birds, which means you’re limited because all of these birds are not distributed widely across all habitats. What NestWatch does is to remove that barrier, so we get reach, we get information on all birds, which means we can track all habitats, which means we can get to all landscapes, which means we can get to all audiences. This is a really interesting and exciting approach for this kind of program. If you’re in the city and you’re a metropolitanite and you have birds nesting on your apartment building, you can enter that information into NestWatch. So it’s a means of branching out our audience.

Virtual NestWatch is a nest-monitoring project that relies on observations of online breeding behavior. The only way to participate is virtually, and it is through those Web cam images that I just showed you. That also allows for wide distribution because as long as you can get to the Internet you can participate in Virtual NestWatch.

Project Goals

Here are some of the goals we have for NestWatch and Virtual NestWatch. With the scientific goals we’ve been a little more specific. We’re interested in knowing how breeding factors vary across time and space, the factors that limit breeding success, and how climate change influences breeding. Our goals in terms of educational impacts are to teach people about bird reproductive biology and things like how to monitor nests properly; to increase their scientific literacy and environmental awareness; and to have them understand how their actions can impact the environment and, as a result, impact breeding birds.

Our conservation goals are to promote better land stewardship practices that would benefit breeding birds. We also have a technological goal, and this is new for us. We all do technology, but it is never one of the inherent goals. Because these projects are so technologically based, we have included the goal of creating online learning communities and online collaborations.

Conceptual Model

I’ve tried to come up with this conceptual model, just for visual learners to understand how these two projects are situated. There are two different ways to participate: self directed or mentored.
Either way, the data that comes in from those two types of participation is the nest record type of data, when you’re out there collecting information in the real world. Then there is this virtual participation, and this is a data source that is image-based. It is a visual set of data. In combination, these two data sets both help to increase our understanding of breeding biology and reach the scientific goals that I just mentioned.

On the educational side, when we look at the formative and the summative evaluation data from these three different types of participation in combination and in comparison, it will help us to analyze different learning outcomes from these different models of citizen science. Essentially, this analysis of learning outcomes of different models of citizen science is what is new and innovative and exciting about this project. It is a new focus for our research, and it is going to contribute to our overall understanding of how to deliver informal science education to different audiences.

When all of this is said and done across the projects and across the treatments, what we want to learn is who participated, how, what was it like for them, how they were affected, what worked, and what didn’t, using several different kinds of evaluative approaches.

**NestWatch Mentored Participation**

I want to start with the NestWatch mentored experience because that is the most intensive, and after I give you a full picture of that, we will get to the other two types of participation. These mentored experiences are site-based at our partner sites. We call them “Nest Quest” workshops.

The partners sites are responsible for holding two Nest Quests per year, with a minimum of fifty participants per year. The first workshop at each site has Cornell staff there so that we can train the trainers how to run these workshops. The second time around they do it on their own. Sometimes they host a Nest Cam site as well. This year, two of the four have successfully gotten a cam online. Another possibility is to incorporate banding days, which two of the four sites have been able to do. That is what is going on in the picture here, a master bander is showing participants up close some of the birds he just caught.

Our partner sites include very different types of organizations, and we can compare across those different types. One is the Smithsonian Migratory Bird
Center. The Neighborhood NestWatch program that they run is fascinating and very intensive. You have to go out to 200 homes in the Washington, D.C. area and sit with the land owners. They find birds, they catch them in nets, and they take blood samples, so they have a lot of intense interaction not only with the participants but with the birds. We are using them as a model but more importantly, we are getting a lot of our formative evaluation information from this kind of intensive scientist-participant interaction.

We want to know whether these four-hour workshops will enhance learning and behavioral outcomes. For example, will people be likely to participate in this project and maybe even go beyond that and start to take part in stewardship practices? So we do things like goal setting, we have them sign pledges, we do pre- and post-workshop evaluations, and we do interviews, focus groups, and other types of observations.

Another thing that we want to understand is whether this is an effective way to help people overcome barriers to participation. These are some of the major barriers that we are aware of when it comes to participating: I can’t identify birds; I don’t know anything about birds, forget about nests. So it involves teaching them these deductive approaches. What do you do when you find a nest, and how do you figure out what bird it belongs to? We also offer an introduction to breeding biology and binocular demonstrations and an understanding of how they work. Data entry is a huge barrier for people to overcome, so we walk them through that process of entering their data. Finally, we train them on finding and monitoring nests. It is sometimes just getting them aware that their observations, what they see, can really tell them something about breeding birds in the area.

So we go on these Nest Quests. Sometimes it even involves putting up a ladder in a donkey stable to peek inside of a Barn Swallow nest.

We also go through the complex task of collecting the data. We talk about the code of conduct when we’re out there monitoring, as well as following...
Mentored Guidance for:
- Data Collection
- Code of Conduct
- Protocol

They use Google maps, they describe their sites for us, they give us visit information every time they visit a nest, and they can also summarize a nesting attempt. We have people with up to five hundred nest boxes or nest sites, so we also have a lot of tools for them to manage all of this data.

We have completed seven of eight of these workshops and have had about 150 participants. The preliminary evaluation so far indicates that people find these very informative. I’ve read a lot of the evaluations and surprisingly, the four hours might not be long enough. People want a little more, especially in terms of going out and finding nests. That was the part that was really engaging for them. The majority of them indicated in their pledges and in the evaluation information that they were likely to monitor nests and record and submit the data. We’re going to track that and see if, in fact, they do and more importantly if they don’t, to determine why they can’t keep up with it. We also want to evaluate our recruitment plans.

NestWatch Self-directed Participation
Now let’s move on to self-directed participation. Basically, somebody joining us would go to the Web site www.nestwatch.org and they attempt to do everything I just explained in the mentored experience, but essentially they are on their own. They have got to figure it all out and understand broad concepts like avian ecology, breeding biology and natural variation.
This is actually a prototype Web site. It is just being developed and designed and we hope to have this up in a couple of months. I should say that from this point forward, everything I am going to show you is a prototype. The launch for all of this is 2008.

They also need to understand the complexity of collecting data and submitting and retrieving data. And again, this is on their own.

I’m going to quickly show you one of the great features that I think is going to key in on the social networking factor around data. This is something Chris Marx developed. You’ve all seen Google Maps. Basically, you can click on here and say, “I want to see what’s at my location.”
You get a listing of all of your nest sites and there is a summary for everyone. They can download and export this and that is really cool—people love seeing their own data. Then they can say, ”I want to see the people around me within fifty kilometers.”

You can see other people’s nest sites and exchange information with them: ”Hey, you have that kind of bird? How did you get them to nest there?”

So there are these ways for the social network to happen. There is one other way that I think is really cool that we’re all very excited about. You can go to YouTube and upload your video. We have people who are crazy about the cams and who have their own nest cams. Now we can tell people, ”We know you want to share this information with everybody, we know you want to show everybody what your birds are doing.” We send them to YouTube. We’re not liable for what’s up there, we’re not storing that stuff, but we can link to it because it’s public and we can bring it into these Google maps. People can describe their habitats this way, and they can tell us what is going on with their birds. This is really exciting stuff. If you want to know more about this, contact Chris Marx (Programmer/Analyst, Citizen Science, Cornell Lab of Ornithology, chrismarx@gmail.com).

He has even figured out how to overlay temperature data onto this stuff and is just starting to really get into it, so if you’re interested make sure you talk to him. He is a whiz.

One of the other things that we are really excited about is the data infrastructure for entering historic data. We have in one of the rooms in this building 300,000 cards like this that date back to 1965 from the Cornell North American Nest Record Card Program. We’ve never been able to use these data very well because there wasn’t a place to put them. Now there is, and in the next year we’re going to be entering all of these data and I think there is going to be a lot of interest by scientists and by the public, regarding how birds are affected by local climate change and how things have changed over the last forty or fifty years.

Virtual NestWatch

Basically, the crowd we are trying to engage with Virtual NestWatch is the “bowling alone” crowd, people who just love to spend time online. We also want to answer questions that are of behavioral interest; we want to develop software for image
Virtual NestWatch
A citizen-science nest monitoring project conducted completely online
• Engage “bowling alone” crowd, increase audience reach
• Answer questions of behavioral interest
• Develop software that can be used for image coding
• Determine whether collecting data online encourages people to get outside

Virtual Participation
• Cam highlights, commentary, narratives
• Discussion forum
• Photo archive
• Cam stats
• Game format
• Animal behavior videos
• CamClickers

CamClickers is the application for collecting the visual data. A user might go in and say, “I want to look at Barn Owls, I want to look at them during the nesting period, and I want to look at 500 images.” What they would get is much like you see here, with all of these images.

CamClickers
How does it work?
• User chooses species, nesting phase, # of images
• Tag animal behaviors using drag and drop tools
• Consensus tool for coding, stats
• Friendly & competitive game, incentives

On the right hand side we have predefined a whole bunch of behaviors. We have divided them up, though not explicitly, between observed and inferred behaviors. They tell us what the observed behavior is and can then give us sub-behaviors. For example, they...
could choose "a female sitting," and then if they go down a level they can choose "incubating" or "alert" or "at rest." Those are the inferred kinds of behaviors that we want them to drag and drop onto the screen.

On the back end, what they’ve tagged are coded for us so that we can use those and search those out. There’s going to be a consensus tool for coding, so if you’re a user it might say, "This image was flagged and 95% of all of the other people also said the same thing for this image." So we’re trying to build up consensus but also trying to make it a little bit competitive for them. There are also incentives. For example, if you get through X number of images, you may get a free pass to the Urban Ecology Center. We’re trying to do that kind of thing with our partners.

Innovations and Broad Impacts

The innovations and broad impacts are listed at left, including large-scale research on breeding biology of birds and new tools for searching visual data. What I would like to see, once we get all of these archived and get these seven million images tagged, is that other people like yourselves who have thousands of hours of video and footage might want your own data analyzed. Maybe we can get volunteers in networks to get some of this footage analyzed in a faster way than it is being analyzed right now.

In terms of education and ISE research, in addition to increased environmental awareness we also want to advance the field by increasing our understanding of how these different models of citizen science delivery influence what people learn and how they learn.

Acknowledgments

I would like to thank all of the people listed here. This was a huge team effort. It has been an ambitious project, it’s innovative, and it is starting to launch in 2008, so please look for it.
biodiversity inventories and beyond: 
bringing scientists and communities together 
at an environmental education center

Michelle D. Prysby 
Virginia Polytechnic Institute and State University
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that this document did not originate as a formal paper. Rather, it combines an oral presentation with accompanying PowerPoint slides and reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

Documentation of the conference is meant to serve as a resource for those who attended and for others in the field. It does not necessarily reflect the views of the Cornell Lab of Ornithology or individual symposium participants.

The following is one of three focus point presentations delivered on day one of the Citizen Science Toolkit Conference as part of the opening session titled “Citizen Science Challenges and Opportunities.”

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org
Biodiversity Inventories and Beyond: Bringing Scientists and Communities Together at an Environmental Education Center

Overview

Citizen science has been the focus of my career for about ten years so it is really fun to be here and discuss it with such a knowledgeable group of people. I am currently at Virginia Tech in the Department of Forestry, coordinating the Virginia Master Naturalist Program, but what I am going to be talking about this morning is work from when I was at the Great Smoky Mountains Institute at Tremont.

Specifically, I was asked to talk about biodiversity inventories and the All Taxa Biodiversity Inventory in Great Smoky Mountains National Park. What I am going to try to do in this case study is illustrate biodiversity inventories as one form of citizen science collaboration, and also illustrate how environmental education centers and nature centers can be key partners for citizen science efforts. Rather than give you too many details about the program and progress, what I hope to do is identify some questions and challenges for our discussions during the rest of this workshop.

Biodiversity Inventories

Studying Natural Resources

When we think about citizen science, we have lots of examples of long-term monitoring programs that involve citizen scientists, and a smaller number of examples of real, hypothesis-driven research programs that involve citizen science volunteers.

Michelle Prysby, Virginia Polytechnic Institute and State University

Michelle Prysby has done way too many different things with citizen science for me to explain them all, but really got started with her thesis in graduate school when she developed the Monarch Larva Monitoring Project, which is still going on, though she has gone on to do other things. While she was at the Great Smoky Mountains Institute at Tremont, the center hosted the first ever, that I know of, citizen science conference.

- Rick Bonney, Director of Program Development and Evaluation, Cornell Lab of Ornithology

This case study will:

- Illustrate biodiversity inventories as one form of citizen science collaboration
- Illustrate how environmental education centers can be key partners for citizen science endeavors
- Identify questions and challenges for further discussion
When land managers talk about the ways that we study natural resources, there is a third type of scientific study, and that is biological inventory—an effort to document the resource, including presence and abundance of multiple kinds of taxonomic groups and sometimes even abiotic elements such as soil and water.

### Why Match Inventories and Citizen Science?

**From a scientist’s perspective:**
- Need for sampling over potentially wide area
- Need for sampling at non-prime times
- Not critical to have repeated observations by the same observer
- Many potential roles for citizen scientists

**From an educator’s perspective:**
- Inventories involve basic skills such as using keys, recording data, mapping and GPS use
- Opportunity to teach about classification biodiversity
- Can involve a range of audiences
- Opportunity for community-based and community-driven projects

### Inventories and Citizen Science

Why match biological inventories and citizen science? From a scientist’s perspective, biological inventories often need sampling over a potentially wide area. There are entire states doing biological inventories, and there are tiny little parks doing biological inventories. There is often a need for sampling at non-prime times. The expert taxonomists might only be able to sample during the summer, or whenever the particular focus of their field season is, but they might miss some of the “shoulder” seasons, so to speak. Citizen science volunteers can be very useful for sampling during those non-prime times.

It is interesting that, unlike with long-term monitoring, with an inventory it is not so critical to have repeated observations by the same observer. That is one way it matches well with citizen science. Also, in an inventory there are often a lot of potential roles for volunteers, and I will be talking about those in a moment.

From an educator’s perspective, one reason to match inventories with citizen science is that inventories involve basic skills that educators in general like to teach people about, such as how to use a dichotomous key, how to record data, and how to do mapping and use a GPS. Inventories are also an opportunity to teach general topics about classification of life and biodiversity, the same topics that you see in our science standards. Inventories can involve a range of audiences, from K-12 all the way through adults, from novices to amateur naturalists. They also hold opportunities for community-based and community-driven projects versus a more top-down approach, though there is room for both approaches.
Inventories and Citizen Science: Examples

One example of a citizen science approach to biological inventories is the "bio-blitz." In brief, bio-blitzes are short-term, focused sampling efforts to look at the biodiversity in a specific area. They are snapshots in time, usually done over a day or two. They are done regularly in some places. Connecticut does one every year, and there is one in the general D.C.-southern Maryland-northern Virginia area that is done every year. They are being done in the national parks as well, and I’ll be talking about that in a moment.

Another example of biological inventories of a sort are NatureMapping programs. These are programs that came out of Gap Analysis and started in Washington State, then spread to a handful of other states. NatureMapping basically involves citizens in opportunistically documenting the flora and fauna that they see outdoors and in collecting spatially explicit data on those observations. One goal of the NatureMapping program is to keep common species common, so they are looking for people observing the things they should normally be observing, like robins. Concern would arise if those common species dropped out of the observations. There is also the potential for observing species that hadn’t been recorded in a locale before.

The third example of inventories and citizen science, and the one that I am going to focus on today, involves all taxa biodiversity inventories (ATBI). These are longer term, more focused efforts to document all of the diversity in a specific area over time.

All Taxa Biodiversity Inventories

All taxa biodiversity inventories are going on in a number of different natural areas and reserves across the U.S. Great Smoky Mountains National Park is known as the mother of these, but they are working on forming an alliance with a number of other national parks and reserves that are all either engaged in ATBIs or gearing up to try to do one.

Figure 1. The Alliance of ATBIs.

Great Smoky Mountains National Park is about a half-million acres, located on the border of Tennessee and North Carolina. It is an extremely biologically rich area. It is a biodiversity hot spot in part due to its great range of elevations, diverse geology, and temperate climate. Because of its location, it tends to have the southern edge of the range of many more northern species and the northern edge of the range of many southern species.

There are estimated to be about 100,000 species in Great Smoky Mountains National Park. Now that is just an estimate, and who knows? It may be way off, and it doesn’t include bacteria. If you look at these simplified pie charts, the overall size of the circles indicate the number of species that are thought to occur in that group. These pie charts would be similar for most areas. We know the least about the invertebrates and about fungi and non-vascular plants, and the greatest diversity, of course, is in invertebrates and in fungi and non-vascular plants. We know most of the vertebrates and the vascular plants that are in the park.

Overall, when the ATBI got started about ten years ago, it was estimated that about ten percent of the species occurring in the park had been documented, and that ninety percent remained undocumented. If you’re familiar with the National Park Service, you know that its mission is to preserve and protect the land and what is on it for future generations. Of course, that mission becomes difficult to accomplish if we only know about ten percent of what’s there. The All Taxa Biodiversity Inventory in the Great Smoky Mountains National Park attempts to remedy this problem. It is an effort to document and map the distribution of all of the species occurring in the park.
The inventory involves everything from moths to mammals, snails to slime molds, and algae to amphibians. It goes beyond just creating a species list and some maps. There are a lot of offshoots of the project: better understanding of the ecology of these species once they are documented; the creation of keys so that both experts and lay people can better identify those organisms and know about them; and an effort to rekindle a love for taxonomy and train future taxonomists. Taxonomy as a field is dwindling, making these types of biological inventories even harder to do because we don’t have the experts. Of course, it being a national park, there are many education goals related to the ATBI as well and many roles for volunteers in the projects.

Roles of Volunteers

There is a range of roles for volunteers. There are one-time volunteers, park visitors who are just there for a day and might do something to help out the ATBI. Then there are people from the gateway communities around the park who enter into long-term interaction with the ATBI and come repeatedly to help out with it.

There are novices involved, those who really don’t have any experience with species identification or doing this kind of work, and there are what we call “parataxonomists.” These are people who maybe aren’t professionals in this field but have really dedicated themselves to it, much like many birders do, and become experts of a sort in a particular group of organisms. We have levels of engagement from

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people whom we call “window shoppers,” those involved with a very small piece of the inventory, to people who are doing almost independent research related to the ATBI.

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The roles these volunteers play include field assistance: recording data, collecting georeferencing data, and deploying traps for collecting organisms. There are a lot of volunteers involved in all aspects of collecting and identifying samples. There is also lab assistance, which includes curating specimens. There are specimens being collected and curated for every one of the species that is found in the park. Volunteers are also involved in doing biological illustrations of species, some of which have never before been described by scientists. The ATBI has resulted in many, many species new to science as well as new park records. We also have what I referred to before as parataxonomists, who are coordinating local efforts, overseeing other volunteers, and developing their own expertise.

Why are Environmental Education Centers and Citizen Science a Good Match?

I’m going to shift gears for a moment to talk about this from the perspective of somebody who worked at an environmental education center. Why are environmental education centers and citizen science a good match? I’m using “environmental education center” as a loose term for all sorts of nonformal science education institutions including science museums, nature centers and the like.

I think there is a strong match in goals and objectives between most citizen science projects and what most environmental education centers are out there to do. They’re very place-based, so you have a staff there who know that particular area. They know all the trails, they know where all the good habitats are. If I want to know where I can find vernal pool habitats, the staff are going to be able to help.

Environmental education centers can potentially reach a very diverse audience including K-12, teachers, retirees and general park visitors. Naturalist clubs often have an association with an environmental education center or nature center, and of course those clubs are full of people with some of the skills that we’re looking for in our citizen science volunteers.

Because the staffers are generally really knowledgeable, there are great train-the-trainer opportunities. We just heard an example of

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**ATBI: Roles of Volunteers**

- Field assistance: recording data, collecting georeferencing data, deploying traps
- Collecting samples
- Identifying samples
- Lab assistance: curating samples, species illustrations
- "Parataxonomists": coordinating localized efforts, overseeing other volunteers

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**Why Match EE Centers and CS?**

- Potentially strong match in goals and objectives
- Place-based
- Diverse potential audience (K-12, teachers, retirees, general park visitors, naturalist clubs)
- Knowledgeable staff, train-the-trainer opportunities
- Infrastructure for recruiting and managing volunteers
- Opportunity to network statewide or nationally
that in the NestWatch project presentation, in which those staff can be trained and then go on to train volunteers. The centers also often have an infrastructure for recruiting and managing volunteers, which can take the load off the scientists from having to do that aspect of citizen science.

Environmental education centers are also networked together. That is particularly true in some states like Minnesota, and less true in other states. Nationally, many of them are networked through the Association of Nature Center Administrators, so there is an opportunity for one citizen science program or one scientist to use this network to reach centers all over the United States.

Great Smoky Mountains Institute at Tremont

The GSMIT Citizen Science Program

The particular center that I was at was Great Smoky Mountains Institute at Tremont, which is located right inside Great Smoky Mountains National Park, with a campus that includes the whole 500,000 acres of the Smokies. Our audiences were mainly fifth through twelfth grade in terms of students, but also summer campers, adult audiences, visitors coming for wildflower weekends or wildlife weekends, and teachers, all coming together in this one place-based center.

Our citizen science program in the Smokies started at the same time as the ATBI and really developed in parallel. There was an opportunity to enhance the ATBI by involving Tremont in it, and Tremont saw the opportunity to increase our programming by adding citizen science to the mix.

The goal of the citizen science program at Great Smoky Mountains Institute at Tremont is to connect people with nature by involving them in research, inventory, and monitoring in the park. The audience includes both one-time visitors and long-term volunteers. It’s a residential center, so most of the program participants are there for one to three days. The citizen science program also offers the oppor-
tunity to connect to the local community, which Tremont really hadn’t done very much of before. This presented the potential for teen volunteers to come in from the local communities and do research projects there at Tremont.

We were engaged in a whole variety of inventory, monitoring, and research projects. Some of the taxa studied as part of the ATBI included moths, bees, snails, and fungi. Almost every taxonomic group you can think of, we tried it. Maybe that’s where my 80% failure rate that Sam Droege talked about in his presentation comes in. We would try to do ATBI projects with a whole variety of species, and then we would figure out which ones worked for citizen science and our educational goals and which ones didn’t.

We also had varying levels of intensity. We had opportunities for park visitors to just report opportunistic casual observations of species that they saw, and we would take their observations and put them into a database that would actually be functional for the ATBI. There were also short searches for particular taxonomic groups, and longer-term intensive collecting and identification of specific taxa.

Example One: Moths and the ATBI

There are a couple of examples I’m going to tell you about. One is a study of moth biodiversity that has been really successful, in which we used a unique way of observing invertebrates. We used the typical light trap that most people are used to seeing, but because we were at an environmental education center, because we were going to be doing this over time and collecting a lot of samples, and because we were in a national park that does have rules and permits associated with keeping specimens, rather than the trap going into a bucket that had some sort of killing solution, it led into a refrigerator. The moths and other insects that were collected would stay alive overnight in the cool environment.

We deployed the traps in the afternoon with the students or whoever was going to be involved that day. It was left up overnight, and then we could bring the whole refrigerator in the next morning and pull
out whatever creatures were in there. The participants, whether they were students, adults, one-time visitors to the park, or people from the community who were helping out with our project pulled in the refrigerator, pulled out the insects that were collected, and then used our reference collection to identify the species of moths that were found that night. The reference collection was built up over time. We also had field guides to help the participants identify the species.

It is amazing that this is something that people can do. You really can identify moths with a good reference collection and some good field guides. You can’t identify every moth that you might find, but most of what we found in the park, our participants were able to identify.

We did have the help of some interns in the program. These were people, myself included, who started out with no experience in identifying moths, but through experience with the project and self-study, we were able to supervise and help the newbie one-time visitors to the park who might be working on identifying moths. This is also a neat project because some of the students could be involved in the curation, doing the pinning of any new species that we found.

Moth Project Successes

**Science**
- Study filled an important need within the ATBI
- >15000 moths examined and identified over the last 10 years
- >600 species documented, >120 new park records
- Development of new collecting method

**Education**
- Hundreds of Tremont program participants involved, including K-12 students, college students, and adults
- Strong support from and positive interactions with professional scientists
- Involvement in many steps of the inventory process
- In-depth participation by a subset of high school students
- Springboard to other types of scientific study
- K-12 students show an increase in understanding of biodiversity in Great Smoky Mountains National Park (from participation in overall school program)
I think there were a lot of successes with this project. It is still ongoing today and has been going on for about ten years now. It fills an important need within the ATBI. The moth group had been very understudied when this project started—I think there were only 120 species listed for the park. Over the ten years, more than 15,000 moths have been examined and identified at Tremont, and more than 600 species have been documented just at Tremont alone (we’re talking about one little site within the park), and 120 of those have been new park records. Another success was the development of our new collecting method, which we’ve shared with many other groups.

In terms of educational success, we’ve had hundreds of youth and adults participate. We’ve had very strong support from and positive interactions with professional scientists who were helping us with those species that we couldn’t figure out on our own. I think a nice thing about this project is that participants were involved in many steps in the inventory process. They were involved in setting the traps, in bringing them in, going though the species collected, identifying them, curating them, entering the data, and could look at what they’d found on the data. We had in-depth participation by those interns that I mentioned, who were mostly high school students, and this was a nice project to springboard to other types of high school study. Those high school interns, in particular, could then take this project and say, “Okay, I’m going to now see how the habitat affects what we catch in the light trap, how the light we use affects the light trap, the data, etc.” And we do have some evaluation data in general from the Tremont school programs that demonstrates how students show an increase in understanding of biodiversity in the park after visiting Tremont.

On the other hand, in terms of challenges for this project, there really is a need for oversight by experienced leaders because although they’re capable of a lot, if you just turn fifth graders loose on the moths, they’re going to have a lot of misidentifications. Also there is a lack of charisma of the study organisms. You see insects in jewelry and all kinds of things, but kids aren’t always very excited by insects. They’re a little more turned off by the creepy-crawly nature, even though moths really can be rather pretty.

### Moth Project Challenges

- Need for oversight by experienced leaders
- Lack of charisma of study organisms
Example Two: Dung Beetles

The other project I wanted to mention is a study of dung beetle diversity that we did. This was a project that involved participants in inventorying the beetle species that would occur in dung throughout the park. They had to identify the critter that the poop came from and they had to collect beetles from the poop.

Looking at the successes of this project, we did get seventy-five samples and twenty-plus species that were all geospatially referenced, which is important for the ATBI, and two new park species records that weren’t identified in the park before.

On the other hand, I think there were a lot of challenges inherent in this project. Going beyond collecting samples was hard. Unlike the moth project, the participants weren’t really involved in the identification because getting it down to the species level for beetles is just too hard for novices. The result was a disconnect between the collection and the identification. The volunteers came and collected the species, but they never heard what happened after they collected them and it was hard to communicate that later when we got the identification back from experts. And again, I thought kids would just be thrilled about combing through poop and picking out beetles, but that wasn’t necessarily the case.
Fodder for Discussion

I want to end by throwing out some fodder for discussion. How can we involve citizen scientists in more steps of the processes, whether we are talking about inventory, monitoring, or research? How can we help these citizen scientists grow in their roles and go from field assistants, who are just out there collecting a beetle with an aspirator from some poop, to being principal investigators who are really engaged at many more levels? And finally, how can we overcome issues with non-charismatic species and systems?

I look forward to talking about these issues with you over the rest of this workshop.
citizen science as a catalyst in bridging the gap between science and decision-makers

Hague Vaughan
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Environment Canada
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that this document did not originate as a formal paper. Rather, it combines an oral presentation with accompanying PowerPoint slides and reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

Documentation of the conference is meant to serve as a resource for those who attended and for others in the field. It does not necessarily reflect the views of the Cornell Lab of Ornithology or individual symposium participants.

The following is one of three focus point presentations delivered on day one of the Citizen Science Toolkit Conference as part of the opening session titled “Citizen Science Challenges and Opportunities.”

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org
Citizen Science as a Catalyst in Bridging the Gap Between Science and Decision-makers

The Role of Citizen Science

I have a different way of looking at things. I don’t come from a citizen science background, I come from a science background. I was in charge of monitoring water quality with the federal government across the Prairies and Northwest Territories. For years I was with the National Water Research Institute, and have now taken on the management of the Ecological Management and Assessment Network (EMAN) Coordinating Office.

I like to start with this particular image because when Don Quixote starts tilting at windmills, you’re seeing a confrontation between two worlds. One is that of Don Quixote, which is very dramatic, very passionate, very inward-looking. Then there is the world of the miller, which is perhaps not quite that way, but is certainly bereft of understanding of why someone would be running at his windmill with a lance.

Enhancing the effectiveness of ecosystem research & monitoring programs by building complementary localized capacity in communities to collect, share and use ecological information for informed decision-making and the adaptive management of sustainability

It is the kind of confrontation and disconnection that we see between ecological science and ecological monitoring and the world that pays the bills. In essence, we are getting into trouble because we are not being very effective in terms of how we inform society’s decisions and society’s policies. We are too self-referential. What citizen science can do is begin to try to bridge that gap. I see that as a
fundamental role for what we are doing. I am not in any way diminishing the importance of education and outreach and training the next generation and long data sets, but with our focus on certainty and peer-reviewed publications, ecological scientists have painted themselves into a corner, and citizen science provides the kind of mechanism and the kind of information that we need in order to begin to actually inform society’s choices more effectively.

The Ecological Management and Assessment Network (EMAN)

Background: Breaking Out of a Self-referential Box

The original EMAN was made up of long-term integrated sites across Canada. It grew out of the Acid Rain Program, when we began to realize we had to start to integrate—from surveys, from research, from monitoring sites—into a total package in order to inform policy with regard to acid rain. So we had to standardize, we had to look at how we integrate that data. Out of that grew what EMAN has become.

From the Environment Canada point of view, it allows us to extend our capacity, but EMAN is a network and nothing more, and I don’t run the network. I run the Coordinating Office. EMAN is made up of over 600 partners across Canada involved in various aspects of either monitoring or assessment. What I work at through the Coordinating Office is where they have common problems, and the biggest common problem is, why isn’t ecological monitoring and assessment actually effective? Why are we speaking to ourselves? Why does no one get us? Why don’t peer reviewed publications penetrate the public? There may be obvious reasons, but we’re just scientists, we don’t think about this very much. We’re in our own little self-referential system.

So I work where they have this common shared interest, and what we look at is standardization so that each group is starting to do the same things in the same way. We focus on increased engagement of people who will either generate or use ecological monitoring infor-
mation. There is assessment on the basis of place instead of some isolated chunk that we’ve carved the ecosystem into. It is not just fish and not just trees, it is what is happening here, in this area: an integrated view that informs discussions. And then there is delivery, which is a very deliberately chosen word. When I was out monitoring water quality we were supposed to make an integrated data base that absolutely anyone could use should they care to. When I was at the National Water Research Institute, we were generating new data and making it available through the peer review publication process. I doubt there are many people outside the scientific community who love peer review publications.

At the moment, what we are doing is creating integrated databases—again, for all of those people out there just hungry for integrated data. As I say that I’m reminded of the fact that I was talking to a book seller one time and he pointed out that most of these big fancy cookbooks are not bought by people who cook, they’re bought by people who like to look at food.

But "delivery" is a word that we chose deliberately because it means the cogeneration of knowledge in a decision-maker. How do I package my information so it serves your needs, and out of that you have a better foundation for your decisions or your policies? How do I deliver that to you? That becomes a new wrinkle in terms of science and how effective it can be.

Protocols and Toolkit

We started out with standardization. What would be the things that we wanted to standardize across Canada and have all our sites begin to look at? The emphasis that we took as a network was that we wanted to get early indications of change—that change was occurring, and we wanted to draw attention to it so our programs could be more responsive. That was what we took as our sort of toolkit. If some of these things are changing, that means we should be responding to them. We don’t have to wait for statistical certainty, we can begin to respond to early information. And there’s nothing too much weird about them, nothing very strange, and a lot of them are based on biodiversity.

We began to realize that the same toolkit could be applied to citizen science; that a lot of these things could be done by park super-
intendents who needed to know how they were managing their landscapes. And a lot of this could be done by schools and universities.

So out of this came a community because of the monitoring toolkit, which has not yet been perfected, but at least this is the direction in which we’re going. We do have some of these as our Nature Watch programs in combination with Nature Canada. EMAN as a network and as a coordinating office does almost nothing unilaterally. We do everything in partnerships and in collaboration, so there is nothing that Environment Canada does unilaterally through this. It sees itself, it sees EMAN, as a way of extending its capacities, reaching out in areas where it doesn’t have a mandate, so we work entirely in partnerships.

We have a FrogWatch program up on the Web site, which we can talk about. We have salamanders, and birds, we’re starting a butterfly program as a way of engaging youth, and we’re working on developing a pollinator program. We develop these with the best scientists we can find, put together some sort of protocol, then look at how we deliver these and engage citizens in providing our information.

We have IceWatch, looking at freeze up and thaw on the lakes, and we’re about to come up with a report on that. Quite simply, based on reports by citizens across Canada, the frozen season is getting far shorter. We are seeing a much earlier thaw all across Canada.

For plant phenology we have our PlantWatch programs across Canada and have regional coordinators for these. They survey the data, contact the people who input to the data bases, and establish aspects of quality assurance.

We have been surprisingly unsuccessful with Worm Watch. It’s one of the biggest hits in terms of the most people coming in and looking at Worm Watch, but we get very little data and I don’t know why. There is a chopstick decomposition program that we worked out with the National Forest Service. It involves a standardized package that is buried and we come back and look at it and weigh it, and if we
don’t see any decomposition then we know something is going on.

We also have tree health, seedling survival and biodiversity plots, based on the Smithsonian Institute plots. We have lichens in the air as an indicator of air quality, and I’ll show you some data from that. We’re trying to develop a standardized approach to benthic invertebrates, but it’s like pulling teeth at this point because there are too many people up there already doing it. We’re trying to develop a standardized method, but everybody thinks that standardized method should be their method, so it’s very hard to establish agreement.

We also include land cover and change if accessible. We are in a very weird situation in which all of the satellite images are sold through the private sector, so even our scientists who work on space-based research and space-based observation can’t afford the actual images to work on.

There are others including local knowledge, community mapping, valued attributes—all of these are the beginnings of some sort of community ecosystem toolkit that we are putting together. And they do correspond to the Ecosystem Services, so that becomes sort of our touchstone: Is this a complete set that would allow us to detect the existence of change and give us early information that change is occurring, or that there are hot spots emerging?

The idea here is not to gain ten years of data and then begin to look at it. The idea is to fill in that gap between what monitoring science does and what the public needs by looking at either sentinel information that something is changing, or that there is an area emerging as a hot spot, or providing feedback—feedback based on timeliness rather than certainty. Risk is something that most decision-makers can deal with. It is only scientists who really feel that they have to establish something to be of certainty before any action can be taken or any voice can speak.
Environmental Research & Monitoring Goals

- Characterization of conditions, responses and the sources of observed variability
- Surveillance, Detection and Description of emerging concerns, threats, vulnerabilities or changes
- Assessment of recent and historical status and trends
- Understanding of stressors, processes, pathways, linkages & relationships related to ecosystem structure and function
- Identification of critical thresholds
- Models and Forecasts
- Support for Resource Management including effects, compliance, indicators, and establishing the need for, probable effects or success of interventions

Research and Monitoring Goals

These are some of the original research and monitoring goals: thresholds, models, forecasts. We still do all of this, but there are a whole lot of things that we don’t do, and they have to do with how well we inform decisions.

Environmental Research & Monitoring Goals

- Delivering effective feedback on the adequacy of policies and programs and on the effects of development patterns or trends
- Providing timely identification of emerging environmental problems

Enhancements are required

We do not provide effective feedback on the adequacy of policies and programs. If someone with policy comes to a research agency or an agency such as mine and says, ”Can you give me an answer to this question?” and we say, ”Yes we can, in five years,” that’s not really a very adequate response to fulfill the needs of society. So we’ve really fallen down on providing effective feedback.

We also want to provide timely identification of emerging environmental problems. You can’t wait for statistical significance. We know, for example, in water quality monitoring that with site-based monthly monitoring it takes twelve-and-a-half years before we are statistically certain of either a characterization or a change, and we cannot deal with that in terms of decision making. There is a tempo in decision-making, and ecology and environmental science are not meeting the actual needs that are there.

We want to provide policy-makers with a sound basis for effective action and deliver information effectively to decision-makers. And decision makers aren’t just Congress, decision-makers are people in
their backyards. Everybody makes decisions, yet we as ecologists are not actually effective in giving them the information to inform their choices, and that becomes a really motivating factor in terms of how EMAN begins to get involved with citizen science.

A Significant Monitoring Issue

This is a big gap. Monitoring tends to think of itself as purely a science, and it is a scientific activity, but monitoring is mostly a management activity. We gather information to feed into management, whether it’s a model, whether it’s understanding, it has to do with how we actively manage the affairs of society and how we manage resources and ecosystems. Yet we don’t even begin to consider, what is the nature of the information that a manager wants or needs? Instead we say, here it is, it’s a peer-reviewed publication, it’s an integrated database, go and use it. In fact it’s not very effective.

One possible improvement to the way we manage our monitoring or our research would be to add program performance measures: the effectiveness of the information delivery outside of the scientific community and the resulting improvement in outcomes of decisions and policies. But no scientist or scientific organization wants to take that challenge up easily, and probably our biggest issue is how do we get science to realize it has a responsibility, first and foremost, to inform society’s choices and its policies? That is fundamental if you are using public money, and most of us are. Society has a right to require and expect that.

So EMAN has worked at this, how to enhance ecological monitoring effectiveness. We do investigations, we do pilots on how do we better integrate and communicate science and how we develop that responsibility to do so among scientists. And how to better deliver information that is actually specifically tailored for the needs of policy decision-makers. How do we understand what they want and then build in order to fulfill that?

Problems

On the following page is a diagram illustrating a couple of the problems. When we do science, we aim for this point where we actually reach statistical certainty (point A on diagram). This is the way in which all issues develop, they either spread or get worse, and by the time we actually reach statistical certainty it may be too late. We can track the decline of a species in Lake Ontario and by the time we are certain
of it, we are certain because the species is gone. We never pick it up early enough. Precautionary principle would take you to around point 1, with eighty to ninety percent certainty. Canary in the coal mine would be around point 2. What you’re after are the early indications that things are going awry, and I think of it as compass readings. If you’re talking navigation, how do we pick where we want to go as a society? Where do we want to go in terms of the community? What aspects do we want to preserve? These compass bearings allow us to stay on track, and so the whole point of citizen science rests in providing that kind of feedback and that kind of sentinel information that something is changing.

Think of someone navigating a boat. It’s one thing to decide, okay, we’re going to head for Europe and we know that Europe is over there, and never look at a compass and just go straight ahead until you bump into Africa. And at that point you know you were wrong. You need compass readings, and citizen science can provide that. That, I think, is its strongest goal because we are in a bit of an emergency in terms of what is going on on this planet.

Here’s why. Everything is going exponentially, all of these things and many more. These graphs show everything from McDonald’s restaurants to coastal zones, ocean ecosystem decline, and carbon dioxide concentration. To me, all of these represent a failure of ecologists in a lot of ways. These are things about which we should be providing information and providing the basis for sound
decisions, and yet they are all growing exponentially and they all represent some sort of threat to our well being.

This is another one. Things are getting fairly uncontrollable because we’ve got invasive species, we’ve got climate change happening, we’ve got excess toxic chemicals, we’ve got that whole exponential thing going, and there is a lot of uncertainty because nature is full of surprises.

And yet we have this little body of knowledge down in here, and that body of knowledge, because of the nature of students and grants, tends to be organized around the study of one-meter-squared plots and two or fewer species for three years. We know a lot about one-meter-squared plots and two or fewer species for two to three years, but we don’t know a whole lot about complexity. What this dictates, as shown in this complicated-looking diagram, is that we need to start talking about resilience, not exploiting things to the maximum but leaving a little bit of cushion, and we need to talk about adaptive management—management that actually responds to information and begins to try to track changes. And again, there is this idea of these compass bearings.

Response: EMAN Adaptive Ecological Management Model

In response to this, what EMAN pulled together is an Adaptive Ecological Management Model, a variation of the one by Cairns. It is essentially very much like the human health model, or why you go to the doctor every year. We engage the stakeholders in defining what they mean by “sustainable.” When we did this in communities we simply asked, “What would you want to preserve while allowing economic development?” And you end up with what you’d expect: healthy waters,
fishable streams, healthy soils, biodiversity, those sorts of things.

And we’d say, fine, we can develop corresponding ecosystem measures. If your stream is a concern we can use benthics, if your air is a concern we can use lichens, and we can report to the community every year with a simple monitoring program on whether things are getting better or whether things are getting worse; whether the things that you, in fact, identified are in fact being affected by highway development or by influences from outside. And if they are being affected, we can begin to engage scientists to come in or we can look and examine if this is happening elsewhere.

So this is kind of your annual checkup, when you might be told not to drink as much or don’t smoke or eat fewer french fries, and these are the measures of your physical condition that you can actually deal with. But everything depends on the pace at which this is done because this has to fit the tempo of decision-making. This has to be annual, as a choice, or maybe every two years, but you’re looking at this circle of monitoring and assessment, whether things are getting better or getting worse, and if they seem to be getting worse, you actually have a response. The response may be nothing more than “Let’s ignore it for a year and see if it’s there next year,” or it may be “Let’s go in and investigate what’s happening.” It’s an adaptive management model that complements where science has been going.

We have looked at this in a number of areas. We applied it in thirty-one communities across Canada. We usually use a multiple of ten to get a sense of U.S. versus Canada. You have ten times the population, ten times the GDP, so it would be roughly the equivalent to 310 communities in the U.S. Not huge, but enough.

We began to take this model and ask, how can we engage the citizens in actually monitoring, using our protocols, whether things are getting better or worse and how do we feed that into the local decision-making system so that it actually begins to be used?

What emerged was that it was far more difficult to get people to talk to their city managers than it was to get them involved in monitoring. Everyone wants to leap into monitoring, but without the sense of how you are going to use this information, and is it relevant, and will it be used, then it is kind of a waste of time. Background information is great, but here we are talking about how do we affect decision-makers.

So we had this emerging, non-adversarial role for community groups
as they began to concern themselves with how they could get involved with the decision-making system within their communities. And we began to talk about some of these tools that we had given them as ecologists. We talked extensively about the reporting on the three pillars: economy, sociology and environment. We talked about five different kinds of capital, or getting industry involved in “continuous improvement,” and the triple bottom line. But we scientists have not been giving them the information that actually allows them to do that. We have not been giving them the information that allows them to report every year on the triple bottom line because of our focus on certainty. So these are the types of tools that bridge that gap.

Throughout this I talked to extensive numbers of communities, industries, and watershed groups, even in Hamilton, where I live, which is probably one of the dirtier cities in North America due to steel mills. People involved in steel mills are perfectly willing to say that when they make decisions they would like to see that environmental information on the table. Where they would disagree with me is the weight they would put on it versus social, versus economic, but they want the information because they want to see continuous improvement. They’re not fools. They just don’t want to see an adversarial, confrontational situation, so we can ease that by providing information that suits their needs.

Lessons Learned
Linear Themes?
As we tried to come up with a general model that would begin to suit the rest of Canada, we began by thinking there must be linear themes or some initial context. Which factors are most important? Which should be included? For example, should we include “articulate planning needs,” or “ecological monitoring,” or “inciting issues”? The latter is a double-edged sword because sometimes that would polarize a community, whereas sometimes it was a very handy thing to supply us with a focus. We tried to find out which of these were the most important, and it turned out not to matter.

Community Engagement and Social Capital
What really mattered was creation of social capital, and that once you began this process you could begin it anywhere. There is a seminal paper on social capital called “Bowling Alone,” which refers to our relationships and the fact
that we don’t talk to each other and don’t come to some sort of consensus about what we want and what is acceptable and what is not acceptable.

So we began to put these people into a room and ask that question: What would you not give up while allowing development? That was, in many cases, the first time these people had ever sat down and talked about why they lived there, and we saw this creation of this magic social capital that feeds this like an energy battery. Once we begin, more and more people are included, more and more people are included, there is more and more discussion about more and more community facets, it just goes on and on. And this happened in every single community we looked at. So this Community Engagement Spiral is now the model we are seeing applied in Canada and elsewhere as we start to engage communities, as we start to involve citizens, and this is our expectation of citizen science.

This is a report that we did. It is in the library section at www.ccmn.ca. This is the summary. There is also the background report and the results report. We inform local decisions because it is a local definition of sustainability, but we also realize what we were looking at was site-based monitoring, and that was the wrong way to go. What we needed was more of a mapping approach which is what we’ve done subsequently.

Characteristics of Usable Information

The other real earth-shaking realization for us was in this nature and characteristics of information that they will actually use: that it must be relevant, usable and targeted, and we can certainly do that, but it must also be timely. There is this whole issue of timeliness and it trades off against certainty. If you are going to be timely, unless you spend a fortune doing a really intensive survey, you’re not going to achieve certainty. But timeliness is far more important than certainty to most decision-makers. They are quite comfortable with a degree of risk, and we as scientists have never asked ourselves, what is the acceptable degree of risk in the answer that you want here? Are
you willing to have it be wrong? You dial back what the response is. You’re not going to close the factory: you’re going to go in and further investigate the impact of that factory. That decision can have a certain amount of risk involved with it, and we as scientists don’t have to speak with certainty about that.

Allow the decision-makers to weigh the choices. That’s very difficult for scientists. We’re used to being able to walk in the room and say we’ve been studying this for fifteen years, we have fifty peer-reviewed publications, and can stand up in any scientific forum and say, “You must do this.”

What happens there is that you undermine the right of the decision-maker to make the decision and you will automatically be resisted no matter what you say. It is a social phenomenon. His or her standing and position are determined by the fact that they are the one making the decision, not you. And it has to assure that all of those involved control the problem. Those are major things for those with a scientific outlook to have to deal with.

A Process to Optimize Impact

We worked with the International Institute of Sustainable Development out of Winnipeg recently, and we started to ask this question of how we optimize impact. How do we begin to see that monitoring makes a difference? How do we begin to design it? And the results have reversed our whole thinking on this.

Start with what are you seeking to change right from the beginning. What are you trying to do? You do this with your groups within your community, with whomever you are trying to engage in this. What is it that you are trying to accomplish?

Who is going to do it for you? Who is the person who can help you do it? What is the nature of the information that they need and what kind of relationship can you establish with that person?
So this reverses this whole thing. We are not gathering background data now. We’re looking at how we can be more effective, and effectiveness lies in knowing what you’re trying to do and who is going to do it and establishing a relationship with them and understanding what their information needs actually are. At that point you can involve your citizens and start to work and say, “Okay, here’s the information this person needs.”

One of the best ways to do that is to put the decision-makers on the board. Put them on the board so that you’re not surprising them and you’re not dealing with a social liability at the end where you’ve got all of this information gathered by all of these volunteers meeting all sorts of scientific standards, and yet it makes no difference—perhaps because of the person you haven’t talked to, or perhaps because there’s a rule or a law by which you can’t make a difference.

So understand the people, seek the knowledge, and then carry through. This completely reverses the way we are going as scientists. This says, “What are you trying to accomplish?” not, “Can you make a career as a scientist?”

Learning from Mapping

Next we have learning from mapping. This is Hamilton. We have a protocol for lichen biodiversity on freestanding trees that we developed with the Canadian Museum of Nature. We used it here in Hamilton, and we trained seven students from Brock University, took a whole morning, then went out and in two-and-a-half days did this survey. We then took it back and mapped it in GIS through Brock University and were able to present this to the city of Hamilton and say, “Here’s a rough approximation of where you have air quality problems.” The darker it is, the higher the diversity. We’re actually beginning to see long distance transport, we’re seeing the effects of steel mills, we can see where an extraction from a quarry is spilling down into the richest area of the town.

After everybody looks and sees where they live, this becomes a very powerful map because you’re able to say, “This is just lichen on trees. It’s not in-your-face confrontational information, but it should feed and help your decision process. And a decision you can make (which they have made) is to repeat this regularly and use it to measure the effect of your decisions on the air quality in the city of Hamilton.”

And you can measure this and ask, I wonder what the health records show? Do people who check into hospitals come from these places? And you can engage scientists who will come in and they take clean...
lichens from one of the dark areas of the map at upper left and transplant them to a tree down in the central light area on the map, and then measure the metal uptake.

So it becomes a spur to all of these things happening and it is done through citizen science in a timely way. This took, what does it add up to? Three days plus the GIS, and you have this survey. This has the ability to give you hot spots and to look across a broad geographic area and do it in a timely manner. It’s a powerful link between science and decision-making.

Issues of Scale
When we apply it at larger scales it gets more complicated because you have huge governance issues. Who are you trying to inform? The city of Hamilton or a park or an industry is a single regime and a single domain. In other words, you have an area that it controls, and you have one decision-making body that you need to inform. But when you move into landscapes you have multiple communities, multiple sectors, multiple functions, and then you have this whole layer cake of licensing and governance. I’m sure it is true here, it is everywhere. For every parcel of land you have one license for tree clearing, another for hunting, another for ground water, another for mining, and it is all done separately in an uncoordinated manner.

Then there is the question of what you want. What are we trying to optimize in these landscapes? What we end up with again is my good friends, ecological goods, services and resilience. If we can put together a monitoring program to feed an inclusive decision-making forum and optimize those within the landscape, that is probably a reasonable target for ecologists to pursue. But in order to do that we have to have some sense of what we are measuring, what the threshold values are, and who we are going to deliver it to.

That is where EMAN is now planning to go, to that kind of problem, because ecological goods and services are unsubstitutable, they do link to system dynamics, to society, and they become a currency of exchange between science and decision-makers. To be honest, most decision-makers say they love biological diversity, but they don’t know what the hell it means. But if you talk about goods and services and say you must have clean water, or you must have pollination, or you must have healthy soils, and we begin to set measures in place for how we will

 Applications in Other Regimes/Domains: Watersheds, Landscapes, Seascapes

- Governance Issues: multi-community, multi-sectoral and multi-functional
- Layer cake of licensing and governance
- Optimization
  - Water quality/quantity management, best practices, optimal yields, economic diversity, cultural values
  - Health, security, sustainability
  - Biodiversity, habitat
  - Carbon sequestration
  - Ecological Goods/Services and Resilience
- Criteria, Standards and Effective Delivery

 Ecosystem Goods and Services

- Dependency for human welfare and economic competitiveness: non-substitutable
- Link ecosystem dynamics (Structure, Functions) to societal dynamics
- Currency of exchange between science and decision-makers
- Link to biodiversity, natural capital and resilience
- Focus of Millennium Ecosystem Assessment
- Ecosystem goal: sustainable provision of the full suite of goods and services (rather than ecosystem health, intactness, etc.): note integrity in protected areas
- Address at landscape, watershed and seascape scales as well as roll up standardized results to Regional, National, International and Global
establish whether that has changed or whether there are hot spots emerging at a landscape scale, you begin to engage in a dialogue with the decision-makers who actually have to make the decisions at very local levels right up to the watershed levels.

So it is a new ecosystem goal. For years we’ve dealt with issues of ecosystem health, of ecosystem intactness; these are not very robust concepts. But if you use something like “ecological goods and services” and a monitoring program that provides a framework for discussion that you can deal with, and you can address it at these landscape scales, and if you have standardized protocols, which is what EMAN tries to do, then you can roll up to every other scale across Canada. That is where we seem to be going. These are also linked to human welfare, as we know through the Millennium Ecosystem Assessment.

**MEA: Consequences of Ecosystem Change for Human Well-being**

**CONSTITUENTS OF WELL-BEING**

**ECOSYSTEM SERVICES**

- **Provisioning**
  - Food
  - Fresh water
  - Wood and fiber
  - Fuel
- **Supporting**
  - Nutrient cycling
  - Soil formation
  - Primary production
- **Regulating**
  - Climate regulation
  - Flood regulation
  - Disease regulation
  - Water purification
- **Cultural**
  - Aesthetic
  - Spiritual
  - Educational
  - Recreational

**Needs:**
- Landscape measures & thresholds for Ecosystem Goods and Services
- Tradable environmental allowances
- Basis: Research on ecosystem structure, functions and resilience linked to sustainable provision of full suite of goods and services—indicators, thresholds, predictive models

**EMAN Proposed Response:**
- Collaborative research along gradients of disturbance (Watersheds, Biosphere Reserves, Conservation Authorities)
- Continue to investigate effective delivery of information to support choices, trade-offs and policies

**EMAN’s Current Direction**

This is what we are doing at EMAN. We recognize the need for landscape measures and thresholds, and possibly environmental trade allowances, and we need research on ecosystem structure. So we have decided to look at
collaborative research along these gradients of disturbance, and we are going to continue to investigate the effective delivery of the results.

I’m now less concerned about putting these programs across Canada than I am in possibly focusing them as a suite on monitoring the goods and services along a watershed or some sort of gradient—where there has been an awful lot of activity, where there are major environmental assessments, where there is urbanization—and beginning to where we are seeing an impact on ecological goods and services, and how we involve our communities and citizens. And that is a bigger problem.

Emerging First Principle
We have this principle now emerging from what we have been doing with all of this work with all of our partners. Understanding and meeting the needs of the target decision-maker is the foundation of ecosystem science effectiveness. Essentially, we are not being very effective if we are just generating data for more scientists to play with. We’re not being very effective if we’re focused on databases and peer-reviewed publications. How do we meet the needs of decision-makers? How we see our knowledge used in decisions becomes the measure. The delivery of tailored information becomes the point.

Our experience to date amongst the very practitioners involved in the EMAN network suggests that the priority is that the government and scientific community should be empowering citizens, developing the tools and developing approaches to bridge that gap between civil society and decision-makers. And there is that focus again on feedback and sentinel information and community engagement, with all of the other benefits we’ve spoken about: long-term background data, education, outreach, engagement. Those are powerful reasons, but there is something more immediate, and that is how we inform decision-makers.

SAMPAA EMAN Workshop
Bridging the Gap between Science and Decision-makers: Tools for Effective Research and Monitoring Programs that Influence and Inform
Goals:
• Integration of recent models and approaches
• Collection of papers and synthesis
• Manual

Emerging 1st Principle
- Understanding and meeting the needs of the target decision-maker is the foundation of ecosystem science effectiveness
- Delivery of tailored information as needed, where needed, and when needed to support choices and policies
- Experience to date indicates that the priority is government and scientific community providing information, tools and approaches to bridge between civil society and decision bodies at local and landscape scales with an emphasis on feedback and sentinel information → focus on community engagement in generation and delivery plus huge education benefits

How do we meet the needs of decision-makers? How we see our knowledge used in decisions becomes the measure. The delivery of tailored information becomes the point.
are talking about as we go forward, trying to engage communities at these landscape scales in developing and using information.

### Recap: Lessons for Citizen Science and Beyond

<table>
<thead>
<tr>
<th>Lessons (not just for Citizen Science)</th>
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<tr>
<td>• Monitoring must have purpose and a framework</td>
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<td>• Know what you are trying to change, who can help, what they need, how to communicate on their terms</td>
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<td>• Respect decision processes and protocol</td>
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<td>• Involve and work backwards from decision-maker needs</td>
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<td>• Include them on boards and coordination committees at the outset</td>
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<td>• Build relationships: trust, respect and inclusion</td>
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<tr>
<td>- Non-confrontation</td>
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<tr>
<td>- Processes and practices</td>
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<tr>
<td>- Allow for crises</td>
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<tr>
<td>• Manage expectations: avoid social liability</td>
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<td>• Quantify management questions → designs to answer</td>
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<td>• Tolerable uncertainty and risk</td>
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<td>• Baseline important but limited rewards</td>
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<td>• Communication plans are as important as monitoring plans: develop in parallel</td>
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<tr>
<td>• Understand the decision-maker’s needs and goals</td>
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<td>• Linkage easiest if point or locally based: single domain and regime</td>
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evaluating citizen science: examining the goals of science education

Kirsten Ellenbogen
Director of Evaluation and Research in Learning
Science Museum of Minnesota
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that this document did not originate as a formal paper. Rather, it reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

Documentation of the conference is meant to serve as a resource for those who attended and for others in the field. It does not necessarily reflect the views of the Cornell Lab of Ornithology or individual symposium participants.

The following is the opening talk of the session titled “Citizen Science Project Design,” delivered on day one of the Citizen Science Toolkit Conference.

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org
Evaluating Citizen Science: Examining the goals of science education

Overview

I prepared this talk in advance but after getting to this workshop, seeing who is here, reading all the bios and talking to people, I changed it. So I’m going to give a little bit of the old talk and a little bit of the new talk.

I am going to talk about the basics of evaluating citizen science, but I think there are a lot of places we can go to look at articles on that, so what I want to spend most of my time talking about is how science education is reflecting on evaluating these sorts of experiences and the notion of “What is science?” and therefore, what counts as science education?

So: evaluate what? The evaluation breakout group at this workshop is already bringing up the fact that we tend to spend a lot of time evaluating impact on public participants. We spend a lot less time talking about: What is the impact of our citizen science work on scientists? What is the impact on community? What is the impact on the environment? Some people would say “environment” and “community” shouldn’t even be on that list, but we have a huge variety of citizen science projects, and these are some of the things that came up this morning during the evaluation group’s breakout discussion as we started thinking about project impact.

The Challenges

Another thing that comes up really quickly, and I’m sure we’re about to get into this discussion in our evaluation breakout group, is why evaluation is difficult. Based on some of the articles that are out there and some of the experiences that I’ve had with evaluating

We’re going to start out with Kirsten Ellenbogen. We’ve heard a fair amount about beginning with the end in mind, and I think that was the name of Kirsten’s talk at one point. Kirsten has been at the Science Museum of Minnesota for a couple of years. Before that she was at the Institute of Learning Innovation, working with John Falk as well as with Martin Storksdieck and Kate Haley Goldman, both of whom are here, and a bunch of other good people. - Rick Bonney, Director of Program Development and Evaluation, Cornell Lab of Ornithology
citizen science, one of the first problems is that a lot of this is set up in a way that assumes a deficit model of the public. We walk into the situation presuming that the program is going to deliver everything and that we’re not getting anything back from the public except the data. That often skews the evaluation in a way that doesn’t really appreciate what some people call the “funds of knowledge” that learners bring to these situations. There is a real need to step back and ask, what are they bringing to the situation besides access to the data?

Another difficulty is high scores on pre-tests. This is something we could spend a long time talking about. When you are just talking about some basic concept knowledge, often the fabulous people we have collecting data on these projects already know a huge amount about the content. If your goal is to have them walk away understanding more about particular science content, you have no wiggle room, you have nowhere to go. So what else is there? What else should we be looking at?

There is great variety in the kinds of experiences people have as they join a citizen science program. I’ve sometimes ended up with six or seven different types of participants, noting: these did the Web experience; these did the Web experience plus the in-person experience; these did neither; these joined a friend. There is such variety it makes it very difficult to generalize.

There are also uncontrollable additional learning experiences. Unlike those psychologists who get to study people in a black box, we have participants who read, who watch TV, who participate in other programs, who visit fabulous facilities like the Lab of Ornithology. There is an uncontrolled number of other experiences influencing what you are trying to evaluate.

Evaluating Impact: Traditionally

I don’t mean “traditional” here in a negative sense. In fact there is a great article, “Scientific Knowledge and Attitude Change: The Impact of a Citizen Science Project,” by Dominique Brossard, Bruce Lewenstein and Rick Bonney. It lays out a really good overview of how you start evaluating impact, and it details things like scientific content (no surprise there); understanding of science as a process; and ability to evaluate scientific information.

I see very few examples of the latter in the evaluation reports. I think we are headed there. There was one great example in an earlier presentation today—someone said that they get back to folks after they’ve collected data and show them, “Okay, this is what we’ve done with the data.” That is so close to taking it back to the folks who collected the data and saying, "How did we get
here and what is involved in this?” That is what I want to spend some time talking about in my discussion of current trends in the field of science education.

Additional factors include attitudes toward science; attitudes toward the environment; and changes in environmental behavior, which is a big brass ring if you can get there. And “identity” is something that I would like to add to this.

Revisiting the Basics, Defining our Terms

Our Definition of Science

I was going to spend my entire time talking about this traditional evaluation focus, but the more I talked with folks here I realized that in some ways we need to go back to the basics of asking, what are we talking about? If we are going to evaluate a citizen science program, what is the science, who is the citizen, and what are we hoping they learn?

This is a great time to be thinking about this because we have one document that has just been published and another document that will be published next year. The document that has been published is from the National Academies of Sciences, published by the National Academies Press. It is called Taking Science to School: Learning & Teaching Science in Grades K-8. Although the formal education model often has very little to do with what we are doing outside of the world of the school, it remains a very useful document to take a look at, and you can view the entire document online if you go to the National Academies of Sciences Web page.

In fact, we are using it in a National Academies of Science committee that Bruce Lewenstein is cochairing with Philip Bell. The committee is developing a new book that is specifically going to be about learning science in informal environments. We are struggling with this issue right now: What is science when you are talking about an informal environment? What is science learning in these sorts of situations? I was going to try to pull selections from our committee work, but it is so much a work in progress that I felt it would be dangerous at this point to say, “Here’s what the committee decided,” when we haven’t reached a decision point. It will be coming out in 2008 and in the meantime, you should look at the National Academies publication on formal education or follow the committee’s progress online through the National Academies Web site.

You’ll notice this definition of science splits into two parts. It represents a “body of knowledge,” so it is about the content, right? And it is particular here. It says the “current understanding of natural systems,” really focusing on the notion that this is our current...
understanding. It’s not necessarily where we will be twenty years from now or a hundred years from now. The second part of this is the process, and it’s the process of how we came to know the content.

A lot of people talk about this in terms of, “If you want to talk about science, you have to include: What do we know, how did we come to know it, and why do we believe it?” That is how a lot of people summarize it, and that’s a big shift from the science process that I learned, and a big shift from the science my father learned, which didn’t really didn’t even have process in there. And it’s now evolving into something that my children will learn that is different from what I learned. So there is absolutely that shift in our understanding of what counts as science.

The Shift to Process and Talk

Part of that shift, based on the definition that I just showed you, is that there is this huge emphasis now on process and talk, and process is not the series of science posters on the wall in a science classroom that I had growing up. It’s not: "Here is the scientific method." It is instead talking about things like how you engage people in logical reasoning about evidence and help them participate in the culture of scientific processes. There is also a focus on language of science. How do you engage people in moving from data into a theory? How do you help people construct and deconstruct hypotheses? How do you engage people in a scientific argument?

And I don’t mean little kids fighting, I mean that there is a form of argument which is a valued skill in science process, and those of you who are practicing scientists know exactly what I’m talking about. When we send articles to peer reviewed scientific journals—any of us, whether we are social scientists or physical scientists—we are making an argument and people make an argument back to us. We have to defend our ideas. How much of this are we actually teaching in our citizen science programming?

Redefining Science Education and What That Means for Citizen Science

What should science education really look like? What form of science education emerges from this definition of science? The list on the left doesn’t reflect the emphasis that is in the National Academies book, but this is the emphasis that I am giving it for our meeting. First is productive participation, and again it’s very much about the practice and the discourse. How much are participants talking to each other about the data that they are gathering? How much are they talking to the scientists? A number of programs have built various ways—Web communication, asynchronous communica-
tion between a scientist and a participating public—to really enable public participants to get engaged: “Okay, I found this, and it was different from what you asked for in this way. Does it count or does it not?” Engage the public in these arguments of science.

The second characteristic of science education is generating and evaluating scientific evidence and explanations. Explanatory conversation is a critical aspect of science education these days. If you go around a science museum, for example, and record the kind of conversations people have, most of them tend to be identifying things or describing objects. I would bet, and I haven’t seen one of these studies yet, that if I took my camera and a microphone out to some of the citizen science programming, most of the conversation that we’re going to hear is identifying and describing.

That is fine, and that is not to say that is not science talk, but we want some of the conversation to move from identifying and describing to explanatory conversation. For example, “How does this one fit in and how does it not fit in? Why is this one part of this group and not part of that group?” There is a huge amount of explanatory conversation that could go on: “Why are we collecting this data instead of that data? This one should be included because of X.”

Moving our participants into that kind of conversation is a huge leap, but there is a lot of potential. In fact, I would argue that we have a better ability to achieve these goals of science education in a citizen science program than in most middle school classrooms.

The third characteristic of science education is understanding the nature and development of scientific knowledge. What we heard earlier in this conference about citizen science efforts suggests that programs are now helping participants understand why the data they collect is valuable. Helping people understand the role that they’re playing in the development of scientific knowledge is critical.

The last characteristic is one that is much more common in the science classroom: knowing, using and interpreting scientific explanations of the natural world. For example, how should I read a scientific document, interpret it, and analyze it? People get that from a lot of different learning experiences, and certainly citizen science can contribute to it, but citizen science programs are best positioned to impact the first three.

Moving Forward

So where does this leave us? I want to end by making a plea for the integration of evaluation into the program planning process. The more that evaluators and educational or learning researchers are involved
from the beginning the better. We need to sit down together and say, "What are the goals of this program? Where are you headed with this?"

And I would urge that we focus on formative evaluation. We are all required in our programs to do summative evaluation: "Let’s see how we did and report on that.” There is a need for more formative evaluation so that the process is assessed in progress, so that we are able to do pilot tests and say, "Let’s take a look and see how this is going. If we try it this way and that way, who is actually talking more about science? Which version of the program generates more explanatory conversation?" You have the opportunity to do that if you are working with an educational researcher or an evaluator at the very beginning of the process.

Then there is revisiting goals. There is nothing in the grant guidelines that says that you can’t revise project goals after you start. So the process of going through and figuring out that "Actually, what we are doing is leading us more in this direction,” or "What this program can really contribute to the field will take us in that direction.” The process of shifting or changing that comes with formative evaluation will improve our field.

We also need to examine our projects from the very beginning with an eye toward the goals of science education. What I am pushing for is an expansion or an actual shift of your program and evaluation goals. Citizen science programs have the potential to get participants to look at how we’ve moved from these data into these sorts of explanations, to understand how theory is developed, to understand shifts from data to evidence to explanation, to understand why we throw some data away and value other data.

The more we revisit what it means to do science, and reassess our goals for science education, the farther along we are going to be in making our programs a genuine contribution to creating a scientific citizenship.
the monarch larva monitoring project: educational and scientific goals and outcomes

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and
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This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that this document did not originate as a formal paper. Rather, it combines an oral presentation with accompanying PowerPoint slides and reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

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The following is one of three focus point presentations delivered as part of the session titled “Citizen Science Project Design” on day one of the Citizen Science Toolkit Conference.

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org
The Monarch Larva Monitoring Project: Educational and Scientific Goals and Objectives

Overview

I am going to talk about the Monarch Larva Monitoring Project (MLMP), and the focus is on developing a program that has very clear scientific and educational goals from the outset. A lot of times, particularly when citizen science was just beginning, there has been a perceived tension between educational and scientific goals. I think it is important to consider these two categories of goals as complementing each other and not competing with each other.

To set the context and offer an example, I will be talking a little bit about our project. Michelle Prysby developed this project as part of her master’s thesis at the University of Minnesota back in the mid-1990s. She directed the project for the first couple of years and then I took over in 2001.

I will describe the project’s goals and activities, and then talk about how we ensure that both educational and scientific outcomes are achieved. Because citizen science projects are often long-term projects that are going to evolve, it is important to both have the end in mind and be flexible and allow for end goals to change.

This project is probably different from many other projects represented at this workshop because we focus on a single organism, the monarch butterfly. We have the advantage of this being a very charismatic species, and it also has a lot of policy relevance. For example, next week I will speak to the ministers of the environment from Canada, Mexico and the United States about a new North American monarch conservation plan, and citizen monitoring is a huge part of this plan. We have the advantage that this is a species that people care about.

Outline

- MLMP goals, protocol and findings
- Ensuring that educational and scientific outcomes are achieved
- Emphasize flexibility and change—long projects that should evolve
MLMP Scientific Objectives

- How and why do monarch populations vary in time and space?
- Additional questions relate to mortality rates in different life stages, host plant choice, and habitat effects on recruitment

MLMP Goals, Protocol and Findings

Scientific and Educational Objectives

Our overarching question is, how and why do monarch populations vary in time and space? Our focus for this question is on monarch distribution and abundance during the breeding season in North America. Additional questions, some of which have come up as a result of the observations that our volunteers made, relate to mortality rates in different life stages, female host plant choice, and habitat effects on recruitment.

Our overarching educational objective is to increase scientific literacy addressing three main categories: science content, science process and science applications.

MLMP Protocol

- Volunteer, choose and describe a site
  - Gardens, parks, roadsides, prairies (need milkweed)
- Weekly Monitoring
  - Estimate monarch densities
  - Quantify milkweed quality (optional)
  - Estimate parasitism rates (optional)

People learn a lot of science content by going out and observing monarchs on milkweed plants. They also learn a lot of important science process including data collection procedures, use of scientific equipment, and the process of scientific inquiry. Additionally, the project provides examples of how the data can be applied to policy and conservation decisions. We communicate often to our volunteers about applications of the data that they collect.

Protocol

MLMP volunteers first decide that they are going to volunteer, then they choose and describe a site that will be monitored throughout the monarch breeding season. The only requirement for the site is that it contain milkweed, the monarch host plant, and volunteer sites
range from backyard gardens to roadsides to national parks.

This is a fairly time consuming citizen science project. There is a lot of variation in what citizen science projects demand of participants. We all need to think about this; how much time do people spend on these projects? Our volunteers go out weekly and it takes them anywhere from an hour to three hours if they have a big site, depending on how much they want to do. All of them estimate monarch densities, and there are other optional activities from which they can select as well.

Volunteers

We have had over 1,000 participants since the inception of the program in 1997. Because we keep track of individual sites, it is hard for us to know exactly how many people monitor each of those sites, but we know we have well over 1,000 volunteers. Adults are the primary volunteers at sites, but we have learned from surveys that over fifty percent of them monitor with children, so there is a lot of opportunity for science education. Happily for us, from both an educational and a scientific perspective, most volunteers participate for more than one year. In fact, we have several who have participated every year of the project, and lots of people who have been going on for five, six, seven or eight years. Every year we acknowledge people who have been with us for over five years, so we have a good list regarding the amount of time they’ve been involved.

Training

Training can take place in many ways. All of the directions are available on our Web site, mlmp.org. For four years we developed a network of trainers and a train-the-trainer structure with support from the National Science Foundation. We conducted train-the-trainer workshops throughout the U.S., and many of the people trained in those workshops have continued to train more people. All of the other education outreach programs in my research lab involve people in the MLMP whenever possible.
Data Entry and Feedback
The heart of the project is collecting data on weekly monarch densities. Here you can see data from a teacher and her students in Minnesota. The data are organized by dates, so we have both temporal and spatial referencing for the data. The bar graph shows the per-plant density of monarchs at this site, with the different shades on the bars representing either eggs or different larval instars of the monarch, so we have age and stage distribution as well as the time distribution of monarch numbers.

These data are all entered online and immediately accessible in either a site basis or a statewide basis. It’s easy to find links on the Web site that you can click on to see data from your site or your entire state or any other state or site.

Ensuring that Educational and Scientific Outcomes are Achieved

Achieving Scientific Goals
There are several important things to think about in achieving your scientific goals. The first is to formulate questions that have important scientific merit, and then see that the data are relevant to your questions. A lot of citizen science projects don’t think about this carefully enough. It is also important to use the data, both to answer scientific questions and to disseminate basic science literacy. And finally, there is something we all need to think about: maximizing data accuracy.

To save time, I’m only going to briefly talk about two of these areas, relevancy and accuracy. Data relevancy is an important part of the formative evaluation of citizen science projects in that the relevancy of the data requires constant reassessment. This is not a case in which you can just sit back and say you’ve developed a good project. You need to keep reassessing whether your data are relevant.

In some cases the questions may be answered, and there may not be any need for people to continue collecting data on these questions if they’ve already been answered. Sometimes we find that the data that we’ve asked people to collect really aren’t that useful for
answering our questions. There is a fine line between collecting data that might eventually prove interesting—we all have files and files of data that someday might be relevant—and wasting volunteers’ time. That is a key thing to think about.

With data accuracy, it is important to think about all of the possible mistakes that volunteers can make. Again, that is a formative process. We learned a lot about how people could misinterpret our directives that seemed so clear to us. We’ve found that there are four important sources of error: detection errors (finding or not finding something that’s there), accuracy and precision, sampling, and failing to report negative data. To save time I’m only going to talk about detection errors, but we have thought a lot about how to deal with other kinds of errors and I would be happy to share that with any of you later.

As an example, this is a bar graph from one of our volunteers in Texas whom I have gotten to know very well. I call her a lot because her data are completely unbelievable. This pale shade represents 5th instars, which are the largest monarch caterpillars. You can see that on 1/19 she went out and monitored and didn’t see any eggs or larvae, and then a week later she went out and she found some 5th instars. That’s biologically impossible, unless you believe in spontaneous regeneration. So we receive this dataset and we know that it’s wrong, but she is enthusiastic and really loves doing this. We can spot this error easily, and simply not use her data for certain things. We can, however, use her data just for simple presence data.

Another example is a little harder to verify. Some volunteers find too many monarch eggs, often mistaking the milkweed latex that gives milkweed its name for eggs.

In some cases we’ve interviewed volunteers to try to figure out what
they’re seeing, but we’re very careful not to modify their data if they may be correct. We’ve discovered that sometimes they are more right than we are. This is a picture (left) of a milkweed plant with lots of eggs on it. A volunteer sent us this picture, teaching us that egg numbers can be very high. This knowledge comes from constant communication with our volunteers.

We have found that, to avoid errors in our data, we need to have excellent training for people and continually reevaluate our instructions to ensure that they are clear to people. We interview volunteers with questionable datasets. And finally, we find that it is really valuable to go out with our volunteers in the field to anticipate the kind of errors that they might make. I don’t want to make it sound like our volunteers aren’t intelligent people. Usually mistakes happen because our instructions weren’t clear enough. It’s not their fault, it’s usually ours.

I think it’s also important to keep in mind that some mistakes are okay. If you’re installing windows, you want your windows to be exactly the right size, so precision is important. But in a lot of cases it’s not that important to be exactly precise. For example, in our project, presence data don’t have to be as precise as survival data, so if we just want to know if monarchs are there and we don’t care about how many, then we’re okay with that with the data from that lady in Texas who can’t recognize an egg.

Also (and I’m not going to talk about this at length), as others here have said, in many cases we really think that our volunteers are just as good as the people who are paid.

Some mistakes are OK!

- For some of our scientific goals, quantitative precision is not important (e.g., presence data vs. survival)
Achieving Educational Goals

In achieving educational goals, it is important to think about situations in which adults monitor with children. For us, the child volunteers are really important. It is also important to encourage independent science inquiry and promote links between educational institutions.

What we have found in our program is that children are often involved with adults in three different contexts: with their families, neighbors and friends in a kind of very informal setting; with teachers in programs that go on throughout the center and throughout the summer; and with nature center programs. We have formulated appropriate data collection strategies, and we work with the adults monitoring those children to modify our data collection strategies so they are more appropriate for working with children.

Here is a simple example. This is the way our data sheet looked. Each one of the rows on this data sheet is a week of collecting data. If you’re going out with a second grader, you’ll find that most second graders can’t fit their numbers into these little squares. We worked with a teacher to design a data sheet that looks like this, so that each week is a separate data sheet and the big huge numbers that kids write will fit into the squares on this data sheet. It’s really simple, but it made it much more appropriate for kids working with adults to do this project.

We are also trying to encourage volunteers to develop their own questions and protocols. This is something that is really exciting to me.
You don’t need to know the details about this graphic, but it is from a teacher working with a bunch of fourth-grade kids. The teacher came up with an independent project based on their monitoring. We try to support and encourage this.

One of these projects by an incredible woman, Ilse Gebhard, actually resulted in a published paper. She took one piece of a protocol and expanded it and we published a paper using her data and that of a couple of other of our volunteers to kind of go in a different direction.

The other thing is to build links with K-12 institutions and ISEs. We’ve done a lot of work with teachers and ISE institutions and have, as much as we could, provided opportunities for students to engage with scientists in a lot of contexts.

Acknowledgments

I would like to end by acknowledging all of the MLMP citizen scientists who have worked with us. I would also like to acknowledge the funding from the National Science Foundation, the Xerces Society, Monarchs in the Classroom, the USDA, and UM Extension Service. And finally I would like to acknowledge the University of Minnesota staff and students involved with this project.
models of community science: design lessons from the field

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The following is one of three focus point presentations delivered as part of the session titled “Citizen Science Project Design” on day one of the Citizen Science Toolkit Conference.

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org
Models of Community Science: Design Lessons from the Field

Citizen Science Models and Roles

We’re going to shift gears a little bit. I’m going to talk about some different models for community science and make some comments on our experience with them.

What are some models for “citizen” science?

- Citizen science involves a research partnership between community people and professional scientists.

- There are a variety of successful operational models for this partnership.

- These models differ in their goals, the nature and scope of the projects, and the extent of community control over the definition and implementation of the project.

What are some of the models for citizen science? As you well know, citizen science involves a research partnership between community people and professional scientists, but there are a variety of successful operational models and I think we are seeing that at this conference. These models differ in their goals, in the nature and scope of the projects, and in the extent of community control over the definition and implementation of the project.

The issue of community control is the one that I want to talk about. I also want to say that I’m not sure I like the term “citizen science.” I certainly don’t like the term “citizen” because many of the people we work with are not U.S. citizens and I think it feels exclusive in that sense. People have different definitions of that, but I’m not sure they’re doing science.

The roles in which ALLARM engages citizen-scientists have varied over our twenty-plus year history, so let me first tell you quickly about ALLARM.

About ALLARM

ALLARM is a nationally recognized project of the Environmental Studies Department at Dickinson College. We’ve been in existence...
The Alliance for Aquatic Resource Monitoring (ALLARM) is:

- A nationally recognized project of the Environmental Studies Department at Dickinson College in Carlisle, PA.
- Founded in 1986 as the Alliance for Acid Rain Monitoring, the original mission was to study acid deposition on Pennsylvania’s waterways with the help of community volunteers.
- In 1996, ALLARM shifted its focus to provide technical and programmatic support to community organizations interested in watershed assessment, protection, and restoration.
- Through the work of 12-15 Dickinson College students and professional staff, ALLARM currently works with 15 watershed organizations on water quality monitoring assessments.

ALLARM’s goals are:

1. To empower communities with scientific knowledge, and
2. To enhance the quality of undergraduate education at Dickinson by enabling students to participate in community-based research.

Our goals are twofold. One is to empower communities with scientific knowledge, and the other is to enhance the quality of undergraduate education at Dickinson by enabling students to participate in community-based research.

Models for Community Science

Characterizing Various Models

Since we have used different models, I have thought a lot about how to characterize them. It is very difficult to do that, but I think they
can be characterized, at least in part, on answers to these questions: Who is it that is actually defining the problem? That is, who is setting the agenda for the research? Who is it that is actually designing the study? Who is it that is collecting the samples? Who is it that is analyzing the samples? Who interprets the data?

These are all steps in the scientific process, or at least the old scientific process. The answers to these questions can go from professional scientists on the one hand who are doing all of this, all the way to community people who are doing these various steps.

Community Consulting Model
One model I call the Community Consulting Model. This is when the community itself defines the problem and the professional scientists—whether they be graduate students or whatever—actually do the study, so they act in a sense as consultants to the community. It is “science for the people.”

One of the most common examples of the Community Consulting Model is the European “science shops” that some of you may be familiar with. In Pennsylvania we have a lot of money in a Growing Greener initiative that was awarded to watershed associations, and many of them chose to hire consultants to do work on issues that concerned them. ALLARM has also worked using the Consulting Model in a variety of different projects, though I’m not going to go into detail on those.

For academics, the nice thing about the Consulting Model is that it lends itself to doing community science within a university course framework. You can use the actual course and have students going out and doing the work, acting as consultants, and you can begin and end it within a semester framework. We’ve done this very
Consulting Model lends itself to doing community science within a university course framework extensively at Dickinson, with students doing independent research projects on issues that are defined by the watershed associations that work with ALLARM, so we are doing what is really a Consultant Model there.

Community Workers Model

The other model, which seems to be very common at this conference, is what I call the Community Workers Model. This is when the professional scientists define the problem and design the study. Then the community collects the samples and they may also actually analyze them in the field, like the Monarch Larva project in which they are actually counting eggs and making judgments. But then the professional scientists actually interpret the data.

Community Workers Models

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<th>Who defines the problem?</th>
<th>Who designs the study?</th>
<th>Who collects the samples?</th>
<th>Who analyzes the samples?</th>
<th>Who interprets the data?</th>
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<td>Professional scientists</td>
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I have seen a lot of examples at this conference of the Community Workers Model. I think the Cornell Lab of Ornithology uses this model quite extensively. The Audubon Backyard Bird Counts basically use this model. Maryland DNR has a Stream Waders Volunteer Monitoring Program in which volunteers collect macroinvertebrates and send them to the agency and they do all of the analysis. The National Weather Service, which I thought was the oldest volunteer monitoring program until I heard about the lighthouse projects, have weather monitoring stations using this model. The Alliance for Acid Rain Monitoring, which is how we started, used this Community Workers Model.

Community-based, Participatory Research Model

Finally, the third model that I want to talk about is what I call the Community-based, Participatory Research Model, or "science by the people." What this model attempts to do is have the community define the problem, design the study, collect the samples, analyze the samples, and actually interpret the data.

An example of the Community-based, Participatory Research Model is our watershed-based projects in which students, faculty and staff teach community members to collect and analyze their own data. This model is also called "Participatory Action Research" (PAR).
Comparison/Summary of Models
This is just a little summary for those of you who are visually inclined. Basically, on the X axis we have the five questions to ask. If the question is answered by the community it is a tall stack, and if it is answered by professional scientists it is a short stack.

Graphical Summary of Models

ALLARM’s Experience with Various Models

The Community Workers Model
Let me talk a little now about ALLARM’s beginnings, when we worked with the Community Workers Model. The actual research agenda came from our State Representative, John Brojous, who called together a group of scientists and said, “I want to introduce an acid deposition act into the Pennsylvania State Legislature and I’m finding that nobody knows anything about acid rain in the constituency. Shouldn’t we get people out there monitoring
streams to actually see the impact of acid rain?” I was invited to that conference, so that is me in 1986.

The scientists went home and they basically said, “No, no, no, we can’t do this, blah, blah, blah.”

I had mentioned this to one of my students and she said, “Let’s give it a try.” We were thinking that maybe we would try this and it might be a good educational tool. We may not get much data, or much good data, but let’s try it anyway. We started the Alliance for Acid Rain Monitoring, which once again was in 1986, before there were many citizen science projects.

We got volunteers to choose the sites, which sounds a lot like the Monarch Monitoring project, although maybe not as nicely developed. They went out once a week and measured pH and alkalinity in streams and sent us their data.

We ended up getting over 500 sites in Pennsylvania monitored for at least a year. Some people monitored for as long as fifteen years. We now have the largest data base on pH and alkalinity in these streams in Pennsylvania.
Data have been used (by "experts"):

- In published studies connecting watershed attributes to stream vulnerability
- In published studies evaluating the extent of the impact of acid deposition in PA
- To revise fish stocking practices
- To craft expert testimony in support of acid deposition control legislation
- To conduct studies assessing the impact of the 1990 Clean Air Act amendments, by comparing to data taken prior to their implementation (ongoing)

The data were used very extensively, but always used by experts. They have been used in published studies connecting watershed attributes to stream vulnerability; in published studies evaluating the extent of the problem; to revise fish stocking practices; to craft expert testimony in support of the acid deposition control legislation (which failed in Pennsylvania but was eventually incorporated into the Clean Air Act); and finally to conduct studies assessing the impact of the Clean Air Act.

So the experts have used the data; there is me testifying.

So which model is this? Well, the professional scientists defined it, they designed the study, and the community collected and analyzed the samples, so this is the Community Workers Model. What we found is that a lot of people who were
involved in this project said, “We have issues beyond that of the deposition. We care about that, but we care about other things as well. We’d like to expand the focus of our work.”

Expanding the Focus, Changing the Model

We wanted to keep the acronym ALLARM, and I challenged the students to find another name. They decided to call it the Alliance for Aquatic Resource Monitoring, rather than Acid Rain Monitoring, so we kept our acronym and we expanded our focus, and in expanding our focus we changed the model that we were using. Our motto now is “Educate, engage, empower.”

Now what we do is play the role of service provider for the community. We provide capacity-building programmatic and scientific technical assistance to groups who request assistance to address a concern they have. So they define the agenda.

In the case of ALLARM, this involves students, staff and faculty mentoring groups through every phase of the scientific study, including the study design; lab and field training; data management, analysis, and interpretation; and finally data to action.

The greatest challenge in this model for us is the study design and the interpretation of the data. That is, getting the community to do those. They have got plenty of problems to define, and they love to...

We have found the greatest challenges in this model are the design and the interpretation of the study.

These steps involve intensive mentoring by the professional partner (service provider) and a high level of commitment by the volunteers. (Note these steps move the participant from a “citizen” to a “scientist.”)

- Study design
- Lab and field training
- Data management, analysis, and interpretation
- Data to action planning

In this model, we now play the role of “service providers” for the community:

- Provide capacity-building programmatic and scientific technical assistance to groups who request assistance to address a concern they have.
- In the case of ALLARM, this involves students, staff and faculty mentoring groups through every phase of the scientific study:
  - Study design
  - Lab and field training
  - Data management, analysis, and interpretation
  - Data to action planning
collect the data and they do a pretty good job of that, though it is challenging as we have seen. But designing the study and interpreting the data is the most challenging.

These steps involve intensive mentoring by the service provider and a high level of commitment by the volunteers. But also notice that these steps are the steps that really move the participants from a sort of worker mentality into a scientist mentality. This morning I heard the volunteers being referred to as "technicians," and in many cases they really are technicians in our models, but this moves them up into a more scientific role.

For the study design, what we do is facilitate sessions with them and we force them to answer questions like, "Why, what, how, when, and where?" to produce a written document. This can be very contentious. They suddenly find that they don’t all agree on their goals, and they don’t all have the same ideas about what they want to do.

We worked through the monitoring design process below: What are
your organization’s major objectives? Why are you monitoring? How will you use the data? We absolutely made sure they identified how they were going to use the data before they collected it because how you use it will dictate what you monitor, where you monitor, how you monitor, where, when, what are your quality control measures, how you manage and present the data, and who will complete the tasks.

The rules for successful site design are outlined at right, and must include a potluck meal. We have a lot of fun with these but they take a lot of time. They usually take about six months to put together a study plan.

The other difficult step, which I’ll run through quickly, is the data interpretation step. We have had experience doing data interpretation for the folks and going back to them and explaining to them what they have found in their data. So here I am explaining to them what they have found, and here is their reaction.

I finally got to the point where I decided I’m not doing this anymore. I’m not going to be speaking Greek to them and having them not understand what we’re saying. They’d always come up to me afterwards and say, “Oh, that’s really interesting. Could you contact our local reporter and tell them what’s going on?”

I’d say, “You can do that,” and they’d say, “Well, we don’t really understand.” So what we’ve done instead is train the volunteers to find the story in the data themselves. In fact, this is working moderately well.
Here is one of our students saying, “Go get ’em gang!”

Training the volunteers to find the story in the data themselves

Yup, seems like nitrates are highest at our farm sites

Go get ’em gang!

Why is the DO so low here? Do you think it is that #8? sewer plant?

The value of local knowledge!

Steps in the Data-to-Information Training Process

• Workshop #1: Learn the basics using a virtual watershed (Dickinson Creek)
• Workshop #2: Apply these skills to the real watershed data collected by volunteers

One of the advantages of doing this is they can use their local knowledge for this interpretation. They often find things we didn’t find in the data because they use their local knowledge.

We have two steps in this training process. One is we work with them using a virtual watershed where things work out clean and neat, where the data style is the same structure as their data. Then we give them their real data where things don’t work out so neatly, as you know with real data, and they’re able to handle it.

Then what happens is that they can take the data and do something with it. They can develop grant proposals, develop watershed fact sheets for public education, work with landowners to implement “best management practices,” developing conservation easement programs, upgrading stream protection status, removing dams, implementing stream and riparian zone restoration projects, using data to advocate for sound land use decisions by local municipalities.

Typical watershed action plans based on volunteer data and carried out by volunteers

• Developing grant proposals for restoration projects
• Developing watershed fact sheets for public education
• Working with landowners to implement “best management practices”
• Developing conservation easement programs
• Upgrading stream protection status
• Removing dams
• Implementing stream and riparian zone restoration projects
• Using data to advocate for sound land use decisions by local municipalities

1 These workshops were developed in cooperation with River Network, the Stroud Water Research Institute, and the Delaware RiverKeeper.
sheets, work with landowners, develop conservation easement programs, upgrade stream protection status—these are all things we’ve done. We’ve removed dams, implemented stream and riparian zone restoration projects, and have advocated for sound land use decisions at the local level. So they use the data then to do whatever action concerns them.

The Preferred Model for ALLARM

I am going to put the following thought out there so that we have something to talk about. I think there is tremendous value to the Community Workers Model. However, we really prefer the other model, the Action Research Model.

In the gathering of scientific knowledge, there is a trade-off. If you use the Consulting or Community Workers Model, you get immediately measurable, verifiable, scientific results, and that’s wonderful. In the Community-based Model it requires a lot more time and patience and commitment and a very, very complex training process, which is not very efficient. However, in terms of democracy, with the Consulting or Community Workers Model only experts can use the data. The volunteers are very dependent on them. With the Community-based, Participatory Research Model, volunteers can

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<td>Volunteers can shape the interpretations based on their own knowledge and can use the data; levels the playing field in decision-making</td>
<td>Builds community capacity to continue even after experts and monies are gone</td>
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In the gathering of scientific knowledge, there is a trade-off. If you use the Consulting or Community Workers Model, you get immediately measurable, verifiable, scientific results, and that’s wonderful. In the Community-based Model it requires a lot more time and patience and commitment and a very, very complex training process, which is not very efficient. However, in terms of democracy, with the Consulting or Community Workers Model only experts can use the data. The volunteers are very dependent on them. With the Community-based, Participatory Research Model, volunteers can
shape the interpretations based on their own knowledge and can use the data, and I really feel it levels the playing field in terms of decision-making.

In terms of sustainability, in the Consulting Model the money runs out, the scientists leave and the activities end. Hopefully, the Community-based, Participatory Research Model builds community capacity to continue, even after the experts and the money are gone.

And remember, at the end of the day, the story belongs to those who understand it.

Remember: the story at the end of the day belongs to those who understand it, and knowledge is power!

We have done some publications on these different models and I can send that information to those interested in learning more about our experiences.


For more information: http://www.dickinson.edu/allarm
yeah, but...are the data any good?

Sandra Henderson
UCAR Citizen Science Programs Manager
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that this document did not originate as a formal paper. Rather, it combines an oral presentation with accompanying PowerPoint slides and reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

Documentation of the conference is meant to serve as a resource for those who attended and for others in the field. It does not necessarily reflect the views of the Cornell Lab of Ornithology or individual symposium participants.

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Yeah, but... are the data any good?

Overview

After listening last night and today to the introductions, the talks, and the discussions, I would bet that I'm not the only one in this room who has ever been asked a question of this nature: “Yeah, yeah, yeah, sounds good, but...is the data any good?” Has anyone here ever had to deal with that? How do you answer it?

Personally, I have decided not to spend a tremendous amount of my time trying to convince the nay-sayers or convert the doubting Thomases to these types of programs. The data is very useful to answer the scientific questions we’re posing, but also to inform us as citizen science project administrators, managers, and leaders to develop better projects. So I think, yes, the data is very good.

Here is a brief presentation overview. I want to talk about two of our recent citizen science campaigns, GLOBE at Night and Project BudBurst, review some of the concerns we found relating to data quality, give you a lesson learned on data verification that we’ve put into play this year, and then talk about an upcoming event.

UCAR and NCAR Citizen Science Campaigns

About Citizen Science at UCAR and NCAR

At UCAR and NCAR, the goal of our citizen science efforts might be a little different than those of a lot of the projects we’ve heard about so far, and different than a lot of the monitoring and volunteer network campaigns. Our primary goal is to increase public awareness of an environmental issue through data collection. We want to increase public awareness of whatever issue it is we are looking at.

Our citizen science projects are very extensive. We are looking at national or even global levels of participation, and they are open to all. There is no prior training, we never meet the people, and we don’t have train-the-trainer opportunities. We’re looking at how can we do this using existing networks in an entirely Internet-based campaign.
They are also collaborative. We draw upon the expertise of many. We draw upon our expertise as a collaborative university community, a national center in Boulder, and on existing networks that we have. With GLOBE at Night, for example, which is a light pollution astronomy campaign, we also partner with institutions such as the National Astronomy Observatory in Tucson. In a project like Project BudBurst, we collaborate with the Chicago Botanic Gardens as well as botanists and phenologists at the University of Montana, U.C. Berkeley, and the University of Arizona. We are very much looking at the collaborative aspects of what the community in general has that we can use.

GLOBE at Night

I want to talk to you about our very first foray into this idea of taking on the challenge: Let’s do something that will involve the entire world in a citizen science campaign. We started this on January 3, 2006, and when I say “started,” I don’t mean opening up the Web site or getting the word out, I mean sitting down and planning for an event that went live on March 22. This was about eleven weeks, and in that eleven weeks we developed the protocol, we developed the Web site, we developed the downloadable materials, the marketing, bringing in partners, all aspects. And we did this on a shoestring, there was no budget to do this. We just wanted to see if we could have this kind of outreach and impact through this Internet environment.

Our goals are very straightforward and we have them listed everywhere. In one of the breakout sessions this morning we used the term, “being transparent.” This is what we hope to accomplish: First, engage students worldwide in observing the nighttime sky. This is a light pollution study. We wanted to encourage citizen and family science outside of a formal environment. And finally, we wanted to gather light pollution data from an international perspective. It’s not an accident that they are listed in that order, looking at the data being actually the last thing.

If you went to the GLOBE at Night Web site, you would find everything you need to participate. There is a very simple protocol. You simply go out between seven and nine during the time period, which was March 22 to 31 for the 2006
event. We have limiting magnitude charts that you download, and you go out and look at Orion. Orion was chosen because at that time of the year it is visible in almost all latitude bands in both hemispheres. There are also downloadable activity packets, and I’d like to take an aside for just a moment.

The packets were in both English and Spanish. As a national center, we are very committed to providing educational materials and opportunities that will reach the changing demographics of the American population. We wanted children to be involved, and we knew that there would be young kids, children who would be out with their parents. We wanted to reach out to the Spanish-speaking population by having these materials available in Spanish. Univision, the Hispanic television network, picked this up and was able to promote it to the Denver affiliate because of the Spanish materials. I encourage you as we develop citizen science programs to be thinking how you can reach all Americans.

We also have interactive games on the Web site to further the interactive content, simple data entry, and ESRI worked with us on providing the mapping.

Then we had to get the word out and as I said, we hit the ground running. We went through our press releases, we did listserves and mass mailings, Web sites, print media—you name it. We were knocking on doors, encouraging everyone to help us get the word out. We were very excited about it. Did it work? Did we get the word out?

Yes! We were picked up by the New York Times, we were the subject of a Scientific American podcast, and had coverage from numerous print and media outlets. We felt that we really had been able to get the word out.

For the event itself, we had over 18,000 people participate; over 4,500 data points were entered; all fifty states were represented; we

The Event

- Over 18,000 people participated
- From 96 countries on six continents
- From all 50 US states
- 4,591 observations reported
- Averaging 9,100 Web site hits a day
- Over 760 people on mailing list

Getting the Word Out

- UCAR and NOAO press releases
- Listservs and mass mailings
- Web sites
- Print media
- Local broadcast media

NY Times Science Observatory
Scientific American Podcast
Earth Science Picture of the Day
Geography Network front page
Many local papers
Local TV broadcasts
had people from ninety-six countries, all six continents except Antarctica; and we established a mailing list and a community of individuals interested in light pollution.

We had a little bit of embedded feedback information in this campaign so we could learn a little about the people who were participating. If you remember, our first goal was engaging students. Half of the people reporting data were under age eighteen, which told us that this data entry form was pretty straightforward and that kids could participate and enter the data.

What do the GLOBE at Night data tell us? Look at the left graph with a limiting magnitude of one to a limiting magnitude of seven. If you have a limiting magnitude of one, you could be on the strip in Las Vegas or maybe Manhattan. With a limiting magnitude of seven, you could be in a wilderness area in Montana.

"The GLOBE at Night data shows brighter skies in areas with more people. By submitting our observations to GLOBE at Night, you made an important contribution to science. You have provided valuable information that would have otherwise been impossible to obtain!"

The curve is what we would expect. When the data was analyzed, it wasn’t a surprise. Again, darker skies have lower population densities, brighter dots would show higher population densities.
What were some of the data quality challenges? As I said, we did this entirely Internet-based, so we did not have the opportunity for feedback to see if people understood the protocol. I like the way Karen Oberhauser put it in her presentation: "We thought it was easy and straightforward." We didn’t have that opportunity for feedback.

Another major challenge was location, how to get latitude and longitude. This was international and remember, we didn’t have people register and there weren’t specified study sites. GPS units certainly helped if you had access to them, but there are large parts of the world in which those are just not available. We were able to develop different methods using Maporama and Google Earth to show people how to get the latitude and longitude.

And finally, there was the issue of reporting data. I know you probably have all had experience with this. We know people were out there doing the activity because we get this kind of feedback, but they don’t enter the data.

What I’d like to do in the interest of time is focus on location. The gray dots represent data that we were able to use. The black dots represent data that we felt were just erroneous—say out in the middle of the ocean.

This data told us we had to make a change in doing the latitude-longitude data entry. This is just a screen capture. You enter your latitude and longitude as well as comments on your location. What you
get then immediately is verification. ESRI worked with us on this. If you put in this latitude and longitude data you get a verification screen and can see—yeah, I’m probably pretty close to Fargo—and you get that immediate feedback.

In the 2007 event, not only did we have increased numbers, we had more data that was actually usable.

The gray again is data we were able to use and the black represents data we weren’t able to use. This time we rejected less than we did the first time in terms of it being useful data.

When we looked at the numbers we were able to identify where and how 1,000 people made changes in longitude and latitude. We felt this was a good thing, and we probably had a lot more data that was usable, but I find that the top one is particularly interesting.

If you have a degree change of greater than or equal to ninety degrees, you’re basically talking a
hemisphere. They were way off. In this case, and in many cases, a negative sign might not have been put in. That was something we felt we were able to learn. We required participants to verify their location, and it seems to have helped their rejection rate a little bit. And eleven percent of the people did choose to make changes based on that.

So was the data any good? It was very consistent compared to the satellite data. The 2007 event allowed for this better lat/long verification. And please keep in mind, never in those goals did we expect to topple any paradigms in the field of astronomy. This is not what we were going after. So we weren’t surprised that the data showed what we expected.

Using the wonders of PowerPoint, over lunch I was able to throw another slide in. One thing that Sam Droege said during his presentation that I really think is key in any of these events, and I know other speakers have said this too, is feedback. You have to do something with the data. If you just let it go into the black data hole, that’s just wrong. It’s just not the right thing to do. Within six weeks after the event, it is always our goal to have a report out. We did do that in a simple and straightforward manner. We sent it out to the listserve, publicized it throughout the Web site, and anyone who participated could go in and see it—even the people who were out floating, by the way. We left their data there, it’s just we didn’t use it in the analysis of light and dark. They could drill down, using GIS tools, and go in and see their data point and compare it with others. So Sam, thank you for saying that first thing this morning. I hope we hear that all week long: Get the feedback to the folks you want to engage again.

Project BudBurst

I want to get a little more down to earth, get away from astronomy, and talk briefly about Project BudBurst. This was the outcome of a citizen science meeting last fall of the National Phenology Network in Milwaukee. I and a number of other people were part of the citizen science working group. I know
most of you have had this experience. You go to meetings and they want you to be in working groups and develop white papers, and so on. We had been talking in the citizen science group and said, “Let’s do something. Let’s do something national, a simple thing to capture the imagination.” We wrote a couple of pages, and decided to go forward with it.

Kay Havens, my colleague from the Chicago Botanic Garden, took this two-page white paper we had written, submitted it to BLM, and got $20,000 to let us get this little seedling thing going. As a result we launched the pilot in the spring of 2007.

It was a phenology study, and I know that many of you are very familiar with this idea, but the link for us, particularly at NCAR and UCAR where there was a lot of interest in this, was the climate change aspect because that’s the basis of so much of our research.

We launched it in 2007 and I know a number of you here have heard about it. We had such positive feedback on this and excitement. We launched it in April of 2007 and it just ended last Friday, so the data hasn’t been analyzed; it’s still pretty new.

One of the things we did get immediately in April, not surprisingly, was: "Wow, this sounds like..."
a great idea, but I live in South Carolina and everything has long since budded out and leafed out." So this was truly a pilot, just a proof-of-concept to see if it worked.

We had a wide range of collaborators. When you are trying to do these extensive, large-scale projects, having collaborators and really building on the community is absolutely invaluable.

As I said, it ended last Friday and we did have over 500 data entered and hundreds of e-mails of interest and support. I want to thank Craig Tufts, who is here, for always supporting this and getting the word out for us. We have had numerous organizations and agencies that want to collaborate with us on this, and we are going to expand the 2008 event to start in January, run through December, and be able to capture a lot of phenological events throughout the year.

Great World Side Star Count

Finally, we want to go back to the heavens, and we are stealing this from the birding folks. We are going to develop the Great World Wide Star Count. It starts in October from the first through the fifteenth, so I would invite all of you to get a kid, go outside, and look heavenwards. I bet everyone in this room got their start in their career at some point because you just wanted to be outside and look around. I strongly encourage you to go outside, go onto the Great World Wide Star Count Web site, which is open to everybody, enter data, and let us know what your night skies look like.

When you are trying to do these extensive, large-scale projects, having collaborators and really building on the community is absolutely invaluable.

Great World Side Star Count

Join thousands of other students, families, and citizen scientists counting stars this fall for the Great World Wide Star Count! This international event encourages everyone to go outside, look skyward after dark, count the stars they see in certain constellations, and report what they see online. This Windows After Dark citizen science campaign is designed to raise awareness about light pollution and the night sky as well as encourage learning in astronomy. The Great World Wide Star Count will be held from October 1st through October 15, 2007.

For more information visit
www.windows.ucar.edu/
citizen_science/starcount
or contact Dennis Ward at dward@ucar.edu
provocations/questions: citizen science project design

Martin Storksdieck
Director of Project Development
Institute for Learning Innovation
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that this document did not originate as a formal paper. Rather, it reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

Documentation of the conference is meant to serve as a resource for those who attended and for others in the field. It does not necessarily reflect the views of the Cornell Lab of Ornithology or individual symposium participants.

The following recap poses provocations or questions in response to the four presentations delivered as part of the session titled “Citizen Science Project Design” on day one of the Citizen Science Toolkit Conference, which focused on the importance of project evaluation.

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org
Provocations/Questions: Citizen Science Project Design

Summary of Key Elements

You need to keep all of this criteria for success described in the previous talks in mind to be successful? That is quite a challenge. That was my first impression. What that conveys to me is that designing effective citizen science projects is a nontrivial matter. If anything, we are learning here just how hard it is to do this well. I think the first stage is to simply do it; the “well” comes later, and that is where evaluation kicks in, which you can use to your advantage, as has been said many times.

Let me first summarize what I heard in what were possibly four different terms or four ways of thinking about citizen science projects. What I heard in the last four presentations was basically: make sure you know who you are; and we heard there are models out there that are very different. Which model your project represents is something you need to determine for yourself, but it seems that when you say what it is you want to achieve—your objectives—that may already have something to do with who you are. So you need to go back and ask yourselves: What determines who I am? Why am I here? Why am I doing this? Who do I need to involve—those whom I think I am doing my project for or with—and bring to the table in deciding who I am? I think that is a feedback mechanism right there that involves something that hasn’t been mentioned here so far, which is needs assessment and front-end evaluation.

Once you have figured out who you are and what you want to achieve with your project, you want to make sure that you grow and adapt and are flexible, and you want to make sure you change as much as is needed to be successful. The other thing I have heard here is that you want to not do it alone. Everybody talked about how success comes from collaboration and how you want to share. That kind of summarizes what I heard, and now let me go into a little more detail.

Kirsten Ellenbogen started with what I thought was a wonderful introduction. She was focusing on something that, as evaluators coming from a learning perspective, we are very concerned about, which is: What do people personally take away from their experience? What, in other words, happens in their head as a result of their involvement? Not necessarily the data quality, which we didn’t have...
to touch on because others here with much experience in that area were talking about data quality in terms of their projects.

What we saw was just how broad the potential is, how many different objectives are out there for citizen science projects that have to do with who you are. I think keeping that in mind and being true to yourself, whatever “your” means, is an important aspect. We could walk away from this conference saying, “That was so cool what somebody else just told me, and I wish I had done that,” but I think it’s important to realize that you are doing something for your own purposes.

There was also the whole notion of having very broad objectives when you think about what the objectives might be, and narrowing later on through processes that Kirsten was describing as being circular from the perspective of an evaluator and researcher. Think about that not as an afterthought. Good design and successful design has a lot to do with integrating evaluation into the process of your work. It’s not something you do and stop when it’s a success, or something that you only do in the beginning to assure you’re on the right path, it’s something that you do all the time, talking to people and getting feedback. Everybody mentioned that in one way or another: in formal and informal ways, they get feedback.

Questions for Discussion

I was not only charged to summarize, I was also charged to ask provocative questions. I think a provocative question here is, how on earth do we do all of this and do it well? One of the things I find interesting is that from the talks I just heard, what I would take away is: I have to be an expert in all of this? I need to keep in mind learning theory, activity theory, social theory of action, and so on and so forth? There is a lot in there, and you may feel very quickly overwhelmed, or at least I do. I get the feeling: Don’t try this at home!

I think that is the challenge that I see in this. The challenging question is: Where are you competent? What do you do well and what don’t you do well? I don’t mean to say that you’re not all fabulous. The idea is to identify where you need to partner, and I’m not even sure you’ll find the right partner. But what I take away from this is really the hard question: Where do you excel and where do you see that you have deficiencies—or not deficiencies, but where do you see that you need to bring others in?

That is basically the summary for this session, which I found amazing, and I hope you all found it valuable too. We are talking in our evaluation breakout sessions about how to come up with ways of thinking about what objectives might be and how they are linked to
the design. And then, of course, how do you measure that? What we haven’t touched on is just how difficult that can be, particularly when you do it on the side rather than embed it into your process.

It seems to me that there is this whole idea of assessing objectives, having that evolving over the time of your project, and documenting that in some way, not only for the purpose of knowing you did well, which is important, but because citizen science means that there are lots of people and stakeholders involved, and we want to tell them that what they did, what everybody did, was successful. Doing this and communicating what your project is about and what it accomplished is important.
when pigs can really fly, we’ll build a tool to count them

Steve Kelling
Director of Information Science
Cornell Lab of Ornithology
The following is the opening talk of the session titled “Technology and Cyberinfrastructure,” delivered on day two of the Citizen Science Toolkit Conference.

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

[http://www.citizenscience.org](http://www.citizenscience.org)
The Impact of Advances in Technology

I really don’t know much about counting pigs, but I bet I could figure out something. What I want to talk about are four related technologies that have really transformed how we manipulate information.

First, Moore’s Law has made computers ubiquitous. The law predicts a doubling of the number of transistors on integrated circuits every eighteen months. This has led to rapid and continuing advances in computer power as well as lower unit costs.

The Internet and Web browsers have really created a global standard format in which we can pass information around between computers. Over the late ‘90s, advances in the amount of fiber optic cable that have been laid out across the world have made fiber optic cable a commodity that is allowing everyone to have access to computer networks. Finally, information description languages, data management processes, and software application integration have created seamless work flows for access, manipulation, and processing of almost limitless data resources.

What This Means for Citizen Science

What does all of this mean for citizen science? First, this has allowed us to create integrated project designs that allow us to record submissions, error checking, data management and data visualizations, all delivered through a single Web interface.

Second, this broad access and usability means that we can engage people in Panama or New Zealand just as easily as we can engage somebody in Peoria, Illinois. The scope of access is now global.

Third, data organization strategies have really allowed us to synthesize in markedly advanced ways that were unheard of several years ago.
Finally, this all has allowed us to create a whole series of data information products, applications that allow a user to interact with all of this information in a number of ways and strategies that have never really occurred before.

The Focus: Observations

The way that I see it, the focus of citizen science is on observation. What we do is engage people in making observations of the world. What I mean by “observation” is a representation of the measurement of a defined attribute (e.g., a number, behavior, or physical property) of some “thing” observed. This could be an organism in the field, an observation of a bird flying overhead, a measurement of a specimen in a collection, or gathering of a sample during an experiment. The observation occurs at a particular time (e.g., date, time of day) and at a particular place (e.g., latitude and longitude of a point, transect, or polygon).

Observational data can be gathered using sensors or sensor arrays. It can be gathered by direct observations or by looking at biological specimen collections in museums. Observational data represent the greatest source of information on the distribution and abundance of organisms both across time and through space.

eBird

Origins and Overview

In 1997 the Lab, in collaboration with the National Audubon Society, initiated a project called BirdSource. The goal of the BirdSource project was to establish an ongoing data center capable of gathering, maintaining, analyzing, and broadly distributing the most current and comprehensive information on North American birds. While BirdSource has morphed into eBird, the basic goals of BirdSource are still the basic goals of the Information Science Program at the Lab.

What I want to do today is describe the Lab’s efforts in developing
this data center. Specifically, I want to talk about the enterprise application foundation of eBird, new directions we are heading in application development, and our efforts in the Avian Knowledge Network to organize and analyze observational data on bird populations.

What is eBird?

EBird is a hemisphere-wide checklist program whose goal is to engage birdwatchers to submit their observations in a standardized format. We began eBird in the fall of 2003 and are currently gathering over 35,000 checklists and 500,000 observations per month. Roughly about 10,000 individuals participate monthly.

EBird has been developed within an enterprise application framework. We use middleware software designed to set up, operate and integrate transaction-intensive applications across multiple computing platforms using Web technologies. We are using the same kinds of applications that banks use to process information to allow us to collect information via eBird.

Data are stored within an Oracle database management system, which allows us to create, update, and extract information very quickly, with much accuracy, and it can be scaled to be extremely accessible.

The most significant factor in eBird are its data gathering abilities, which have the potential of creating a network of bird observations at a global scale. However, if the data submission forms are not easy to use, then regardless of how sophisticated the data management or visualizations, not many people will participate and little information will be gathered.

Sample Data Entry: A Conference Birdwalk

The process at eBird begins with an introductory page with lots of new features. You can submit observations, you can use a map or an

To demonstrate data entry, Kelling goes to the eBird Web site to enter observations from an early morning birdwalk by conference participants.

Try entering your own birding observations at:

http://www//eBird.org
There are several protocols or observation types in eBird, and my guess is that the birding group that went out this morning did a traveling count—you walked around an area. All of this information including the location, the start time, the length of the walk, and number of people in the party allows us to standardize the way observations are gathered. One of the important pieces of information that we always ask for is whether you are submitting a complete checklist of the birds that you saw and heard. For example, you may have seen ten species of birds but didn’t know what they were. Or you may have focused on just counting one species.

You then see a checklist. The checklists are specific for the region, in this case upstate New York, developed by an expert who knows the distribution and occurrence of birds across the year. This particular checklist is made for this area for the month of June. The checklists are being used by a range of age levels and abilities, from middle school students all the way up to expert users.

I’ve deliberately made an entry error and have recorded 175 Belted Kingfishers rather than 1. It flags our potential error and says, “175 is an impressive number...care to confirm?” We’ll correct it, changing the 175 to a 1. Then we hit Continue and the list allows us to confirm what we saw. It asks, “Would you like to add a note?” We’ll enter that this is a Citizen Science Toolkit expert bird team, and then we click Submit. We can e-mail this to the listserve. All of these data are now in the database so we can start looking at the results.

Maps and Checklists
You saw during that demonstration examples of the kinds of filters we use. We probably have five or ten thousand of these filters created now for regions across the country, so the lists of birds we can present at any time are very accurate.

Users must be easily able to find the location in which they made their observations as accurately as possible. As I noted, this can be done
using a Google map, but it can also be done via known locations or address matching.

Data Quality and Expert Engagement
The other thing that we do is develop tools that allow us to engage regional experts to actually fill in the data, edit the data, and change the values of whether we accept the information that someone submits.

There is already much known about the distribution of bird populations in North America. We have used this knowledge to create smart data forms that flag records that are unusual. For many organisms (birds are an excellent example) expert opinion on species ranges and seasonal distributions are a valuable resource to improve data quality. Editing tools allow experts to view flagged records, contact the individual who made the observation, and validate or reject those records.

My eBird
Probably the most significant component that we’ve added that allowed us to increase the number of people participating is the "My eBird" feature. This is a way to allow anybody to keep track of the observations they’ve made, not only their life lists and things like that, but for particular locations. You can also generate graphs and maps of all of the observations that you’ve made.

Data Visualizations in eBird
The exciting thing about these kinds of occurrence data that we’re collecting is that we can provide accurate estimations of the dynamics and patterns of abundance of bird populations at specific locations across North America. Because all eBird data are associated with a location, it is easy to organize
results in a variety of interactive visualizations. Histograms are generated dynamically from georeferenced data.

Working with the New York Audubon Society, we have built an application that allows us to look at bird populations across all of the important New York bird areas. You can choose one or you can choose them all, and you can see how the patterns of things like the Least Sandpiper or Semipalmated Sandpiper appear in the spring as they migrate north and then spend some time at the Montezuma refuge in the fall until they leave.

Additionally, we are able to create maps showing the dynamics of bird populations across time and space. This is showing the pattern of a series of warblers in the winter, early spring, late spring, summer, early fall, late fall, and winter. [Note: In original presentation, an animated version of the map below cycled through all seasons listed.]

An interesting thing about this map is that because we ask that question, “Are you recording all the species you observed?” we also have information on where species weren’t observed because we can infer that. All of the light gray squares that you see are locations where we have observations, but the species of interest weren’t being reported. This is a significant advancement and a really relevant component of observational data that is important with the
types of data we are collecting with eBird.

The Need for Collaborative Development

The Enterprise System Dilemma

We have a problem, and I call this the “enterprise system dilemma.” While the information architecture used for eBird has been successful, it does have its drawbacks. First, it is expensive to develop and maintain. Second, it takes a lot of effort to add or modify existing applications. Third, it is difficult to adapt this system to gather other types of data.

Observational Data Systems

So we are starting, with some other groups, to look at how we can share the characteristics of observational data and develop systems that integrate these heterogeneous data sets and allow us to collect information across taxa. Additionally, data standards are currently varied across the observational community, making data integration and analysis difficult. We are interested in developing single data standards that will allow us to bring these kinds of data together.

Collaborative Development

These issues are not only being addressed by the Lab of Ornithology. NatureServe, which is managing most of the heritage programs of the Nature Conservancy and collecting that kind of data also have these kind of issues.

The National Center of Ecological Analysis and Synthesis (NCEAS), which works a lot with the long-term ecological research stations across the country also face these issues. These three groups are now getting together. We are going to have a meeting in July in Santa Barbara, and quite a few people from a broad range of backgrounds are going to be coming to begin to discuss and develop ways in which we can collaborate and bring these kinds of data together.

Our goal for this collaboration is to build a core observation data ontology. We want to make sure this ontology is extensible to allow flexibility in the different ways that data are gathered. That is going to allow us to develop an integrated project framework based on this core model.
Plugable Service Architecture

The concept that we are thinking about is development of a plugable service architecture to create a novel observation network. A user interface similar to Google Gadgets or Yahoo Pipes will provide an intuitive and straightforward environment that connects applications and code within the basic system framework. For example, you would have pieces of application code of something like the gadgets in Google Gadgets that a user, via a Web browser, can connect to and then create a kind of citizen science project or observational data gathering tool that they are interested in developing. They can then go online and start collecting these data.

We are going to have an application framework and, via this Web browser interface, an individual can add quality control features or different ways in which they want to collect, display and store these data. The concept is that this will all be built in an open source environment, so anybody can build additional gadgets or modify gadgets to increase the functionality. Anyone developing a data gathering application will be able to use these off-the-shelf services, extend existing services, or create entirely new services.

Lessons from Gathering Observational Data on Birds

Observational Data

We have already had great success in the bird monitoring community organizing and making available a rich and diverse data resource on bird occurrence. This is a fly-over of North America, and these red dots [visible in animated fly-over] are all the locations where we have information on the occurrence of bird populations.

This is a huge resource. Right now there are probably over 30,000 records that we have stored in the Avian Knowledge Network. We have records across broad geographic areas. It is sparse in some regions where there aren’t many people, but we have a lot of data in Los Angeles. As you see during this fly-over, the concept is to bring all of these data into a single resource.
The Avian Knowledge Network

But we are really not interested in the data itself, we are interested in converting those kinds of data into knowledge, so we decided not to call this the Avian Data Network but instead the Avian Knowledge Network, primarily because we want to do more than just collect all of these data. The Avian Knowledge Network is an effort to convert these data into easily accessible knowledge for use in conservation and management of birds.

We are motivated by the fact that all of these data, these counts of birds collected by various people and organizations, are potentially valuable beyond the data’s initial use and potentially of even higher value when combined with similar data collected by others. This past week we just brought in ten years of breeding bird survey data. We just brought in some data from a watershed in Northern California. Our concept is that if we can integrate these data sources into a single repository that we could then analyze, the synergy of bringing those data together will allow us to explore the causes of species occurrence, bird populations, and current problems.

This has allowed us to create a whole series of different kinds of exploratory analyses. This is a map of occurrence of high Arctic breeding shorebirds through the years across North America [animated].

This was generated to begin modeling the spread of avian influenza by some researchers here. What you see by looking at these maps is
the occurrence, then the breeding up in the high Arctic, and then there is movement down across the continent.

Additionally, we can do things like look at the difference in population densities of Purple Martin across the United States, so during the breeding period you can see [in animated version] there are lots of locations where we have data on Purple Martin, but the red line shows that they are in low numbers. Then in July that changes. The average number reported increases rapidly, but the number of observations really drops.

![Purple Martin](image)

**Exploratory Analysis**

These kinds of applications, these new data mining tools that we’re creating, allow us to look at the patterns of occurrence where we can relate precipitation of rainfall or cultivated crops—actually about 1,200 environmental variables. They are also allowing us to look at what influences bird populations.

![Shortgrass Prairie](image)

**Use Data Mining models to generate environmental requirement profiles for bird populations across broad geographic regions.**

- 30,000 observations
  - Rocky Mountain Bird Observatory
  - 2001-2005
  - 10,000 locations

- **138 Predictors**
  - NLCD Habitat
    - 21 classes
    - 6 scales
  - Climate (EPA)
    - Average Precipitation
    - Average Snowfall

- 30 grassland species
The cool thing that we are doing is taking all of these data mining and analyses results and building a really simple user interface to a fairly sophisticated statistical package that will allow people to explore the patterns of species occurrence, to look at the impacts of population density for a year across bird populations.
Conclusions:

- Engage citizens to participate in observational data networks.
- Networks gather enormous volumes of data.
- The cyberinfrastructure is becoming more flexible and adaptive.
- The challenge is to convert these data into knowledge.
- Develop sound biodiversity conservation strategies.

Conclusion

In conclusion, what I really want to say is that we can now develop citizen-based sensor networks that can gather observational data at continental scales. These networks gather an enormous volume of data and the same engineering and systems management techniques used to calibrate and maintain vast autonomous sensor networks must be employed to insure the data quality.

The cyberinfrastructure that organizes these observational data networks is evolving and becoming more flexible and adaptive. The challenge now is integrating data from disparate resources and developing visualizations and analytical techniques that convert data into knowledge.

The ultimate goal is to develop sound biodiversity conservation strategies at all scales and for all organisms.

This is one of my favorite places. It is the view out my window here at the Lab.

All there is to thinking is seeing something noticeable, which makes you see something you were not noticing, which makes you see something that isn’t even visible.

Norman Maclean

Every day I make observations of the birds and the weather and submit those observations to eBird. My goal is to develop these kinds of opportunities to allow anybody to submit their observations into these continental-scale database systems so that we can begin to explore and conserve biodiversity across the continent.
vital signs
open source data input tools

Sarah Kirn
Vital Signs Program Manager
Gulf of Maine Research Institute
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that this document did not originate as a formal paper. Rather, it combines an oral presentation with accompanying PowerPoint slides and reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

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The following is one of three focus point presentations delivered as part of the session titled “Technology and Cyberinfrastructure” on day two of the Citizen Science Toolkit Conference.

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http://www.citizenscience.org

Cover art by C. Michael Lewis
About the Gulf of Maine Research Institute

I am from the Gulf of Maine Research Institute and I’m here to tell you about VitalSigns, our cyberstructure-enabled citizen science program. I wasn’t going to talk about GMRI’s greater mission, but then I had a conversation with someone from the conference who asked about the Institute and I realized that a lot of what we do could be called citizen science. So I’m going to tell you a bit about it.

We have a three-part mission: Science, Education and Community, focussed on the Gulf of Maine marine ecosystem. What we mean by “community” is that we provide a neutral, inclusive forum to which we invite people with different perspectives on marine natural resource issues in the Gulf of Maine. We get them to share their information. We don’t advocate for any one of them, but we believe that getting more information to the decision-makers will lead to better decisions.

We increase scientific literacy through place-based, user-driven, inspiring, authentic, aquatic science programs, and those words are all very deliberate.

And third, we execute this ecosystem-based research program. What is special about that ecosystem-based research program is that we very rarely use research vessels for our research programs. Instead we use fishing vessels. This serves two purposes. One, fishing days
have been greatly reduced in an effort to rebuild the fisheries, and that leaves the fishermen, obviously, under great hardship to make a living. We are interested in sustaining all of the communities around the Gulf of Maine, both the wild ones and the human ones. Working with the fishermen and paying them for their time at sea helps them through this tight spot while we’re waiting for the fish to rebound.

More importantly, those fishermen have an enormous wealth of knowledge from years and generations of summers and winters spent fishing those species in the Gulf of Maine. I went out with one fisherman and I had done some sailing myself so I said, “So Vincent, where are your charts?”

He looked at me and said, “Charts? I don’t have charts,” and he pulled out this little black notebook. It had all of the notes that his grandfather had made about the bottom and where the best fishing ground is. His father had the book and had made annotations, and now he had the book and he made annotations. And he was navigating by the bottom, which to me is amazing. We think that in citizen science we are using citizens who don’t necessarily know much about science to help us answer these great questions. Often the citizens bring a lot more than volunteer hours to the table, and I just wanted to mention that.

Vital Signs
Overview
What I am really here to talk about is Vital Signs. At Vital Signs we are now kind of between things, but we have had almost ten years of experience using technology for citizen inquiry and citizen science and have thought a lot about how this works. Right now we are moving from proprietary solutions to open source solutions, from very linear replicability to unlimited or nearly unlimited replicability, and that is what I am really going to focus on in this talk. The basic outline I will follow is what we’ve done, what we’ve learned, where we’re going, and why.

What We’ve Done
We started out on an Apple Newton, which is interesting because the CyberTracker program started on them as well. But this is the first project that we really rolled out. It was developed for the Palm
operating system. That’s a Palm IIIc I think, which is color. We developed software that let students use these devices to collect an image, the temperature (with a temperature probe), GPS position, and written observations.

This started with the idea that, well, kids like computers, maybe they’d like to use computers to collect observations. That was really the genesis of the idea. There was no question. There was the notion, wouldn’t it be interesting if we developed these tools and gave them to students, scientists and fishermen? Would they collect different information because of their different perspectives? That might be interesting.

We gave it to six schools (four middle schools and two high schools) and two natural science centers to test informal versus formal education venues. We just gave them to the teachers and said, “Call us if you have any technology problems and we’ll drive up and help you, and you tell us how this works educationally.”

We also developed custom conduits, which is computer software that pulls the information off the handheld onto the desktop. We were limited to PCs. We developed our database and online mapping system based on ESRI software. We found a great ESRI developer who could develop a much more user-friendly, customized interface for us.

Then we had a group of visitors from Ireland on an economic development trade mission, who saw this and said, “Hey, this would be perfect for what we need to do in economic redevelopment and revitalization of part of the western border between Northern Ireland and Ireland, where the troubles and military response have divided previously intact communities. What if we gave handheld computers to kids on either side of the border, and got them looking at the water that makes up that border using the same equipment and sharing their data online? Wouldn’t that be a great science education and peace and reconciliation, community-building project?”

So they hired us, licensed the software, and we worked with them to develop a new version of the software because of course, all the hardware had changed since we started it in Maine. Now the camera
was integrated into the handheld, and the handheld had Bluetooth capability so it could have wireless connection to GPS. We actually took the probes and disconnected them from the handhelds so that we could upgrade our probes.

I came onto the Maine project after it had already been started, and was looking over the equipment and noticed that the handouts that came with the little probes that we were using had a box at the top that said, “Warning: for educational purposes only. Not to be used for research or commercial purposes.”

What a way to shoot the whole thing in the foot! We’re trying to make this something real and then we tell the kids, “Well this is just for you and it’s really not going to mean anything.” So we got rid of that and are using real probes that scientists use.

We are hosting the Ireland project Web site, primarily because our partners in Ireland didn’t have the funds to purchase the ESRI software and didn’t have the intellectual property rights and expertise of our software developers, who had customized the mapping interface. We couldn’t give those intellectual property rights because we didn’t own it. So we’re hosting the Web site, but otherwise they are independent. You can go to vitalsignsireland.org and see the students’ data. I highly suggest looking at the pictures and reading the notes.

So the Ireland project was up and running and it was time to bring the new technology back to Maine. But of course, of the two years all of the technology had changed yet again.

What We’ve Learned

Before I talk about where we’re going, what did we learn from all of this? We learned that students really do like that fancy technology. They love those handheld computers. That was true in Maine, and it was true in Ireland. Interestingly, the teachers had a little bit harder
time with the technology, and more than once I would drive multiple hours only to find the problem was that the batteries were dead in the GPS receiver, or somebody had taken the batteries out of the cameras because they weren’t using them and then forgot and didn’t check. So the teachers had a harder time than the students. The smart teachers got students to be their technology helpers in the classroom, which is really interesting, and very insightful and good, and I could go on and on about that.

The other thing that we discovered is that scientists really like this idea of collecting data in the field with a computer because it gets rid of transcription errors and saves time, and you can also have that at-the-moment-of-data-collection feedback to prevent errors while you are still in the field and can correct them. In the eBird presentation earlier, we saw that data entry error response when you enter 175 kingfishers instead of 1. You can catch things like that in the field before it’s in your database, before you have to cull through and try to find things like that and remove them.

There is one thing that we have heard over and over again: Teachers really wanted the data that the students collect to mean something outside their classrooms. That is more true maybe in Maine than in Ireland, but I wasn’t involved as much with that implementation. But teachers kept asking, “Who is using the data? I want to be able to tell the students that Dr. So-and-so is answering such-and-such question with this information.”

I had to say, “Well, at the end what we have is temperature, picture, location, and observations, and no scientist can really use that,” which was hard for me and hard for them.

Another thing that we learned is that not everybody uses longitude and latitude. I’ve noted that here because it is amazing, the assumptions that we make. I was in Ireland setting up this project and I was going through the software with fisheries people and said, “So here is where your latitude and longitude are recorded,” and they said, “We don’t use latitude and longitude.”

I said, “Excuse me?” They explained that they had an Irish National Grid System. I asked whether there was an Irish grid system and a Republic of Ireland grid system and luckily the answer was no.
The point is, and it is a point we heard in earlier presentations, you’ve got to tailor your data collection to the question that you’re asking and to the people that you’re working with, and it reinforces how important it is to involve those people from the start.

The other thing that we’ve learned is that closed, proprietary solutions are limited and expensive. We’ve just heard this during Steve Kelling’s presentation also. In the Ireland project, they can’t have their whole project over there on a server because they don’t know how to handle the software that was developed and they don’t want to buy the ESRI software license that would let them do that.

The other thing we discovered when we came back home from Ireland is that the mobile computing industry is currently upside-down and sideways. PDAs as we knew them two years ago are no longer and neither are cell phones. They are kind of merging, but which one is going to win out? And every one has its own operating system. Because we can’t forecast who is going to come out on top, it’s really hard to predict the winner and develop for the operating system that is going to be around the longest. They’re all sort of going their own way, and who knows what’s going to come?

The other thing that we discovered as an organization was this idea of providing universal access to our programs. We discovered that it was actually achievable and really important and hugely inspiring and galvanizing. There is another project at the Gulf of Maine Institute in which we bring every fifth- or sixth-grade student in the state to our lab for a half-day marine science experience. We have two busses that really do look like the one below that drive to schools, pick up students, and deliver them to our site for those experiences. We’ve devised a risky and somewhat bold funding strategy to make that possible at no cost to the schools. It is just amazing what providing universal access has done for that project.

Where We Are Going

So that is what we have learned, and now we are thinking: Okay, what is the next step, how do we do it, and how do we do it really smart? How can we do this to the best of our abilities? What is the best investment of our hard-won, fund-raised dollars? What would be the best experience for students and scientists? What we decided is that

What We’ve Learned

- Proprietary solutions are limited
- Proprietary software is expensive
- Mobile computing industry currently in flux
- Universal access is achievable and important goal
while technology is in flux, something like the Internet is probably going to be around in ten years. We’re still all going to be connected and sharing information and talking to each other. Something like that is probably going to be around in twenty years. The functionality of the Internet is something that is going to be around. The technology of it is likely to be entirely new.

We are also collaborating with the Maine Learning Technology Initiative. We had a very bold governor named Angus King who took surplus money in the budget one year and said, “I’m going to make a statement, I’m going to put Maine on the map, and I’m going to set Mainers up for twenty-first century careers, and that means we’ve got to prepare them better in schools. I’m giving all seventh and eighth graders and their teachers a laptop.” And he did it. Now the program is being extended to high school teachers. That has just been announced in the last couple of weeks. Right now we have 32,000 students with laptop computers across the state, and their 6,000 teachers as well.

We’ve decided that open source is the way to develop so that we can be ready for replications outside of Maine. We realize that if we solve some of these problems for Maine, we solve them for people elsewhere, and we want to make our solutions available.

We’re also thinking about these standards-compliant data formats.

The developer that we are working with is the Gulf of Maine Ocean Observing Systems, and they do two things. One is develop open source software, but they also serve the data that is collected by eleven oceanographic buoys that are collecting data and reporting it in real-time or near real-time to a Web site.

They have done a lot with the Open Geospatial Consortium, which is working on a set of standards that don’t prescribe how your database is constructed, but do describe formatting that enables data to be seamlessly shared. So if I’m juggling apples over here and you’re juggling oranges over there, I can throw an apple through my ceiling and it changes format into a tennis ball and the tennis ball is a universally transferable type of fruit, and when it falls through your roof, it turns into an orange because that’s the format you work with. That is my analogy, anyway. In any case, our data is going to be housed in a way that you can easily pull it into your database and use it for your own purposes.
We’re also collecting data that scientists can use. With that picture, the location data, and simple observations of the environment, we can perform a great service to scientists and communities by monitoring for invasive species. To set everyone up for success, we’re choosing species that scientists have told us they would trust students to be able to identify, and developing protocols that work for teachers and scientists. We designed the protocols together with scientists and teachers. We are incorporating different levels at which teachers can participate so that it is flexible for multiple classrooms, and we are building in evaluation tools and point-of-collection data feedback.

I would like to end with a somewhat abbreviated picture of the Gulf of Maine watershed. Watersheds don’t physically honor geopolitical divisions, so it’s nice to look at this in a way that is not chopped up into states or Canada-U.S. divisions.
projects and problems: location, scale and precision in citizen science

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This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that this document did not originate as a formal paper. Rather, it combines an oral presentation with accompanying PowerPoint slides and reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

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This documentation is supported by the National Science Foundation under Grant ESI-0610363. Any opinions, findings, and conclusions or recommendations expressed in this documentation are those of the authors and do not necessarily reflect the views of the National Science Foundation.
Projects and Problems: Location, Scale, and Precision in Citizen Science

Introduction

This is going to be a big change of pace as well as a change of title. While the original title was "Mashups for Michigan Heritage Water Trails," I really don’t have a lot to say about mashups and heritage water trails, though I do want you to know what a heritage water trail is. Really what I am going to be talking about is geography; about projects and problems of location, scale, and precision in citizen science.

I don’t do a whole lot of citizen science, yet, but I’d like to. Janis came to Western Michigan and talked a lot about the Bluebird project, but also talked about citizen science. I thought, wow, this is a really cool thing for what I’m doing. What I do is work with communities and citizens on planning problems in various ways, economic development mostly. I applaud Sarah Kirn for what she is doing at the Gulf of Maine Institute in working with fishermen to connect research with economic development and jobs. That’s what I do, dealing with things like ecotourism, looking at various planning problems, and I’ll talk a little bit about those. But what we are really going to be focusing on is location.

I am the son of a real estate broker, and what did I hear from day one? Location, location, location. Location is everything, and location is really an interesting problem in terms of how we encode it. I’m floating down my river and I see a Sandhill Crane (fortunately we’re seeing a lot of Sandhill Cranes, they’re all over the place in southern Michigan now).
Where do I place that crane? Do I place it where I am, where the crane is, or someplace on the river, on either side of the river, in a point in polygon? That is more or less what we will be focusing on here.

Location, Scale, and Precision

Where am I? Where is the bird? Does it matter? How do I geocode the location into the map/database?

Projects, Problems, Issues

The Michigan Heritage Water Trails

Now I’ll tell you a little about some projects. I’m Director of the Michigan Heritage Water Trails program. Let me give you a little history. Michigan was one of the last states to get a water trails program. Water trails are trails on rivers and lakes that you paddle by canoe or kayak, mainly kayak nowadays. We couldn’t get a bill through the legislature getting a state water trails program because the state is broke (because of Michigan and the car industry) and they
didn’t want to fund it under a government recreation program.

So we repackaged it. The Michigan Heritage Water Trails program is an economic development and education program. The basic idea is that we map the river and we do research on history, culture, and the environment, and then we interpret it. As you paddle, you see the signs, you look at your interpretive guide, and you learn as you go down the river.

One of our problems is that we’d like to get people back on these trails after doing them once, and we want people to go to these villages and spend money. So how do we get them back? Well, maybe we can get them back if they start monitoring the river. If they do it on a regular basis, they’re going to eat at the restaurants along the way regularly as well.

This is our basic sign format: the name of the place, a little bit of interpretation to tease you, logos, and most importantly, down at the bottom, is the sponsorship.

The entire thing is funded by sponsorships. You get somebody to pay $500 for the sign sponsorship and the sign only costs about $35. The rest of it goes to print the interpretive guide, which we then sell, which then gives you money to implement the trail and go on to the next.

What we are doing with mashups is that if you want to know where to go paddling, you can punch in your address and say how far you want to paddle and how far you want to drive, and the program will tell you what trails are available and what regions of the river are suitable for what you want to do, and we’re filtering that system through a data mix. That product was then transferred to a project looking at street trees.
Kalamazoo Project Description

- The Emerald Ash Borer is destroying Ash trees throughout the Great Lakes. The Green Ash (Fraxinus pennsylvanica) and White Ash (Fraxinus americana) are among the most common street trees in the Midwest, having been a common replacement for the blight-killed American Elms.

- While there is much work being done on tracking and/or slowing spread of the Emerald Ash Borer, there is little work being done on replacing the millions of trees already destroyed by the infestation.

- Many of the trees are being replaced by an Oak monoculture, setting the stage for the next blight.

- This project seeks to develop a decision support system to assist homeowners in choosing a replacement tree that fits site parameters and maximizes biodiversity in an urban forest.

- The system eliminates species that are numerous within 200 meters of the home location.

Kalamazoo Street Tree Replacement Project

In Michigan we lost ten million Ash trees in the past two years due to the Emerald Ash Borer. A lot of people are doing research on that, but nobody I could find was looking at what to do about replacing those trees. People are currently planting an Oak monoculture over the top of the Ash monoculture, which is on top of the Elm monoculture, which is on top of the Chestnut monoculture in our Great Lakes cities.

I thought, this is a great opportunity. Maybe we could try for some biodiversity in our urban forest this time. I came up with a proposal to do a decision support system. We got a file from our urban forester who had geocoded 25,000 street trees in the city of Kalamazoo, every street tree in the city, and we put them into a MySQL database. When you put your address in, it does a point in polygon search to find out what 200 meter grid cell you’re in. Then it says okay, there are a lot of Norway Maples and Sugar Maples and maybe a few Beech trees in this particular neighborhood. We’re going to give you a recommendation on trees based on the parameters you enter, whether you have power lines or sidewalks, or sewers, whether you want shade, fruits, blossoms, whatever you would prefer. We’re going to recommend a tree, preferably a native, that will increase biodiversity in your neighborhood. So hopefully when people in Kalamazoo have to replace Ashes, they will plant something other than a Norway Maple.

Map Technology

The basic map technology that we use is Web sites. There is some type of location, based on address conversion or clicking on a map with Google’s map location mashup, and a point in polygon routine to determine...
what polygon you have to be in. That is followed by a database query to a MySQL database, which is based on underlying grid cell formats. We also are doing online questionnaires with e-mail returns. Hopefully, we’ll be switching into database for that.

Spatial Data

Now let’s switch over to geography. The spatial data that geographers deal with is based on space or location, theme or attributes, and time. That makes things wonderful for geographers because they deal with spatial data—space, theme, and time—so we can do anything we like. There is not much that is not spatial.

There are various ways of looking at space: address, coordinates, and looking at linear objects or polygon objects; thematic data—your nominal, ordinal, interval and ratio data, which then can be analyzed in different ways; and discrete and continuous time (or space for that matter).

Location Issues: Where is the Observation?

So, some issues: Where are you and how do you find it? Your street address? Latitude-longitude or some other coordinate system? Pointing on a map to where you think it is, more or less? Or using GPS, which may be accurate or not accurate depending on your equipment, the time of day, where the satellites are?

You’ve got line data. Dealing with rivers, this system works fairly well. You know where you are between two points—the river reach, or the street segment. Sometimes you do milepost offsets, or centerline or left side/right side. I’ve done a lot of work on this once upon a time, doing a database standard for CalTrans, where every
regional group had a different database and interoperability was absolutely impossible.

With polygon data you can look at bounded spaces; you can locate a point in the spatial center, a centroid; you can use grid cells; you can use buffers around points, around lines, around polygons or other minutia of where you are.

Scale Issues
One of the issues of scale is in terms of your points: Are you looking at the spot where you are? Are you looking at some distance around where you can see a landscape scale? Are you looking at a region near the spot?

And it is the same with the line and polygon. Are you looking on the line? Are you looking at the corridor? Are you looking at line of sight from the line on either side, looking on each side from the river into the trees? Are you looking at some region around the line? Within polygons there are your grid cells; a parcel like your backyard; a
bounded area such as a county; or some unbounded area, a region, something that’s somewhat fuzzy.

What is your neighborhood? Ask two different people what their neighborhood is and they’ll give you two different answers. How do we determine how many birds there are in a neighborhood unless everybody’s definition is the same? Think about it.

**Precision Issues**

The big issue is, how precise do we need to be? We don’t need to be right on the point for most data. Counting our birds, we need to know more or less where they are. For some analysis it may be important, but for other analysis, fuzzy is okay. So are we looking for accuracy or precision? How much effort do we want to put into precision if accurate is good enough? It’s a “horseshoes or hand grenades” kind of thing: It’s close enough if it works.

What are we observing and at what scale? Is it significant? Are there related data sets that we can compare with our data, and do we need to have interlocking scales? How much does location really matter for what we’re observing?

And how precisely do the citizens locate themselves? Do they know where they are? How do they record or select their locations? We need to know that in order to develop our user interface. And do we really want to be precise? Do we want to hide our sites?

**Issues for Discussion**

Below are some issues that I’ve talked about for later discussion. Are we allowing for appropriate types and classes of location? Are our current location entry and coding technologies adequate for what we are trying to do? How can we error check the locations that are being submitted? Are we thinking about appropriate scales of analysis, and are we thinking about appropriate scales of precision in our location schemes? Are we thinking about appropriate metrics, classes, and precision of our temporal data? A lot of times we think about space, but not so much about time. How can the technology be used to promote accuracy in our attribute data?

I have included some other related issues that I just thought were kind of cool. How can we integrate recreation and tourism with citizen science? I think there’s a real future for that. And how can we

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**What is the Scale of Observation?**

- **Point**
  - Spot location
  - Buffer (distance) around the spot
  - Line of sight from the spot (landscape scale)
  - Region near spot

- **Line**
  - On the line
  - Corridor
  - Line of sight from line
  - Regional near the line

- **Polygon**
  - Grid cell
  - Parcel (yard)
  - Bounded area
  - Unbounded area (region)

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**How Precise Do We Need to Be with Our Location?**

- Is our objective accuracy or precision?
- What are we observing?
  - At what scale are our observations significant?
  - Are there related data sets with which we can compare our data?
  - How much does location matter for what we are observing?
- Do we want to be precise?
  - Do we want to avoid other visits to the site?
integrate citizen science with physical fitness and anti-obesity efforts, which are really important things? Looking around this room, it’s pretty clear that it works. You look at a general population sample and the average obesity level is going to be much higher than it is in this group, and I applaud you all for that.

Discussion Issues

- Are we allowing for appropriate types and classes of location?
- Are our current location entry and coding technologies adequate?
- How can we error check the locations that are being submitted?
- Are we thinking about appropriate scales of analysis?
- Are we thinking about appropriate levels of precision in our location schemes?
- Are we thinking about appropriate metrics, classes, and precision of temporal data?
- How can the technology be used to promote accuracy in our attribute data?
- How can we integrate recreation and tourism with citizen science?
- How can we integrate citizen science with physical fitness and anti-obesity efforts?
information commons: a catalyst for scientific and social innovation

Josh Knauer
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Information Commons
MAYA Design
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

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About MAYA Design

I’m going to begin with some quick background because I don’t come from the citizen science community. I work for a technology research lab in Pittsburgh called MAYA Design. We take a multi-disciplinary approach to helping individuals and organizations understand how people interact with technology and the information that they get via technology.

A lot of our clients on the commercial side of our operation are Fortune 100 companies such as Panasonic and Whirlpool. I specifically work on the research side. We come from an academic background. Three professors left Carnegie Mellon University and started MAYA in 1989. We have a core focus when we look at technology, and think in terms of a concept that we call “information liquidity.”
The Big Problem: Information Liquidity

The concept of information liquidity came from thinking done in the late '80s by our founders. They thought about a crazy sci-fi future when there may actually be trillions of devices in the world that need to be interconnected. How do we have a single piece of data be available to all of those trillions of devices?

Trillions of Information Devices

Obviously, these are all devices that exist right now. We have computers embedded in almost everything: in our refrigerators, in our cars, on wrist computers. They’re used in the military, but coming to a child near you soon. We worked with one of our clients on a system to embed a bit of computing and storage into every building system they sell, so there is the concept of pervasive networking throughout buildings in ways that we haven’t even thought of how to take advantage of. And then, of course, there is the computer. In the work that many of you do, obviously the computer is a big focus point in terms of how people enter data into a computing device that we all link up to through the Web.

What I would like to pose to you is that in the future, computers as we know them are going to change, just as in the early part of the 1900s the concept of a motor or an engine changed. It was a very specialized concept that was in people’s homes. You had big conveyer belts that ran off the one motor that everyone had in the home and it ran your lights, your fans, and so on. Now they’re completely ubiquitous. Computing is going to be as well.

So the question isn’t how you build a better Web forum for people to enter data, but how can you actually push your organization, your mission, out to devices that people are using and are going to be using in the next five to ten years?

As a result, the big problem that we’ve been focusing on is informa-
tion liquidity. Do existing information systems support trillions of disparate devices that are all in different formats and standards and all the rest? The question is, how do you get the data to where it is needed?

We also have a mission focus with our research, which leads to the question, how do you make sure that public data is always available at all times? If the government server goes down or if, god forbid, the EPA decides to change some of its data midyear as they’ve been known to do, how do you know what they’ve done? How do you get transparency of that information? We’re talking about unambiguously public data.

Before you can think about actually doing all of this, we like to look back at history. We are big, big fans of history and looking at how technologies and other types of institution patterns have happened in the past.

**Public Libraries: The Original Information Commons**

It turns out that public libraries are one of the best models for efficient data distribution or information distribution in a physical form. Let’s explore this a little bit, and let’s look at a very popular book from the Harry Potter series, *Harry Potter and the Philosopher’s Stone*, which was released in 1997.

When any book is released into publication, libraries start to massively replicate copies of books. What happens is that they maintain the intellectual property of the publisher and the author, they maintain all of the information that you want to know about who published it and when and who the author is, and you get a complete copy of this intellectual property scattered across millions of libraries across the planet. At least I think there are millions, though maybe I should check that number. Let’s just say “lots.”

An interesting question arises when you go to a library that doesn’t have the book that you want. This is where a very specialized function starts to kick in that the public library system in the United States and also around the world is very good at. In the United States you have
something called the Inter-Library Loan System, so when you go to a specific venue and it doesn’t have the information you were asking for or the book that you want, you are guaranteed that within a fixed period of time—a couple of days, maybe a week—that book will be sent to that venue by one of the other libraries out there. The intellectual property basically gets passed around and flows to where it is needed. I don’t know if you realize this, but when an Inter-Library Loan happens, if it’s not a rare book, frequently the library will then order a copy of the book that was just asked for. So it’s a sort of demand model that happens in public libraries in the public sector that is very interesting.

This guarantees that there is always a copy of the intellectual property wherever it is needed. I was looking into the history of things like book burning, when you want to destroy things. I mentioned the EPA earlier. The EPA changes data—there are documents with proof of this—because of pressure from corporations that don’t believe that the problems reported exist. Sometimes it’s a legitimate problem, sometimes it’s not, but the issue is that the record is destroyed, and if the EPA pulls it down off of its Web server, not many people are replicating that data sufficiently right now to have a true copy of what it was at a fixed point in time.

In terms of book burnings, this incident in New Mexico was religious fanatics who have a problem with Harry Potter for whatever reason. This took place in 2001, so this isn’t something that only happened in the past. The attack on intellectual property in the public domain side of things is very real, it happens all the time, but through replication the library system is able to basically withstand that. You can’t burn all of the copies of Harry Potter. You can’t destroy the concept of this book or any other that is stored within the system.

Applying this Model to the Digital Age

The Goal

The question is, how can this model be applied to the digital age? Right now, all of you who have Web sites and are storing your data in centralized systems and enterprise systems and all the rest, even though you are backing it up, are basically building massive silos of data. You are basically taking all of the important knowledge and putting it into one library without replicating it anywhere else. What is happening is that if you have a crash, if lightning strikes, if somebody malicious gets in, your data is lost, it’s gone. That is a very big problem in the digital age and it is something that I worry about a
lot in terms of scientific knowledge and the dissemination of it in this world that we live in.

Our goal as a research lab is to unite all of society’s public data and information into one open (and that is important), massively distributed database to ensure its availability to all. What we are proposing is really an information architecture. We call it a database because that is a language that you all understand, but what we’re trying to promote here is a concept of how data can be shared and distributed and replicated across many, many trillions of machines and devices, similar to the way that the Web is an architecture for how information can be passed back and forth.

The Need for an Information Commons

Our model for this literally mimics the public library system almost to the T. We have many, many venues—it could be a cell phone, it could be a laptop, it could be a drone flying around in the air, it could be your refrigerator or the light bulb. Basically anywhere that there is storage, a bit of computing and networking can be the equivalent of a public library and serve that same function in society, to help replicate and spread information around as much as possible.

There are lots of other things that start to happen when you have one big database that everybody actually starts sharing. At this point, many of you may be scratching your heads, confused. Or you may be thinking, we already have the Web, we already have the Internet, what’s the problem? Why are you trying to solve something that isn’t really a problem right now?

To explain, I’ll offer a very quick review of the current state of the art in terms of how we retrieve information. We do a lot of work with communities and the example I’m about to give you is one in which we started looking at the proximity of schools to toxic facilities in communities. Fourteen states have laws saying you can’t build a new public school within half-a-mile of the toxic site in the community.

Well, if you’re a parent and you want to know where the toxic sites in your community are, you’ve got some problems. If you’re a data expert, a GIS weenie, you can try to do it using a limited number of datasets. You can go through the Web and download the Toxic Release Inventory, you can go and download the RCRIS database which gives you all the mom-and-pop storage of toxics in the community, like drycleaners and gas stations and things like that. Then you have to go to the National Center for Educational Statistics, which is a federal center where all of the data for No Child Left Behind gets sent.
The problem is when you start collecting this data and you say, “Wow, we’re starting to locate schools right next to toxic release facilities,” and historically we have, “what are the other impacts of these toxic facilities in the community?”

Then you start looking at property and the census and demographic type information, such as whether crime increases and all the rest, and you have a very big problem, even if you are a data expert. You end up building multimillion dollar Oracle-data-warehouse-type things that are not scalable across many, many different domains.

The issue that we thought about in all of this is, is there a different way? I have a limited amount of time for this presentation and I’m skipping over a lot of the deep technology architecture, so you’ll just have to believe me that this works. What we’ve done is to take all of this data. We have thousands of data sets that we have collected from federal, state and municipal government entities as well as from organizations and individuals. We are starting to gather and transform that data into what we call a universal format. Let’s not go there in detail, but it is a very simple data transformation that can take place from any type of data source, any data format, and transform it in a way that allows it to be replicated within this information commons.
Then what happens is that when you build applications, rather than going to the source dataset and trying to figure out how to download and fix the data because the latitude and longitudes are wrong, or whatever it is, what we do is allow many standards. The arrows on the left above represent user interfaces that are built through standards that exist today—Web standards, GIS standards, ESRI, and lots of other types.

There are also ones that we haven’t thought about yet or that are starting to emerge. For anyone who believes that XML, SOAP, and existing methodologies for how we transfer data are going to exist five to ten years from now, and is thinking that we’re far too evolved in this technology information infrastructure, consider that KML emerged onto the market and exploded out onto the market in less than two years. What if you asked people in the GIS community ten years ago what standard people would be using today? Today the USGS, the EPA and lots of other federal agencies are now starting to publish their data into KML instead of ESRI format because it’s just easier.

That’s going to evolve over time, so how do you as organizations figure out what to do and how to keep up with this? This is where information liquidity saves the day, as we have data transformations now that translate any data in the Information Commons into many, many different flavors of portable data formats like XML. The neat thing is that as we find out about new ones, a new standards release or whatever, it usually takes a coder a day or two to
grab that and transform the data into that format.

What is also neat is that because this is in a commons these arrows actually reverse, so basically you can start having data flow back in from sources that it’s going out to. It isn’t just a one-way flow of information. For example, if somebody builds a piece of software that allows you to transform data into some new standard that hasn’t been developed yet, that software itself can actually be put into the commons and redistributed out and used by others. So not only can data be reused, but software and applications can be as well.

The Benefits

Through research partnerships that we have started to establish with other organizations, we’ve been finding that there are benefits to organizations in terms of using this type of architecture, and in terms of thinking about their data as a fluid resource and the organization as a fluid resource that can flow out onto many, many different computing devices.

Probably the first and foremost among them is the reuse of data. We did a project with the Heinz Endowments in Pittsburgh looking at environmental toxins and how people come into contact with them. One of the big problems that they came to us with was that in 2004, many different organizations came to them for funding to go out and hire GIS consultants to download the Toxic Release Inventory so that they could do an analysis for toxins in watersheds.

The interesting thing is that of that funding, which happened many different times, we calculated that sixty percent of the work was duplicated. By having a common shared resource of unambiguously public data like the Toxic Release Inventory, where somebody else has already done the work, you should be able to reduce duplication.

By the way [referring back to the diagram, top of page 7] you can do things like attach what we normally think of as metadata to the data on the way in so you know who put it in. They digitally sign it and when they put the data in, they include what the source of it was and so forth, and if you choose to trust those sources of the data, you can then basically filter. You could see that three different organizations have imported a Toxic Release Inventory for whatever reason, and you could choose which one or which groups of them you want to trust and filter into the system that you built. If you trust other institutions with some of that data and you reuse that data, you can have an exponential savings of time,
cost, and effort in integrating your effort with other domains.

We are also finding it is not just about the data. It’s the reuse of the data and the reuse of the code, and we are seeing this happen across applications, across projects, and across organizations now over time. You should all be very happy that two years ago the University of Pittsburgh took the entire bicennial census for 2000, 1990, and 1980, and imported all of it into the commons down to the census block group level for the entire United States. We have many different projects right now that are incorporating that data into their projects at almost no incremental cost because it was just there in a format that they knew. They could put it on their Google Earth site or their Web site or their custom application, or they could import it into ESRI if they wanted to. So data reuse is really big.

Then there is another benefit, and this is a controversial one for a lot of people. There are opportunities for data fusion. For example the Cornell Lab of Ornithology may collect the bird count data that they have and want to organize it into counties and identify how many birds per county were found. We have lots of data about counties that we have collected from other places. We have census data about counties, we know all the schools in the counties, and we know all the nonprofit or tax-exempt organizations by county. The whole point is that we could actually cross-correlate populations of the American Robin to religious organizations in a given community. Hopefully every scientist in the room is protesting, “Oh my god, you can’t do that, that’s not why we collected the data.”

The interesting point is that you could try to see if there are correlations between that data in places where you never could before. This actually led to something that was very interesting. We did work with the highly endangered Florida panther and collar readings from the panthers, and made wonderful visualization tools with the very precise locations of them. This is where you start stumbling into the social mistakes that start happening around data: Just because we’re geeks and we can, we think we should, right? That is why I now frequently talk about “unambiguously public data” as opposed to highly confidential information. If you’re talking about the last eight Florida panthers on the planet, you don’t want to be providing the exact GPS collar readings of where they might be found.

What we did at the time was to correlate that data to breast cancer mortality data. This was me just showing off random data sets seen together. We were doing this at a center for oncology and one of the doctors said, “That’s preposterous! You should not be doing that!” It wasn’t because of the endangered species issue, it was because it was bad use of data and cross-correlation.

The doctor standing right next to him said, “Well, do we know that
there is no cross-correlation?” Obviously you can do cross-correlations all over the place, but you have to be very careful about how you do it and we have a lot of experience with that.

This allows for collaboration across domains and organizations, as I’ve said, and I’ve already pointed out the replication issues. The most important issue here is the incremental growth of your system. This is the thing at which we all fail. We set our rockets up for the moon shot and we get millions of dollars of funding from NSF and the foundation community and all the rest, and something happens and we forgot the attribute that we needed to add into our application and usually we have to redo the entire thing. It’s a very expensive process. Moon shots are a bad idea because frequently the geeks get it wrong (sorry, but we do), and also frequently the people collecting the data get it wrong as well. You want to be able to adapt over time the types of information you’re collecting and the other types of correlation you want to be able to make with the data. Our system, in the way that it deals with ontologies and things like that, allows for that to happen almost to a fault. A lot of people find it hard to get their heads around the fact that they can do that.

Lessons Learned

I try to stay away from using lots of language that geeks tend to use, but one of the lessons we’ve learned along the way in terms of how to get information to start flowing and become liquid is to separate identity of the data object, the thing you’re trying to describe in your data structure, from semantic meaning. For example, the big thing in science right now is the Semantic Web, and in the Semantic Web world, they tend to identify individual data objects by the location of the server it’s on and the location on the server that it’s on. And trust me, I’ve had very animated discussions with people in the Semantic Web world about this and they claim it’s not true, but in practice, that’s how it happens. The problem with that is, what if that server goes down? In a distributed world, going back to the public library system, you don’t care where the library comes from, you just want to make sure you get your data.

We very much believe that semantically meaningful identifiers, like names for example, are very bad. For example, if you go to Wikipedia, lots of the concept names and place names are in English. Well, lots of the world doesn’t speak English or express themselves in that way and there is a very hard effort to try and cross-correlate between multiple translations of a word and the concept that it refers to in Wikipedia. In fact, the only solution they’ve come up with is to create separate

<table>
<thead>
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<th>Lessons Learned Along the Way to Liquidity</th>
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<tr>
<td>• Separate identity from semantics</td>
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<td>• Peer to peer distribution</td>
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<td>• open architecture</td>
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<tr>
<td>• one database across every device</td>
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<tr>
<td>• Metadata IS data</td>
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<tr>
<td>• One data object can belong to many ontologies</td>
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<td>• Allow arbitrary incrementalism</td>
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duplicate listings for every translation of the same concept.

Peer-to-peer distribution is very important. This is an open architecture. MAYA built this, we came up with the architecture for this, we published the architecture so that other people can build their own versions of the database application that runs it, similar to the way there are many different types of Web servers (Apache, Microsoft IIS, etc.). It is already at the point where there is no centralized control of this commons. There are enough organizations that we partner with right now, and enough data flowing around and replication of that, that I actually believe that it couldn’t be shut down. It’s an interesting concept—it’s completely out of our control at this point, which is great.

The real key concept of it though is that there is one database in the world. And this is the future, whether it is this architecture or another, and it has to be distributed. It can’t just be Google or Yahoo or any one company that does this for us, it has to be openly distributed everywhere.

Another thing that we’ve learned is that metadata itself is data. We don’t separate metadata from the data, it is part of it. You can take any individual piece of data out of this information commons cloud that I was showing you, and you can know everything about it. That is very important because you need to be able to mix and match data across multiple data sets and know the impact of that.

The next lesson is one that the ontology people like: One data object can belong to many ontologies. You don’t have to design the uber, be-all-end-all ontology. You can build incrementally and craft the data incrementally across ontologies. That means classification systems of geography, for example, or species, or whatever. When you are talking about the American Robin for example, if some child or group of children decide to call it the “orange rusted bird” and that is the way that they classify it, that’s okay. Somebody can make a mapping of that, publish that mapping back into the information commons, and you can start ascribing lots of other assertions that people make regarding orange rusted birds or American Robins and have multiple ontologies converge.
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Further Information

We have many papers written about this. I encourage you to read some of the papers that we’ve written and others have written about us and this process. Almost all of them are at the Web address at right, and a lot of the work that we’ve done has been peer reviewed, so feel free to dig in and ask a lot of questions if you want to.
from citizen science to policy and planning: examples from the united kingdom

Stephen Baillie
Director of Populations Research
British Trust for Ornithology
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that this document did not originate as a formal paper. Rather, it combines an oral presentation with accompanying PowerPoint slides and reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

Documentation of the conference is meant to serve as a resource for those who attended and for others in the field. It does not necessarily reflect the views of the Cornell Lab of Ornithology or individual symposium participants.

The following is the opening talk of the session titled "Impacts of Citizen Science" on day two of the Citizen Science Toolkit Conference.

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org

This documentation is supported by the National Science Foundation under Grant ESI-0610363.

Any opinions, findings, and conclusions or recommendations expressed in this documentation are those of the authors and do not necessarily reflect the views of the National Science Foundation.
Introduction

Thank you for inviting me to this workshop. It is a privilege to be here and I have enjoyed very much talking to all of you about your citizen science projects and learning lots of new ideas about how we can develop better volunteer surveys.

What I want to talk to you about this afternoon is a couple of examples of how research and monitoring undertaken by the British Trust for Ornithology (BTO), based very largely on volunteer surveys, has had an important input to conservation and environment policy in the U.K. The first example involves work on the conservation of farmland birds and secondly, a bit more briefly, I’ll say something about our recent work on Avian Influenza.

Farmland Birds

This graph shows the Farmland Bird Indicator for the U.K. This is an indicator that has been adopted by the government and is a simple summary of trends of farmland birds, which is the logarithmic average of the population changes. You can see from this graph that farmland birds declined quite severely in the U.K. from the 1970s through to the mid-1990s. You can also see, if you look in a little
The Breeding Bird Survey

BTO/JNCC/RSPB Breeding Bird Survey (BBS) is the UK’s main survey for monitoring the changing numbers of our widespread breeding bird species. The BBS was launched in 1994 and replaced the Common Bird Census (CBC) after 2000.

BBS is a UK-wide mass-participation volunteer survey. Organized by the BTO and funded by BTO, JNCC and RSPB.

I want to talk first of all about how we generate this index and how it has become important as a measure for government policy on farmland bird recovery. The underlying data gathering scheme for this is the BTO/JNCC/RSPB Breeding Bird Survey, which we started in 1994. It replaced the previous spot mapping survey called the Common Bird Census. I’m not going to go into the details of what we’ve done, but will say that we have been able to calibrate these two surveys. Through some fairly elaborate analyses it is possible for us to produce joint trends going back to the 1960s, based historically on the Common Bird Census and, since the 1990s, on the Breeding Bird Survey.

The Breeding Bird Survey now encompasses about three thousand sites as you can see from this map. It uses a line-transect method.

Virtually all of these surveys are undertaken by volunteers. In a few years we’ve supplemented their efforts by a very small amount of professional fieldwork, but essentially it is a volunteer-based survey and it is rigorously designed. It was developed to improve our survey coverage and to remove some

- The BBS uses a line-transect method of sampling bird numbers.
- BBS observers count all the bird species they see and hear along a 2km transect route, within a randomly selected 1-km grid square.
- Quick and easy methods (5-6 hours of fieldwork per year) enable a large number of sites to be surveyed (2,879 in 2005).
- Squares surveyed in two or more years are included in the production of trends (3,366 squares in 2005).
- Results take account of different coverage intensities across the UK.
shortcomings from the Common Bird Census.

Observers count the birds in a one-kilometer square by walking a two-kilometer transect route. The methodology is quick to apply, and observers need to make just two visits to their square each year, or perhaps three if they choose to do their habitat recording separately. Squares included in two or more years can be used for the trends index. One important thing to point out here is that we have a formal, stratified sampling design, and it is stratified by potential observer density. This means that we can use all of the observers that we can find in southern England, but we can still get representative trends from the whole country by appropriately weighting the analyses.

This is an example of the type of trend for a single species.

We use generalized additive models to calculate the smoothed trends. By doing this we are taking out short-term variations, for example due to short-term fluctuations in the weather, and arrive at a summary of the long-term trend. This particular graph shows a target for the recovery of this particular species, the Corn Bunting, which is one of the bird species that has declined most severely.

As a result of the declines in farmland birds and discussions with conservation organizations, the U.K. government has decided that it is important to achieve recovery of farmland bird populations. They
have agreed on a high-level government target, what is called in our country a Public Service Agreement Target, to reverse the decline in farmland birds by 2020.

I’m now going to talk about the mechanisms for this because if you’re going to have a target, the first thing you’ve got to be able to do is to agree what you’re measuring in terms of recovery. It was decided that what would be used for measuring this was a smoothed version of the Farmland Bird Index. So this is just like the Farmland Bird Index I showed you before, except this generalized additive modeling has been used to produce a smoothed trend, so we don’t get to worry about short-term fluctuations.

What we are looking for is to see that the trend has been reversed and that we have a significant upward trend rather than a significant downward trend. The overlay graph (B) shows the agreed criteria that are used to make this assessment. What we’re looking for is a contin-
ued period of significant increases that will indicate that the target is being met. If you look at the main graph (A) you can see that the situation got worse through to about the mid-1980s, and since then it has been improving. However, we’re still in a situation where the population has been declining. The graph shows that we haven’t yet reached a satisfactory position, but the rate of decline has at least slowed and hopefully we are moving towards an increasing trend in the future.

The monitoring being done by volunteers through a structured, well-designed survey program has been essential both for identifying the problem and for setting a target for population recovery. But this doesn’t help if you don’t know how to get there. The next thing you need is more detailed information about management of the populations and their habitats in order to work out what measures need to be taken to achieve farmland bird recovery.

My colleagues in the BTO’s Terrestrial Ecology Unit have this as a major focus of their work. The solutions are often species-specific or situation-specific. Let me give you a couple of examples to give you a flavor of these sorts of studies and to show the power of a combination of volunteer-based surveys and intensive professional work. We need to understand enough about how birds are using farmland habitats to be able to design effective agri-environment schemes that have some hope of bringing about farmland bird recovery.

In this case we’re looking at birds in stubbles, which are an important food source for birds in the winter. We’re looking at results from a national, one-off survey of winter farmland birds carried out over two or three seasons, involving volunteers surveying over 1,000 one-kilometer squares, combined with a more intensive study to look at the feeding biology of the birds.

The extensive survey provided information on the densities of birds occurring in different field types. On the far left you can see that the first bar, which is by far the tallest bar, is zero density, so most fields don’t have any Skylarks feeding in them in the winter. There is a scattering of a relatively smaller number of fields that do have some birds feeding.
The next graph shows results from the intensive study where professional field workers measured individual seed densities. There is indeed a strong relationship between weed seed density and bird density that helps us to explain the pattern of variability in farmland bird abundance between fields. Further work also showed that variation in weed seed density, in turn, is determined largely by the amount of herbicide applied to each field. So we’ve got quite a good understanding of how the winter food for these birds is being determined by particular agricultural management practices, and can then start to think about how to design agri-environment schemes involving combinations of practices that will reverse that situation and increase the winter food supply for these birds.

Another question we need to look at is whether management in the winter is actually affecting the abundance of breeding birds. This was done by combining information from the Winter Farmland Bird Survey and the Breeding Bird Survey. So we’re now looking at combining two different extensive volunteer-based surveys to get at another part of the jigsaw.
The project team used information from the Winter Farmland Bird Survey on the amount of stubble that people had observed. They recorded habitat data as well as bird data. Then they used the Breeding Bird Survey to measure the changes in breeding populations. They found that where there was no winter stubble, there were declines in Skylarks; where there was a small amount of winter stubble, decline was reduced; and where there was a large amount of winter stubble, the population was almost stable. This is an indication that the winter conditions on the ground are actually affecting the breeding populations, which is where we want to achieve and measure farmland bird recovery. If we can achieve more stubbles, then we could expect an increase in these populations.

In an earlier discussion, the question came up: Are good quality journals accepting citizen science results for publication? These particular results were published in the *Proceedings of the Royal Society*, which is one of the most prestigious scientific journals in the U.K. I think that very much indicates that data from citizen science, from volunteers, can provide high-quality data leading to high-level scientific publication as well as to valuable conservation applications. But to do this it is usually necessary for the study design and analysis to be the responsibility of professional ecologists.

Another input to this whole process has been to identify areas for particular species in which there are concentrations of species where particular agri-environment measures need to be targeted. This is a slightly less rigorous type of information. Here we’re simply looking to collate all of the information on concentrations of birds and use this to inform some detailed planning on agri-environment measures on the ground. This is something called the Farmland Bird Database and we can use BirdTrack, which is our version of eBird, as a key source of informa-
Squares selected were on lowland farmland in England—arable or pastoral dominated. In 2005 almost 1000 squares were surveyed by a team of ca 24 professionals, and almost 1500 by BBS volunteers.

Additional Survey Squares
975 red dots [dark gray]

BBS Squares
1474 green dots [light gray]

In 2005 we undertook the first large-scale bird monitoring of the Entry Level Scheme. For this we used a combination of professionals and volunteers. We don’t actually have enough volunteers to provide all of the coverage we need for this, so we are combining volunteers and professionals, both essentially doing the same survey and generating the same quality of data in order to provide the enhanced coverage that we need to assess ELS. We plan to gather additional pulses of such information in 2008 and 2011, which will allow us to compare how the birds are doing inside and outside the areas covered by ELS and related agri-environment schemes. Hopefully, this will enable us to feed into this project. We’ve got bird watchers going all over the country collecting lists and feeding them into BirdTrack (to fulfill a range of objectives). This is less rigorous information than the Breeding Bird Survey, but we can still make use of it for this particular objective of conservation targeting.

Finally, we need to accurately assess whether large-scale agri-environment schemes are successful in terms of bringing about the farmland bird recovery that we’re looking for. Two years ago the UK Government started a really major scheme (the Entry Level Scheme — ELS) that is expected to involve a high proportion of farmers and will be a key mechanism for reversing the declines of farmland birds in the wider countryside. The example below shows that within Environmentally Sensitive Areas, which were smaller areas with special management prescription, Skylarks did better than outside those areas.
to assess and, as necessary, propose modifications to the recovery plan which is now being put in place.

This subject of farmland birds has been a big area of work for the BTO over quite a number of years. We are working closely with the UK Government’s Department for Environment, Food and Rural Affairs (DEFRA) and with colleagues in the RSPB and in a number of other conservation bodies, including English Nature, the government agency which has now become Natural England, and with other similar organizations in Scotland and Wales. There has been a lot of interest in this topic and we now have quite a good understanding of what is happening. Volunteer surveys have played an enormous part in this. Indeed, without volunteer surveys we wouldn’t have known about the problem and we wouldn’t have been able to do much of the work necessary to develop solutions.

Avian Flu

The second applied problem that has required a lot of attention from my team over the last two years has been the spread of Highly Pathogenic Avian Flu (HPAI). We’ve done two pieces of work using extensive data gathered mainly by volunteers to inform government policy relating to this issue. This is possibly a shorter term problem than the farmland bird issue, but it remains to be seen how things will develop. The concern is to identify influxes of HPAI into the UK (or other European countries), and to assist in the identification of the sources and routes of transmission of any outbreaks that occur. Our contributions are in the bird ecology area, though obviously there are some other important components of such work that require inputs from virologists, epidemiologists and veterinary scientists. Indeed, there are indications that in the one significant case when HPAI reached the UK, it may not have been brought in by wild birds. Nevertheless, it is very important that policy makers should have a proper understanding of the role of wild birds and how their ecology relates to issues of that of HPAI.

In response we have done two things. The first was to identify priority areas for surveillance because it wasn’t possible to check every dead bird in the country for possible HPAI. The government wanted to know how they could target effort towards the areas where the disease is most likely to occur. This was considered to be areas where waterbirds, particularly migratory species, might potentially come into contact with domestic poultry.

Areas requiring priority surveillance were based on the combination of:

1. Abundance of ‘priority’ wild bird species
2. Risk from a domestic poultry perspective

Based on data for 24 waterbird species
What we were able to do was to assess the abundance of priority wild bird species from our databases, use government databases to look at the distribution of poultry, and then combine the two to provide information on overall risk. We worked out maps combining data from various bird monitoring schemes. We were actually looking for up-to-date, qualitative, distributional information here, so we didn’t have to rely on one rigorous scheme. We could pull in data from BirdTrack, from the Wetland Bird Survey, and from a lot of smaller projects that we have, and then we produced a combined map for the twenty-four species of interest.

We then obtained a similar map from data on the distribution of poultry farms.

The two datasets were combined to give an overall risk.

The blue areas [darkest gray] have significant poultry populations (inc high number of free range flocks) and high abundance of priority wild bird species.

Then these two datasets were combined to provide an overall indication of the areas at risk, so the darker areas on the map are the areas of greatest risk. Of course, even that is too detailed for policy implementation, as working at the level of ten-kilometer squares isn’t practical. So what we then did was convert this to a summary based on government regions, which identified key areas where DEFRA made a particular point.

In practice...

These are the priority areas for collection of priority species of wild birds (gulls, waders, ducks, geese or swans).
of having a focus on screening dead birds that were found for HPAI.

The second thing we’ve been doing, which is still very much a work in progress, is to develop a Migration Mapping Tool based on banding data. The large majority of banding in the UK is undertaken by highly trained volunteers. This ensures the safety of the birds and the integrity of the data, and gives rise to another very important and largely volunteer-generated database.

What we’ve been doing is developing a Migration Mapping Tool as a first shot in assessing whether there are likely to be bird movements between a specific outbreak area on the continent and the UK. It could also be used to inform us about likely patterns of spread in the event of a series of outbreaks of HPAI occurring within the UK. We are currently working on a second version of the Migration Mapping Tool which will have wider European application as part of our work with the European Union for Bird Ringing (EURING), of which I am currently chair (www.euring.org).

The Migration Mapping Tool allows someone to enter the latitude and longitude to identify the area of interest, or they can use the Google Maps that I think everyone is now familiar with. This then gives them
They can then drill down further to view information on particular species for a particular area of interest, such as diagrams of distances and directions [A]. We’ve produced these dot maps of recoveries, but then we’ve also done a spatial analysis of these data to describe the kernel density where most birds are occurring [B]. [In original presentation, the middle map in this series offered an animated view of the migration of Teal.] You can see in this animation of Teal, which migrates to northern Russia in summer and then migrates south to western Europe in the Winter. Then we can also produce summary maps of average locations of the population at particular times of the year [C].

Obviously, this sort of information needs to be interpreted carefully for a variety of reasons, but nevertheless this Migration Mapping Tool, coupled with advice from our staff, will help to give decision makers a quick route to finding out what they need to know about when outbreaks occur in particular parts of Europe. And I’m sure you can see this sort of tool might also be very relevant to a range of other issues and problems involving bird movements.

Conclusion

I hope I’ve been able to show you that the types of data that we’ve been able to collect through volunteer networks are extremely relevant to conservation and environmental policy issues. I think it’s possible to do good and rigorous science with these sorts of data. I commend the volunteers in our network, and in your networks as well, for the fact that they are able to collect high-quality data and often follow quite complicated protocols to generate data that are just as good as the data we would get if we sent professional surveyors out into the field. I think there’s a great deal more that we can do with this data to address a range of applied issues, and also to test ecological ideas.

I’d like to end by again thanking the Cornell Lab of Ornithology and the organizers of this workshop for inviting me, and all of my colleagues listed here who have undertaken the work that I’ve been talking about today and provided me with some of the slides that I showed you. And finally, I would like to thank the volunteers, without whom we couldn’t do any of this work.
Citizen Science Toolkit Conference
June 20 - 23, 2007

panel discussion: impacts of citizen science

Moderator:
Kate Haley Goldman
Institute for Learning Innovation

Panelists:
Ken Rosenberg
Cornell Lab of Ornithology

Christy Pattengill-Semmens
Reef Environmental Education Foundation

Georgia Murray
Appalachian Mountain Club

ZoAnn Morten
The Pacific Streamkeepers Federation
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that this document did not originate as formal papers. Rather, it offers participants’ oral presentations and reflects the more informal, idiosyncratic nature of deliveries prepared specifically for this live event.

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The following panel presentations and group discussion were part of a session titled ”Impacts of Citizen Science” on day two of the conference. The session began with a presentation by Stephen Baillie, Director of Populations Research, British Trust for Ornithology titled, ”From Citizen Science to Policy and Planning: Examples from the United Kingdom.” The panel presentations provide a wide spectrum of examples of the impact of citizen science in a range of disciplines, projects, and settings.

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org
Panel Discussion: Impacts of Citizen Science

Cornell Lab of Ornithology

“Something resembling a panel discussion” is the degree of direction those of us up here received, so if you feel the need to chime in with comments or questions, please do. In my role as Director of Conservation Science here, I am thinking more in terms of the way-down-the-road-impact of the kinds of work that we have been talking about throughout this workshop. We obviously have a program we have been developing here at Cornell that has lots of different phases and parts to it and different people involved. We have gotten very good at collecting data. We’ve gotten very good at designing interesting projects that collect data. We’ve gotten very good now at educating people about the aspects of these projects. And we’re even getting pretty good at evaluating whether that stuff is working.

But what about taking it to the next level, the kind of things that Hague Vaughan was challenging us with earlier? We can do great science, and publish it out there in good peer-reviewed literature, but is it having any impact?

I think the really big questions out there that need to be addressed to deal with big conservation issues and big societal issues are probably best addressed by citizen scientists, but that gap...from the outcome of a project to influencing policy and influencing decision-making is, to me, the really big challenge.

So we are here to talk a little about impact, which is different from outcomes and different from products. We have at least a few examples here as part of the so-called “Cornell model” that I will share with you briefly, but I want to emphasize right at the outset that this is really the challenge ahead for all of us and for citizen science. I think the really big questions out there that need to be addressed to deal with big conservation issues and big societal issues are probably best addressed by citizen scientists, but that gap we saw in Hague’s slide from the outcome of a project to influencing policy and influencing decision-making is, to me, the really big challenge.
I’m going to share just a few brief examples. The first is one of our earliest citizen science projects, which I’ve learned a couple of you actually participated in, Project Tanager. That was one of Rick Bonney’s original ideas for how to do an experiment and see if we could really get people to collect rigorous data to answer real questions. Project Tanager was what I might call a high-end citizen science project in that it was a very complicated project with a complicated protocol. We posed a very specific question: How large a forest patch is necessary to sustain a breeding population of common forest birds? We picked Tanagers not because they were declining, but because they were pretty and easy to see and people could go out and see them. That was the experimental aspect of it. We have since then evolved that project, using that approach for some birds that really were in more trouble.

Project Tanager ran for a few years and it actually worked. We got not thousands, but hundreds of people out there collecting data at several thousand sites, which is a very large study of this kind. Not only did we get good data and were able to publish it in Conservation Biology and the Proceedings of the National Academies of Science, a couple of big journals, but we then tried to take it to a next step, turning those results into management guidelines for land owners. We produced this nice little booklet, Improving Habitat for Scarlet Tanagers and other Forest Interior Birds, a Land Manager’s Guide. It translated these esoteric scientific results about bird populations and forest fragmentation into how many acres and what kind of forest patch landowners should actually provide.

In some ways that is our best example, from A to Z, thinking about this question; thinking about the impact we wanted to have and producing this result. But even in that case, so what? We had boxes of these guidelines, then we thought maybe we should call up some state foresters and forestry people and landowners and see if they actually wanted this thing. We sent it to them and we got a lot of positive feedback and a lot of people used it, but it still wasn’t really the perfect model, one in which they came to us and said, “What should we do about our woodlots to protect these birds?”

We did take it to another level because we wanted to see if we could apply this to some birds that really were declining, such as the forest thrushes, and we produced a second set of guidelines for improving habitats for forest thrushes. That was actually funded by the U.S. Forest Service, so here we did have more of a connection to the managers and that is what we were really hoping for.

So these are some examples and we are proud of them, but I think this is the kind of thing we need to do a lot more of. We have one other example, which was a much more focused study of a particular species that we knew was one of the highest priority species for
conservation, and that is the Cerulean Warbler. Here, what we did is similar to what some folks have been talking about in this workshop in terms of Monarchs and worms and so forth. We basically produced an atlas. We knew the range of the Cerulean Warbler, but we didn’t really know exactly where they were found, so we sent the birders out and they told us: There are thirty pairs here, there are sixty pairs there. We are actually able, on a state-by-state basis, to draw little polygons around the most important sites for Cerulean Warblers, characterize their habitats, and then get that information out to the conservation organizations in each state.

And we had success. The biggest population of Cerulean Warblers we discovered was in the state of Tennessee, and the Tennessee Wildlife Resources Agency picked up that document, went out, and used their first year’s money that they got through the state wildlife grants to purchase 50,000 acres of prime Cerulean Warbler habitat. Again, and Stephen Baillie was talking about this, that is the kind of thing where the model of really having an impact in changing policy resulting in land management on the ground all started with volunteer data.

I hate to mention this, but in the United States the state can buy 50,000 acres, but nobody owns the subsurface rights. Now the mountaintop removal mining people are going in there to try to clear out that 50,000 acres, so there is yet another challenge and maybe another study we need to do.

So there are a few examples but again, as I see it, this is the big challenge of thinking this through and maybe thinking it backwards as a few people are saying: What do we really need to know out there to change policy; not just change people’s minds but actually change the way land is managed, at least in the U.S.? In the U.K. half the population is bird watchers, they have one great organization and the government listens to them. We don’t have that luxury here so the challenge is magnified. That is how I am thinking about the impact of citizen science at this point.
The Reef Environmental Education Foundation (REEF) is a marine fish monitoring program that is similar to the bird watching scheme in a lot of ways except that, unlike the Cornell model that started with one program and has spun off all of these really neat, varying levels of different projects, REEF really runs one basic citizen science program called the Volunteer Fish Monitoring Program. It was developed in the early 1990s with input from fisheries, biologists, and some scientists from the University of Miami and the Nature Conservancy. The basic idea is that we don’t know a lot about fish distribution patterns. There is no atlas for fish distributions in the Caribbean.

The founders of REEF were Paul Humann and Ned Deloach, marine life photographers and authors, and if you've ever spent any time in the water with a face mask you've probably used one of their guidebooks. They were doing one of their earliest guidebooks and wanted to put something under distribution and range and population size. For almost every species it was “western Atlantic,” or “western Atlantic, not known from Florida.” They were really surprised that there was so little information, so the idea was, if bird watchers can do it for birds, we have thousands of people in the water every day all around the world, let’s tap into them.

The reason you become a diver is not to lug a twenty-five-pound tank on your back, it’s because you want to find out what’s underneath the water—you saw something that you were intrigued by in the ocean, or you saw it on TV, or you stood by the shore and saw it. So there was a desire on the part of the diving community and the snorkeling community, but there was also this great need for just very basic distributional data.

That was the beginning of the idea. They turned to some colleagues in the Nature Conservancy and asked them to help design the program and it grew from there. In 1993 the first data was collected. They didn’t go beyond that. They weren’t thinking, we want this data to be used for X, Y and Z, or that in fourteen years they were going to have 106,000 surveys in their database. They never would have thought that, and that is where we are today, fourteen years later.

We get about 2,000 surveys in a month. There is one method and it is a standard throughout North and Central America. In terms of impact, I think the founders were going to be really pleased if we learned something about fish distributions, which we have. REEF now, hands down, has the most extensive database on marine fish populations in the western Atlantic, and it is quickly growing in our other regions as well.

The value of citizen science, and this has been brought up repeatedly by others, is the potential for wide geographic and temporal data.
That is what we have really strived to do, being able to collect data from probably 5,000 sites throughout the Caribbean. We don’t have any prescribed time or place that folks go. It is every time they go in the water, whether it is on vacation or they live on the shore and go in every day, they’ll do a survey.

So for us, in terms of impact, I feel we have reached our goal and people are starting to use the data. Certainly the guidebooks and the third generation of the Reef Fish Identification book is much more accurate today regarding where fish are found. We have also had some pretty exciting applications of the data that have come over time. In our experience, there are some things that we set out to do, but a lot of applications tend to emerge over time. We had this faith that if we started out with this solid program that was well designed with a good data management structure (and if we hadn’t figured that out early, we would have been buried when we started getting 2,000 surveys a month), uses and applications of the data would come with time beyond what we could have ever imagined.

I have a couple of examples of that. About seven years into the program, the goliath grouper, a large fish formerly known as the jewfish, had been heavily depleted throughout its range in the Caribbean, and in 1990 it was closed to all fishing in Florida. The fishery was closed in hopes of having it not collapse. The goliath grouper population responded and that management action has served them well. We started seeing goliath grouper on a lot of dives and people started hearing that the goliath grouper was coming back. Somewhere between 1997 and ‘99, when we were about seven years into our project, there was a big push to reopen the fishery.

If you’re familiar with how fisheries management is done, they primarily use fisheries data to tell them what is happening with the fishery. In this case there was no data because the fishery had been closed since 1990. All of a sudden they realized, wait a second, there’s that REEF project down in Key Largo, they might have some data. Sure enough, we had what was really the only extensive information on goliath grouper distribution patterns since 1993 throughout Florida from thousands of sites. Our data all of a sudden became a very critical piece of information for them to use in a fisheries management decision that, in fact, while they are rebounding, it is not time to reopen the fishery. That was a great success for us.

Since then REEF data have been used in several other fisheries management plans as the key fishery independent data source. People are starting to understand that it is important to look at both the traditional fisheries-dependent data as well as fisheries-independent data. Actually, goliath grouper have come up again. We just got an e-mail asking for an updated dataset for goliath grouper. So that has been an exciting actual impact that our program has had.

The value of citizen science, and this has been brought up repeatedly by others, is the potential for wide geographic and temporal data collection. That is what we have really strived to do, being able to collect data from probably 5,000 sites throughout the Caribbean.

Have you seen any intruders?
Another example involves nonnative species and new species discoveries. This is something that I don’t think folks thought would be of value from REEF, but because we are training divers you get this core group of fanatics who are so good. It’s similar to the kind of person who can walk through the forest and name all of the birds—they are that kind of person, really good. All of a sudden we had this core group of people diving all over the place and they started saying, “That angelfish does not belong in this ocean.” The casual observer would have just thought it was a little more colorful reef fish, but we realized that we were coming up with nonnative reef fish along Broward and Palm Beach counties—basically the Ft. Lauderdale-Miami stretch of coastline.

Sending surveyors out to this area, we found approximately twenty different species of Indo-Pacific and Red Sea native reef fish. We then took the data that we were collecting and had some folks at the University of Washington analyze this. The traditional thought of how nonnative species get in is ballast water, but we all knew that these species weren’t coming from ballast water. They were coming from mostly well-meaning people releasing their pet fish because it got too big or too aggressive or whatever. They think, it’s a coral reef and these are coral reef fish, so it’s okay.

Through analysis and looking at ballast water exchange and where the last ports of call were and the Marine Life Trade data for the state of Florida, we managed to match this up and basically prove that it is coming from the aquarium trade. We started to look back, working with the state of Florida, and realized that it was actually illegal for pet fish owners to return their fish to pet stores and get credit for them. They could return them for free, but they couldn’t get credit because of this weird thing where they’d be engaging in trade of nonnative species. That was another really exciting thing because it kind of caused this cascade effect. The state set up amnesty days for people to bring back their fish, which they would get praised for doing. They had to write that legislation and that was all really the start of them realizing they had this hot spot along the south Florida coast and that people were doing that.

I have two more quick examples. One is zone monitoring. Marine zones have become a big topic: marine protected areas, zoning areas for different levels of use. We have a close relationship with the National Marine Sanctuary Program. There are thirteen national sanctuaries throughout the U.S., and the Florida Keys is one of them and that is where we started. Our program started in 1993 and in 1997 they implemented a series of zones throughout the Florida Keys National Marine Sanctuary. While they did have other more detailed, targeted science projects, they looked to REEF to fill a very important role in their long-term monitoring.

They provide us a contract and we have worked out this design that...
involves going into zoned no-take areas as well as reference areas that they’ve helped us pick out. We go out every year with our advanced assessment teams, our higher level surveyors, and collect data and report back. We’ve since done that type of model in some other sanctuaries along the West Coast, Gray’s Reef in Georgia, and Flower Garden Banks in the Gulf of Mexico. There aren’t really results I can point to from that, but they are using that in their overall analysis of marine zoning.

The last one, which is kind of interesting, is that our data turned out to be a very good source of non-extractive use patterns. People pay a lot of money to do socio-economic analyses to identify where people like to spend time, and in this case how they spend time in and use the ocean in particular. This has come up in California with its Marine Life Protection Act and zoning. They wanted to know where people spend time during non-extractive uses. Where are the places that divers, boaters and other non-extractive users care about seeing preserved in terms of this zoning? The REEF data is number one. It shows them where people go diving. There are almost seven thousand REEF surveys that have been done in California now, so they can look and see where the highest levels of surveyor use are, and that is kind of a proxy for use by all divers. That has been a new development. They’re not even using the biology data, they’re just looking at where people are going and how long they’re going.

Appalachian Mountain Club’s Mountain Watch

The Appalachian Mountain Club (AMC) is a recreational organization, but we are much more than that. We do a lot of education and conservation, and that conservation work includes both science and policy work. The research and monitoring programs that I and others at AMC are involved in are inherently related to resource protection and consequently resource management because what we are focused on is the impact to hikers and the impact to resources that hikers use: mountains, trails, rivers.

My research focuses on the air quality piece: ozone, fine particle pollution, the types of pollution that impact hikers in the environment. We work cooperatively with state and federal agencies in that work and also in the alpine plant community work that we do, so we have those relationships in place.

Our citizen science program, Mountain Watch, grew out of this monitoring work we do in our research department. It involved reaching out to our education staff and many other staff within the AMC to put together a cross-agency program that includes citizen science. It has always had an intended focus on impacting policy and resource management. I say “intended” because I feel we are still in

Georgia Murray, Staff Scientist, AMC’s Mountain Watch, Appalachian Mountain Club

www.outdoors.org/conservation/mountainwatch
our infancy compared to some of the programs at this workshop. We started this program in 2003, but we had what Sam Droege referred to as the 80% failure problem in the course of trying a few different things. We think we have finally shaken out a lot of bugs and are getting on a great path towards success, but can’t yet point to impact in terms of measuring results in the way that some other projects here have described. This is great information for me to take back and hopefully improve where we go from here in measuring impact and working on impact.

I do have some examples of steps we are taking in the direction of impact. For example, climate change and alpine plant communities were identified in the White Mountain National Forest plan by the U.S. Forest Service. They put out their plan just a few years ago and those were key issues and identified as key areas of focus for monitoring. And of course, those pieces relate to our alpine plant phenology program in Mountain Watch.

We want to bring these unengaged hikers along this continuum to become resource stewards and conservation advocates.

The areas where I see the program looking to in terms of assessing the impact of Mountain Watch includes trying to convert our volunteers, and this is really related to our mission as well. We want to bring these unengaged hikers along this continuum to become resource stewards and conservation advocates. Again, we do a lot of policy work. We have a conservation action network which is basically an e-mail alert system that has over 20,000 members to date. We are working to have the citizen science program help us with that effort. Hopefully, the type of involvement the citizen science program offers will bring them that much further into wanting to protect the natural areas in which they are engaged. That is one of the ways we would like to measure the impact of our program.

Of course, the other way of looking at impact would be to look at the impact on influencing policy and resource management. We have made some small incremental steps in that direction. For example, there is the photo monitoring that we have under the Visibility Volunteer piece of Mountain Watch. I took those photos and linked them with nearby EPA fine particle data and other information and presented that and additional AMC comments to the EPA on the recent Fine Particle National Ambient Air Quality Standard comment period that they have every five years or so.
So we are moving in that direction, bringing in the citizen science information and moving it into some of the things that we are already doing in policy. Again, I feel that we are just beginning to look at this and figure out: How do we have impact? How do we measure impact? And how do we move the program towards having more impact? I look forward to discussing this with others and I feel this conference is going to help us move in that direction.

The Pacific Streamkeepers Federation

I am a product of government program decision-making. Because of a government amendment, and actually the government of the United States with the Adopt a Stream program, I am where I am today. And I will reveal to all that I am not a scientist. I am a citizen of British Columbia and in 1988 my son was going to a community school and the school was going to take on a program called Salmon in a Classroom. They were going to bring salmon into the classroom and the children were going to enjoy them. Under the banner of “nonworking mother” I was asked if I would just give a hand, fifteen minutes a week. I said, “Sure.” So I started taking water quality and water temperature measurements for fifteen minutes a week, and that was in 1988.

Then it changed a little bit and got deeper into assessment and you got to touch fish and open them up and do eggs and play god, that sort of thing. After we were doing all of these enhancement things and bringing fish back into the streams, or thinking that we were, we started watching and thinking we weren’t getting back quite as many fish as we thought we were going to get back.

So the community started asking Fisheries and Oceans Canada, “Where are our fish? You told us we were going to do X number of fish and X number were going to come back and all of life was going to be good, and it’s not happening.”

So, how can we look and see what is happening with the fish? These fish, especially coho and chinook, need to have freshwater systems. At the same time we were growing quite rapidly in a lot of areas, and the areas that weren’t growing with urban activity were growing with forestry and mining. We have a lot of resources that we’re able to extract and make some really cool things.

We began asking questions: How come we’re not getting fish back? Where do they want to live? What needs do they have that we need to give them a hand with? So the community was asking about these things and Fisheries and Oceans got together with the Ministry of Environment and a few other people and some scientists—geologists, biologists, all of those people—and the community.
They put together a program through a handbook called *The Streamkeepers Program*, and the whole program is based on this handbook. In here are the “hows, whens and whys” of citizen science. We didn’t know it was called that in those days in 1991. In there they put together some standard protocols, things that we could do, and they were written in plain English. The way they determined that is they asked me to come and read this book and see if I could do it. I thought it was because I was really good at all this stuff, but that’s really not why they asked me.

They asked me to review it to make sure others could understand it, especially the math, because if you ever want to have a problem in your data, ask me to do your math for you. I read it and I made some changes in the math sections and wrote down the formula for area and things like that. That was the beginning of what we’ve done.

When we were asked to talk about impacts, the first thing I thought about was the impact on people. Citizen science kind of made me who I am today. I was a mom and a kindergarten teacher, so some of the stuff comes from that, but I am standing here today because of citizen science. Before that I was a bartender and a youth outreach person and I have a whole different line on things now (though in some ways bartending was very similar).

Then there are the people that I get to play with, and I get to meet the most phenomenal, incredible people because through citizen science and going out wandering the streams, the awe and wonder that they discover while they’re out there just opens their eyes as to what’s going on. I went out for a quick walk before coming into this session, and nature was going on outside while we were in here.

We got people to start looking at life just a little bit differently and in lots of different ways. We’ve got Doug in north Vancouver. He’s seventy-something years old and through this he’s got a girlfriend who he met on a creek walk. They’ve been going out now for three-and-a-half years, and what an impact that has had! But as well as having this great new girlfriend, he is also, as a result of this program, now taking a computer course. He’s learning to use Flickr, he’s learning how to post his images online, he’s learning how to do a slideshow so he can share what he has. He’s got two or three grandkids now who are teachers in really small rural communities. He put them together with me and said, “Could you give them a hand? They have to do a project.”
I said, “Sure,” and we got things together, sent them off on their way to do these things, and now Streamkeepers is in these small native communities that otherwise wouldn’t have known about it. And it’s because of Doug. And we don’t know what else Doug is doing—Doug is doing all kinds of neat things.

But the community itself doesn’t stop and look at itself and say, “Yep, I’m having an impact, I’m doing good things.” They have a tendency to want to save the world, and it’s huge. What they want to do is huge and so they never get there. They never get to that big win. So we have to take the time and show them what the little wins are.

What I did was have these posters made up. The very top line says, “Making a Difference.” Then I asked community people: What do you do that is making a difference? Why do you come out and volunteer? And then I used their photograph. The reason I did that is because I wanted them to take ownership over this poster and take it to the mall and take it to the garden club and take it and talk about what they do. I can’t be everywhere, so it’s great if they can take it out.

We also included in the poster problems they found when they were out and about. One was all about mapping—you get into the stream and you map and you find out where all of the influences are going to be. So we identified the problems that occur when we are out and about mapping, and then the next step was to identify the solutions that we used to try to solve these problems. And finally, what was the successful result. That is the part that we forget to do. We forget to stop for a moment and celebrate our successful results. And it wasn’t about just what that one person did, it was about what they did as part of a group and a team.

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That is the part that we forget to do. We forget to stop for a moment and celebrate our successful results.

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We now have a series of these and I will admit I’ve become a bit addicted to poster making. It only takes about two hours to put together if you’ve got the photos, and it costs about $40 and there is a service that will mail them to your home or to wherever you’d like them sent. We now have this online, describing how other groups can do that. But it is the individual people out there who are having an impact. They’re making a difference.

There is progress with people, program, and policy, and the other thing I’d like to talk about quickly is progress in terms of programs.
Just recently in British Columbia, we've got a couple of new programs that are under way. One is called Living Rivers. Our provincial government has just given twenty-one million dollars in order to take proactive steps and start looking deeper into some of the problems that we're having. For the provincial government to come up with something called Living Rivers is phenomenal, and it's because of the number of ordinary citizens saying, "Excuse me! Our water! Our water!" And so now they've decided to put some dollars into that.

Then they started looking around at these rivers and the organizations out there and they thought, remember those obese people out there? They actually started a program for that and it's called Act Now. It is to get people off the couch and outside working within the community to get people active. We're supposed to be really fit, outdoor folks in Vancouver, but we have some problems in our next generation. Our provincial government looked at that and looked at citizen science as a way to get people off the couch and plug them in.

The federal government has started a program called the FBI, which is the Fraser Basin Initiative. They are putting money into the Fraser Basin in order, I think, to figure out what is going on in there, but working with community people. I notice that NSF has helped us a lot. It has helped us too, but in our case it stands for "non-sufficient funds." It is because of non-sufficient funds in a lot of ways that government people are now turning to citizens and saying, "What are you doing? What have you got? Can I have some of that?" So there is a lot of opportunity now that maybe wasn't there before.

Then there is the policy end of things. The morning I arrive home after this conference, I'm going to a meeting to talk about wild salmon policy. They've asked me to come as a citizen and said, "Can you give us a hand? We're trying to do conservation needs and we want to know what a habitat indicator is." That's scary that they're asking me. But what they are actually wanting from me is to organize the troops to go out and collect information for them. That is what they are really looking for.

So I know what they want, and I know how they want to get there, but I do know that volunteer information is not free. There is no way that it's free. If you don't have a warm body walking alongside volunteers supporting them, letting them know that what they're doing is good and that it's of value, you can't just wish it into being. You have to be there and you have to take part in their lives and they take part in yours, and let them know that what they are doing is making a difference.

Later on that same day that I arrive home I have a Salmon Foundation board of directors meeting. I belong to the Salmon Foundation and
we are a funding body for volunteer groups across British Columbia. Recently we were given some of that Living Rivers money so we are trying to figure out what to do with it. Giving money away is really hard, it’s not as easy as you might think, but at these meetings I get to sit around the table with businessmen and it’s wonderful. I’ve got all different clothes now besides the jeans that I wear every day. I sit with these business men and through that not only do I get to discuss money and giving it away and all these great things that we’re doing, I get to bring the community to that table. And I get to bring community and what we’re doing as a friendly face, not as a protester, to some of the biggest CEOs in British Columbia. I get to sit at that table, and I get to do that because of government program and policy.

Years ago I was driving down the street on the way home and all I wanted to do was go to bed. Instead, I spotted a roadside storm drain and had to stop because there was a whole bunch of stuff that was happening on the road that just wasn’t very good. I determined that I needed to do something. I had to figure out what was going down that drain. So I did a simple thing. I swept six feet on either side of six drains and one other drain where there was construction going on and things going down the drain, and I put the debris into containers. Two days later I went back and saw that all of the places I had swept up were already covered with debris again.

I still had these packages of debris in the back of my truck and I happened to have a scale in my front yard because I was weighing fish that day, and I put all of this debris onto the scale and it was 221 pounds of debris that was going down there. I just couldn’t believe it.

I took some photos and got some other things together and went to my district council. I told them I couldn’t believe what was happening and they couldn’t believe what was happening. And you know, I never had to tell them why it’s bad for debris to go down the drain. I also forgot to tell them all the scientific reasons why debris is bad and all of that kind of stuff. I just let them know what was going on.

Through that, the council got their staff together and had all of our road control bylaws changed for the good in order to make sure that in times of construction or in times of any roadwork the storm drains must be protected because they are part of our stream systems. So that was one thing that happened that was really good.

I also determined through that experience that we needed to do an education program. If you want to have an impact, make sure that you are able to touch everybody at every time. We allow people to make an impact the day that we meet them. We give them one of these [kits]. They can go home and they can make a difference in their neighborhood that day.
yellow fish next to their drain as a friendly reminder that anything going down that drain goes into the creek system. We allow people to make an impact the day that we meet them. We give them one of these. They can go home and they can make a difference in their neighborhood that day.

Because of that little thing I did with my own district council, and it went well, we put my talk up on our Web site. Through that, some people saw it and now next week I get to go to the UBCM meeting, which is the Union of British Columbia Municipalities. All of the mayors and council members go to these things once a year. And I get to go there and talk about storm drains with all of these people, and about the impacts and the changes that those municipalities can do that will help our stream systems.

The next day I get to go to EPMP, which is the Environment Process Modernization Plant. That deals with federal policy all across Canada. They need to do modernization plans. What they basically need, because they don’t have enough people to do the job, is to figure out how to streamline things. As a result, a lot of our policies are being streamlined and through that, there are a few of us volunteers who are being asked to come in and speak about that because we see things slightly differently than some other people. We’ve been asked to come to the table because we have an understanding of what that might mean if you streamline at that layer. At that level, what happens when you say a two-lane clear span bridge does not cause harmful alteration destruction disruption? We can say, “No, it does. You might allow it to happen but it still causes that problem.”

It is those kinds of reality checks that we are being asked to come in and make comments on as they set policy. That would be a federal policy that affects everything across Canada, so it is a great thing to be able to comment on.

And the next day I’m actually going out with volunteers to plant some trees. We had that big wind throw and had lots of trees fall down, so now there’s a report that we’re going to get some sunshine so we can put some different seedlings under there. That’s going to be absolutely grand, I can’t wait.

So on the citizen science end of things and being able to go out and monitor and collect data, one of the main reasons that we ask people to go out and monitor is just to get them into the creek, just to get them in the watershed and make them fall in love with the area. We can then make policy, but remember that not all of your volunteers are ready to make changes in policy. We only send the ones who are truly ready. There is that adaptation that volunteers go through. Don’t send them until they’re ready and don’t push them too hard.
Group Discussion

Balancing Policy Impact and People Impact

- I just have a quick observation in terms of the spectrum between policy and people, the program, and the education work where it falls in between. As we’re all well aware in the current administration, policies and legislation can be reversed and changed. Audubon has learned that the hard way as many conservation organizations have in the last few years. I think what is represented here is a wonderful balance of the power of going directly for policy and directly for legislative change, but also having the backup of the people who have been convinced with hands-on and face-to-face, who can act not only as ambassadors to the politicians and decision-makers, but as ambassadors to their communities and to model to others what they have fallen in love with. That balance is very well represented in this group.
  - Chuck Remington, Director of Field Support National Audubon Society

- It’s true that as you work on one end of things, then the policy or legislation changes. We had a legislation called the Streamside Protection Regulations and there was a whole bunch of us working on it and we worked really hard and just got it enacted and it was in there and it wasn’t bad. And then we got a new government and the next day it was basically, “That was bad and this is good and we’re changing.” They changed to a whole other policy and they didn’t come to the community at all. Because we had had such a huge response asking for community input, it seemed like a bit of a slap in the face for a while. Then we had to realize, they’ve never come to us before so this is nothing new, the other was something new.

But it didn’t work out the same and a lot of the community is not happy with this new policy. They did put a caveat in there that the community had to “meet or beat,” so the different cities in BC have to meet or beat this policy. That meant that the community could now work on their own council to meet or beat this legislation, and that was nice because a community could still work at the local level. So getting to know your council members and mayors and city planners is hugely important, and getting to know them as friends, spending some time with them. But things can change on a dime.
  - ZoAnn Morten, The Pacific Streamkeepers Federation

Moderator:
Kate Haley Goldman, Senior Research Associate, Institute for Learning Innovation

What Do We Mean by “Impact”?

- I wasn’t sure what would emerge from this panel in terms of impact, but it seems to me there was an awful lot there in forty minutes. It was interesting to me how fast we got to policy and how repeatedly that came up through these presentations, but there were all sorts of other things there about leisure, about conservation, about the individual level, the community level, and the organization level. I think we’re hoping to talk about all of those different ranges of impacts. Before I go on about what I heard, I want to open it up instead to questions and comments.
  - Kate Haley Goldman, Senior Research Associate, Institute for Learning Innovation

Scientists Translating the Jargon

- Working on the Streamside Protection Regulations, scientists helped us with the language because you guys speak a different language and it’s really difficult sometimes to understand what it is. Sometimes when you’re making it so that I can understand what you’re talking about, it actually makes it clearer for a lot of other people to understand. For scientists to help us understand their English was very helpful, and not to go beyond what we actually know about because that’s the hardest part for volunteers.
  - ZoAnn Morten, The Pacific Streamkeepers Federation
Citizen Scientists
Translating the Message
• There is a flip side to what ZoAnn said about scientists translating their language. That’s the tension and synergy that you see here in a meeting on citizen science between the scientists and the nonscientists. The scientists need help in getting these messages delivered because as you said, we don’t talk to our municipal leaders or whatever. So you really need both sides of that and I think that is really what sets citizen science apart. - Ken Rosenberg, Director of Conservation Science, Cornell Lab of Ornithology

Cross-training for Citizens and Scientists
• Just as we train citizens in how to do science methods, I think we could train scientists in how to communicate a little bit better. I agree not everyone is suited for communicating, but I get a little tired of: “Well, we’re scientists, we’re not good at communicating, we shouldn’t do it. Let the environmental educator or whoever go out and do it for us.” I think this whole back and forth is a really good one, and I think citizen science could perhaps help teach scientists how to communicate or include more training for that. - Melissa Pitkin, Education and Outreach Director, Point Reyes Bird Observatory

Citizen Scientists
Translating and Delivering the Message
• I think this was terrific and I enjoyed everybody’s talk, and thank you for not doing PowerPoint and for just talking to us. It was wonderful. I think if I could find a theme at all, it is sort of the struggle to figure out how to deliver the very important message that the citizen scientists have discovered. What I feel, which was confirmed by ZoAnn’s presentation, is that one of the most effective ways to deliver the message is to have the people deliver the message.

In the first talk on the Cornell Lab of Ornithology, they were talking about having these great materials and trying to rethink how to get them out there and how to get them to be effective. I was thinking things like, if the land owners could be involved not just in the study, but also in thinking through what’s going to happen to the study at the end and how it’s going to be used, then they themselves might be able to deliver the message to their members. It just seemed to me that was the theme, maybe because I believe this anyway, but what I heard a lot is that one way to translate science into policy is to find a way to engage the volunteers in the translation and deciding where the message should be sent to, and then getting them to send it there. - Candie Wilderman, Professor, Environmental Sciences; Chair, Environmental Studies Dept., Dickinson College; Founder and Science Director, ALLARM

Bridging the Translation Gap
• I think that is a really important concept. What I do at the park sometimes is almost serve as a bridge between the scientists, the general public, and the educators to translate for each audience. In terms of the toolkit, it would be really helpful if that could serve as a bridge because we’ve found it critical. We don’t let our scientists just go out all alone with the public. They often need a translator. Sometimes not, but often that has been our experience. And working the other way, I often have a harder time explaining what I need to the scientists. It’s almost easier to explain to the educators and they grab it and run with it. But it’s how to define what’s important to them in plain English that’s missing. - Mary Raczko, Partnership Liaison, Boston Harbor Islands National Park

An Extroverted Scientist?
• A friend of mine who is a senior aquatic scientist in BC said that an extroverted scientist is somebody who looks at your shoes when they talk to you. - ZoAnn Morten, The Pacific Streamkeepers Federation
understand without knowing the jargon, but having the scientific knowledge and skills behind it. That’s a very important thing, speaking in a way that people can understand and take it and use it, and I think ZoAnn gave some great examples of that. It was really interesting, the continuum of speakers here. It was fascinating and it really made a full circle and highlighted the importance of hearing all perspectives. - Linda Green, Program Director, URI Watershed Watch, University of Rhode Island Cooperative Extension

Citizens Using Citizen Science Data

• There is one thing that hasn’t really come up. We’ve talked about citizen scientists as opposed to just being data collectors; now we can talk about citizens as advocates instead of just being data collectors. Sometimes we’ve talked about our projects falling short in going that extra step. For example, with eBird people go out and collect data, they don’t become scientists.

But one of the things I don’t think we’ve talked about much, unless it has happened in the breakout groups, is the fact that when the data are publicly available on the Web site, citizens can become scientists using those data. Those are data that are there for the public to use and manipulate. Now sometimes people need help learning how to do that. But I’m sitting here thinking about policy, and in the United States, you could go and say all you want if there’s something in the storm drains and nothing is ever going to change as far as I can tell. They don’t pay any attention as far as I can tell. That’s what I meant a couple of days ago when I said that things are better in Canada. But you can have a bunch of people going through the eBird data and figuring out what it means in their community; if there is a species at risk in that community, looking and seeing what the data show. The scientists aren’t going to do that, there isn’t time for that. I just wanted to point that out because I don’t think it has come out in any of the discussion so far. - Rick Bonney, Director of Program Development and Evaluation, Cornell Lab of Ornithology

• Actually Paul Treadwell and I were working on a flow chart to do just that, which we thought might be the beginnings of something towards building the toolkit. - Donald McCrimmon, VP of Academic Affairs, Nature Network, Cazenovia College

Citizen Science for Whom? Determining Goals and Roles

• From the toolkit point of view, if I’m starting out and using this tool, one of the first things I hope I’m faced with is the question, citizen science for whom? We talked a little bit about this in our breakout group, and in a number of sessions what has come up and

Educating the Public in Scientific Terminology

• I believe that part of the citizen science process itself should involve educating them to a higher level so it’s not just what’s in the trout stream but as part of participating in the project you start to learn some of the terminology. You start to think a little more like a scientist. You start to wrap your conceptions around some of the common terminology so that you’re moving up and you’re learning as you move through that process. To bring people in the door you have to talk to them at their level, but I think we want citizen science to be an educational process and part of that is moving them up and giving them more knowledge so that they can go out and make changes. - Paul Treadwell, Distance Learning Advisor, Cornell Cooperative Extension

• I think the point about simplifying the language was well taken, but I also think we can dumb it down too much. We really need both, so we’re using terms like “oxygen depletion” as well as “bad water” or whatever. - Caroline Lewis, Director of Education, Center for Teaching and Learning, Fairchild Tropical Botanic Garden

• Perhaps “public friendly indicators” aren’t the same as “policy friendly indicators.” - Kate Haley Goldman, Senior Research Associate, Institute for Learning Innovation
been really helpful is Candie Wilderman’s model [see Chapter III, "Models of Community Science: Design Lessons from the Field"] to help us think in terms of: Are these just data collectors or are these real scientists planning and designing the experiment of the project? I think that should be up to them.

For example, in our project at REEF most of them are pretty happy being “just” data collectors. There are not a lot of them who say they want to help the sanctuary plan what their zone monitoring protocol should be. From the beginning I think that whoever is designing the project needs to think of the role that the volunteers themselves want to play and then designing what that project would be, rather than dictating that they have to be data collectors or they have to be involved in higher design. - Leda Cunningham, Executive Director, Reef Environmental Education Foundation

• That’s right, but if you want your project to have a broader impact, you want to get an NSF proposal for example, you come up with another way for allowing people to use those data, the people who want to use those data, and they may not be divers. They may be kids in a high school classroom somewhere who are coming up with a project and using those data to make a management recommendation as an exercise that might actually be used for something. - Rick Bonney, Director of Program Development and Evaluation, Cornell Lab of Ornithology

• I would just like to note that we have done that and we have never had an NSF grant (not that we wouldn’t take one). - Christy Pattengill-Semmens, Director of Science, Reef Environmental Education Foundation

• The most common way that we’re talking about things here is that it is going to be a push out to people, and that’s still the common reference even though it has been mentioned many times here that we want citizen science projects to rise up from the population. We need to break the habit of talking about citizen science projects being pushed out. That is one model, and it is a valid and important model, but we need to break that habit if we genuinely want this to rise from the citizens’ influence. - Paul Treadwell, Distance Learning Advisor, Cornell Cooperative Extension

• But it needs to be that combination because the Streamkeepers program actually came out from citizens saying “We want to,” and government saying, “We’ll give you the tools to do that.” So it came from the community asking for something, but there’s a lot of times that there are questions to be asked and I have no idea what those questions are or that they haven’t been answered. I wouldn’t even know where to start with the question, so that’s up to you guys.
That’s why we need the scientists, to let us know what those questions are and then engage us into wanting and striving to be in awe and wonder of your question and wanting to figure out more about it. So speak in English, tell me something I can work on, and we can work together. But you have to engage us to the point where we are going. “Wow! I can’t wait to do that.” And that is in my spare time, and spare time is a hard thing to find. I have heard so many great things here I keep thinking, I want to do that, I want to do that, but as I tell my volunteers: Figure out your watershed and stay in it.

- ZoAnn Morten, The Pacific Streamkeepers Federation

• It’s not always the citizens looking for the science or those questions. A lot of times they just need the experience and then from the experience of doing it (and I’m sure this has happened for many of you) they come up with some amazing questions on their own. Maybe it takes the experience to get to the point where they feel comfortable in exploring those questions. We’ve talked about that a little in our working group, the idea of casting the net wide and then from those experiences, that is often where the questions come up.

- Timothy Vargo, Research Coordinator, Neighborhood Environmental Education Project, Urban Ecology Center

• What I’m hearing reminded me of what I thought the other day about the model, which is that there is community-driven and scientist-driven, but what we are really talking about is collaborative. That wasn’t part of the model, and that is pretty much what I have been hearing everybody saying in the past few minutes as an optimal approach if you can manage it within the confines of your resources and geographic constraints.

- Janis Dickinson, Director of Citizen Science, Cornell Lab of Ornithology

• Did you say that wasn’t part of the model? The Community-based Participatory Research Model requires the intense mentoring of the community by the service provider, and the service providers are the scientists and they may also be people who are good in advising about programmatic issues, but the service providers are critical to the Community-based Participatory Research Model and it absolutely is a partnership. We cannot have one without the other.

- Candie Wilderman, Professor, Environmental Sciences; Chair, Environmental Studies Dept., Dickinson College; Founder and Science Director, ALLARM

• I guess I interpreted that as advisors rather than equal collaborators, that was my interpretation of the language.

- Janis Dickinson, Director of Citizen Science, Cornell Lab of Ornithology

• I think that’s accurate. I think the idea is that they provide the services that the community asks for and that the community needs.

The Knowledge and Skills of “Ordinary” Citizens

• Someone was talking about dumbing down things for citizens. I work with Bushmen trackers in the Kalahari, and sometimes their perception and understanding of animal behavior are in many ways more sophisticated than Western zoologists. Another example is Sarah Kirn talking about fishermen who, in their own way, have a more sophisticated perception and understanding of certain aspects of the ecosystem that scientists can learn from.

I don’t think citizen scientists need to be apologetic or have the idea that science is up there and they need to learn something. There are many ways and many contexts in which the so-called ordinary people actually have a very good and very subtle understanding of their own environment. I think we need to be careful of that sort of assumption that the scientist knows better.

- Lewis Liebenberg, CyberTracker Conservation
In reality, when the collaboration takes place it is very much a collaboration. And as ZoAnn was saying, they often do look to the service providers and say, “Give us some ideas, some good questions. In our study design, for example, what kinds of questions might be asked because we’re not really sure?” The scientists would then step in and talk about their own interests. - Candie Wilderman, Professor, Environmental Sciences; Chair, Environmental Studies Dept., Dickinson College; Founder and Science Director, ALLARM

• I think what you’re saying is that the language is really important because a “font of knowledge” approach does not see the knowledge of those participants as being as valuable as the knowledge of the scientists. - Janis Dickinson, Director of Citizen Science, Cornell Lab of Ornithology
engaging, enhancing, and expanding community-based monitoring programs

Linda Green
University of Rhode Island Cooperative Extension
USDA-CSREES Volunteer Water Quality National Facilitation Project

Photo: University of New Hampshire Cooperative Extension
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that this document did not originate as a formal paper. Rather, it combines an oral presentation with accompanying PowerPoint slides and reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

Documentation of the conference is meant to serve as a resource for those who attended and for others in the field. It does not necessarily reflect the views of the Cornell Lab of Ornithology or individual symposium participants.

The following is the opening talk of the session titled “Community Building for Citizen Science” on day three of the Citizen Science Toolkit Conference.

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org
Engaging, Enhancing, and Expanding Community-Based Monitoring Programs

About Volunteer Monitoring

Introduction

This morning I would like to chat with you a little bit about community-based monitoring programs. What I have started doing lately is starting my talk at the end, which is kind of fun because I spend a lot of time convincing people why volunteer monitoring is an appropriate thing to do and how to get involved in volunteer monitoring. I’m actually going to use that term as opposed to “citizen science” because I’ve been used to the term “volunteer monitoring.”

We’ve found that there are many reasons why folks get involved in volunteer monitoring and participate in citizen science programs. They raise awareness and educate. We’re involving people in real science, something that we’ve seen such fabulous examples of at this workshop—there are so many watches that I am going to volunteer to be a part of when I get home. Our focus is local involvement, solving our problems locally, involving our citizens.

I will have to apologize and say that I was not too familiar with the term “citizen science” except that I always say that volunteer monitors are citizen scientists. This is the definition I found on the Web when I looked up the information, and I thought it was very interesting. I was thinking about this and I realized that to a certain extent, many of the programs that I’ve heard discussed here really were focusing on the science and the big questions, the very important ecological questions that are being addressed by citizen science programs.

In the world that I have been involved in, we have been more involved with the citizen end of it, the people end of it, the community awareness, and the community-building programs. I actually looked up “citizen,” “science,” “volunteer,” and “monitor” in the dictionary to make
More Definitions

**Volunteer**
- Somebody who works for free
- Somebody who does something by choice
- Somebody acting without legal obligation
- Unpaid helper
- Unpaid assistant
- Helper

**Monitor**
- Check
- Watch
- Observe
- Keep an eye on
- Supervise
- Scrutinize
- Examine
- Somebody ensuring proper conduct
- Check regularly for developments

Who Are These Volunteers?

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<th>Category</th>
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<tr>
<td>College-age</td>
<td>7%</td>
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<tr>
<td>Seniors</td>
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<tr>
<td>Mid-life Adults</td>
<td>40%</td>
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<td>Youth under 18</td>
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Who Becomes Engaged in Volunteer Monitoring?

This is very much based on what we call enlightened self-interest. They do it because they care. They also get involved because there is something going on that concerns them, something that they have a passion for in their own community.

The next couple of slides I have are based on a survey that was done about ten years ago on volunteer monitoring and some inquiries we have done through Cooperative Extension about folks who are involved in volunteer monitoring. We see that most of our volunteers are mid-life folks, senior citizens, people who are often on the boards in local communities, and a lot of the decision-makers in the community. We have a lot of youth involved in volunteer monitoring, mainly through school-based programs, and a good number of college-age students also. So there is a good variety of folks.

Volunteer monitoring has a long history as a program. It really came of age in the 1990s. The first National Volunteer Monitoring Conference, and there have been six of those, was in 1988 in Narragansett, Rhode Island. I had nothing to do with the start of it and as a matter of fact, I found out about it just the day before the
conference started and I was just starting my program. At that point there were not many folks who were identifying themselves as doing volunteer monitoring. Those numbers have increased quite a bit, mostly because people found out about it and the things that were going on, and there was great support from the Environmental Protection Agency.

Our current estimates are that there are somewhere in the vicinity of 800 to 1,200 volunteer monitoring programs going on across the country. This photo here is of about 100 volunteer monitoring coordinators who were gathered at the 2006 National Water Quality Monitoring Conference held in California, and they are about ten percent of the folks who were at this conference.

What Volunteer Monitors are Doing

As might be expected, whatever ecosystems are out there are being monitored by our volunteers. The vast preponderance of programs, about seventy-five percent, monitor rivers and streams. Some of that is because many of these are school-based programs and it is easier to go out onto your local river and stream than to go out to the lake or to the ocean. We see over the years increasing issues of getting students on the water because of liability issues. You can’t get them on the lake, you can’t get them on the ocean, but you can get them to walk down to the stream.

Who Uses the Data and How?

Who uses the data? This is very interesting. We would like to see 100% of volunteer monitoring programs using their own data because we don’t think these programs should necessarily exist to provide data to others, but that is always an admirable goal. We
would like to see volunteers using their own data. We saw great examples of that with what Candie Wilderman does and what some other groups are doing. Governments are strong users of volunteer monitoring data, whether state, local, community organizations, scientists, or federal government. These actual percentages may have changed by now, we’re not sure, but they give you a range of what is going on.

And how is volunteer monitoring data being used?

There is a whole gamut of uses. Education represents a huge use of data. I think in just about anything we do, we can’t avoid educating people, and that is an admirable and very important use. There is baseline monitoring, where we had no information about what was out there before; screening for problems; research; advocacy; organizing; planning; all the way to assessing non-pointsource pollution.

**Successes**

**Introduction**

In the course of studying these programs, we have recognized that there are a number of characteristics for a successful program, and I don’t really think it makes a difference whether it’s butterfly monitoring or water quality monitoring or any kind of a program. You need to have a program that is well-organized. You need to start with the end in mind, which was a fabulous title for one of the earlier conference presentations. It is important that the programs have a sound scientific basis, that our programs report the results, that they have support. Many of our most successful volunteer monitoring programs have multiple areas of support. I think the average is three to four sponsoring organizations so that you are not relying on one source of
support. And finally, it is important that our programs make a difference. That is why we are all here, to make a difference.

This is a great slide. It is from the Alabama Water Watch program, which is about eighteen years old. Bill Deutsch, the organizer of that program, commented that this is a slide they used in their very first presentation and they have used it all along.

We realize that there are two themes as we approach our volunteer monitoring. One is how to best collect useful data. That gets into the design, the credibility, the documentation. The other theme is how to best use the data, the data-to-action. So there is a pendulum. There are a number of kits available that we can use that might have value for education, but don’t necessarily provide usable, meaningful data. On the other hand, you can use some very esoteric measurements that are very expensive. I get some calls asking whether we do pesticide monitoring as part of our program. The answer is no, we can’t afford it, it is too expensive and too difficult. So there is always this pendulum swinging back and forth regarding method, accessibility, and usability.

The reality is, we feel that there is a continuum, depending on what you are going to be doing with your program. You may be starting the continuum with education and awareness. How many of you are familiar with World Water Monitoring Day? That was actually started as a celebration of the twenty-fifth anniversary of the Clean Water Act. At the upper left in the slide below, you can see the $17 kit you can buy to do monitoring as part of World Water Monitoring Day. That day is actually a month, but actually you can do it any time of year. That was sponsored by the Environmental Protection Agency and ASIWPCA, and now Water Environment Federation is a sponsor. So a
lot of classroom groups can go out and do the monitoring and enter the data on a national database and see what other groups have found. You don’t have to use this kit, but it is at one end of the continuum.

In the middle we see a lot of kits being used, LaMotte and other kits, and some of the less expensive meters for programs that focus on identifying problems, assessing impairment and local decisions. At the far extreme are the methods that might be used for programs whose focus is legal and regulatory issues, and there are not as many of them. If you look inside the arrow you can see that as you go across this continuum, to move from a program that is educationally based to the other types really involves more time, more thought, and more rigor in your program, more development of quality assurance procedures, and it is going to be more expensive.

A couple of years ago I was being interviewed by an environmental reporter I’ve become very familiar with over the years from our statewide paper. As we talked about volunteer monitoring I said something about the expenses of the program and he said, “It’s not free?”

I said, “Volunteer monitoring is cost effective, it is not free.”

He said, “I never realized that.”

We have our volunteers contributing their time and their effort and energy, but to coordinate the program costs money. This is a concept that a lot of people have to wrap their minds around, that there are expenses in any good program, as we all well know.

But I think whether your program is focusing on education, on out-
reach, on screening, on regulatory issues, on changing laws, what we really want to remember and stress for all of our programs is credibility. This is one of my favorite quotes by a gal who works with me and ran a River Rescue program for many years. It doesn’t mean having the most exacting techniques, it means delivering on your promises, doing what you say you’re going to do, developing data quality objectives, setting up a study design, and then achieving those things that you have set up for yourself to do.

I want to talk a little about the volunteer monitoring system, which really falls under the “herding cats” category. It is kind of mooshy. There are a number of different groups involved in volunteer monitoring, there are a number of direct service providers, there are some national organizations, statewide organizations, regional organizations, nonprofits, universities, extension services, and counties, and they have various aspects of ways they work with volunteer monitoring programs.

There are also different kinds of monitoring groups. I actually was working on organizing a session at a conference and it suddenly dawned on me that one presenter was talking about a volunteer monitoring program of one person. But that is the exception. There are groups that are groups of individuals, there are groups of groups, there are confederations, there are statewide programs, there are programs that range in size from one to ten, there are Texas-size programs with thousands and thousands of volunteers, so there is a whole gamut. It is kind of another continuum, but they are generally characterized as being very decentralized and very independent of each other.

From the start, the EPA has been a staunch supporter of volunteer monitoring. Not so much now, but they have really led the charge, and they have provided a lot of services to the volunteer monitoring
community, particularly in the early days. And everything now, of course, is online and accessible. They developed very detailed monitoring guides for monitoring lakes, streams, and estuaries, and for developing the Quality Assurance Project Plans that anybody who has an EPA grant has to have. They have developed various national directories of volunteer monitoring programs, and Ellie Ely, who is at this conference, has done a tremendous amount of work on those. The last one was done about ten years ago and that is online on the EPA Office of Water Oceans and Wetlands (OWOW) site, so you can look at that to see who is doing what. They are the financial sponsor for the eighteen-year-old Volunteer Monitoring Newsletter, which has been a fabulous way of disseminating information about volunteer monitoring on a topical basis. They have a Volunteer Monitoring Listserv with about 500 program coordinators on it. They were the major sponsor for our six national conferences, and recently they got involved in Webcasts. I did one last year with them on getting started in volunteer monitoring, and all of their Webcasts are archived, so if you want to listen to me from last October you can do that.

There are volunteer monitoring programs in every state. A number of states have agency-operated or supported programs. They may help with the study design, how you organize your program, identifying the questions you want to address and how you proceed to answer those questions. They may coordinate groups or services. I know several of our states have arranged grant programs for volunteer monitoring programs so that if they want to get chemical analyses done they can be done at reduced rates at the statewide laboratory. They may help with program management. They may have training or train-the-trainer programs, and they offer direct management or guidance of programs. These are examples of just a few of the states that are involved in that.

One state in particular that I would like to mention is New Jersey, which has developed a tiered approach. In a way it took that continuum and developed four tiers for their community-based programs, ranging from education, stewardship, and assessment, to indicators and regulatory response. And for each of those tiers the community groups need to figure out what the intended purpose of their program is, who they are defining as the data users, and what are the uses of the data.

The woman who runs the program, Danielle Donkersloot, is very energetic and she has worked very hard to get her community groups to decide what they want to do and then see what tier they fit in rather than designing their programs to match the tier. In other words, she has worked very hard to see that the groups organize and meet the goals that they themselves have identified. She has a group...
monitoring water quality in a watershed that is 98% impervious. Pretty amazing. And what she has also done, which is very interesting among the state agencies, is that she has gone to the various departments in the New Jersey DEP and told the folks who use water quality monitoring data or other environmental data to determine which tier of data is needed to meet the objectives of their program. And she will say, "And you can’t say it is Tier D unless you can prove it to me that you need the most expensive and highest quality data."

So it has engendered a lot of thinking within that agency in terms of how to involve volunteer monitors in what they’re doing, how to incorporate the data, and what kind of data they really need to make their decisions.

Thrown into this mix are a number of national, regional, and other programs that also work to train-the-trainer and have some wonderful programs for enhancing environmental and community-based monitoring: the Izaak Walton League, River Rescue, the Sea Grant program across the country, the ALLARM program we heard about at this conference, and an unpronounceable acronym, CSREES, the Cooperative State Research, Education, and Extension Service.

I would like to talk a little bit about the Volunteer Water Quality National Facilitation program that I operate with a grant from CSREES. Rick Bonney suggested this might be a model when we think about citizen science. This was developed as a part of a National Facilitation Project grant that we originally got in 2000 after being sure there was no way in the world we would get it, so it is all the more satisfying. We realized there were any number of volunteer monitoring programs in the Extension system that were operating in a very isolated manner. No one knew what the other was really doing, no one knew how to make contact, but we kept seeing this overwhelming interest in and concern about improving all of our programs. Because this was an Extension grant, I had to say that I was doing this for Extension-based programs, but the reality was that we knew everything we were sending out would be applicable to community-based programs no matter what their origin was.

In essence, what we wanted to do was create a one-stop shopping place for support for the volunteer monitoring communities so that everybody else doesn’t have to go through thirty-five Google pages on a topic to figure out how to get going and what to do. So we have developed a Web site as everybody else does, and the Web address is listed below.

We have a listing of all of our Extension affiliated programs. There are...
Creating one-stop shopping for tools, tips, ideas, support for volunteer monitoring community

Guidebook Modules
- Designing your monitoring strategy
- Effective training techniques
- Quality assurance issues
- Databases and data management
- Volunteer management and support
- Outreach tools
- Fund raising

One of the main things we wanted to do was develop our guide for growing volunteer monitoring programs, which is comprised of topical fact sheet learning modules, shown on the Web site under “Guide for Growing Programs.” We distilled the knowledge and information that is out there so that folks didn’t have to reinvent the wheel. The modules are in hard-copy, they are online, and they all have numerous live links. Every six months I have a student go through and check every single link to make sure they are still active. The main topics we have come up with so far include designing your monitoring strategy and identification of effective training techniques, developed by people who are expert at doing this out in the field with their programs. What are some of the data credibility about fifty on it, so that is a small portion of the actual volunteer monitoring world. It was actually really hard to find those programs and I was amazed at how difficult it was, but we have direct links to those and all of the program coordinators. They are all listed under “Extension Volunteer Monitoring Programs.” Because of concerns about and interests in how volunteer results compare to professional results and how volunteer monitoring has been integrated into research projects, we queried folks and asked them to give us examples. We have developed an annotated bibliography here under “Related Research and Educational Efforts,” which includes anything we happen to come upon that relates to those topics. I can see, looking at the Cornell citizen science Web site, that we are going to be adding a lot of Cornell references to that list.
and quality assurance issues, the things you need to think about? A lot of these are things we call “things to think about before getting your feet wet.” The final two topics, outreach and fund raising, are ones that we are still working on.

To get a lot of this information out, we developed a listserv. We have about 400 folks on it right now. Folks will typically post questions and we’ll get answers, and we use this as a way to find out what is out there in terms of knowledge for our programs. One of the things we realized is that there were some delightful discussions going on when someone would ask a question.

I then realized my e-mail box was getting full of all of those requests and I didn’t want to get rid of the replies because they had such useful information. So we developed an archive for the listserv exchanges so that we could really preserve the spontaneity of the exchanges, and we got permission from everybody. We will post the question that was posted on the listserv and we will then post what all of the answers were. I could now clear out my e-mail box and people could link who said what and maybe go back to that and get more information.

They are arranged topically and we have a little fact sheet about it, and we now have over sixty topics in our archive, everything from ammonia monitoring to getting programs started, to liability issues, to long-term programs. So any time that a topic comes up and there have been a couple of responses, either from the EPA listserv or our Extension listserv it’s up there. What is now interesting is that every couple of years we start seeing the same questions come up again, so
it is very much of a cycle as new people come on board and more experienced people move on. We can point them to the exchange that has already happened and add to that exchange with the new information that has come on board.

The question arose, who has online databases for volunteer monitoring programs? We investigated and learned that there are about twenty-two programs that we know of that have online databases, so we set up a section on our Web site with direct links to those twenty-two programs. You can now go right in and see what that program has and how they developed it.

Then we developed a factsheet learning module about planning data management systems, the things to think about before you get involved, the questions to ask, and the way to move forward with that. That has received a very positive response. With almost all of these factsheet modules we have held workshops around the factsheet topic, and every presentation we have ever done on any project is also archived on the Web site, including all of the PowerPoint presentations, so you can go back and see what we did. You can also go back and see, if you really want to, how one talk has led to the next. That is all listed there also.

Then we realized that sometimes we had trouble getting people to
read a fourteen-page factsheet. We developed a listing of all of those links under "Publications" on our Web site, so you don’t have to read all of the wonderful prose that links the factsheets and links the Web site with everything. They’re all listed there, which offers a more direct way, kind of a clearinghouse for information.

Last week before coming to this conference, one of the colleagues in our program posted a listing asking for any factsheets related to nitrogen. We got the best response and the fastest response we have ever seen. Within one week we now have thirty links to factsheets and information on nitrogen and nitrogen factsheets. I haven’t looked at any of them yet, but I know that they are going to be tremendously helpful for me as I redesign our very archaic nitrogen factsheet.

We were really thrilled with that. We also heard back from people saying, “Hey, I want information on phosphorous,” or “Hey, I want information on what communities can do to deal with tree issues.” A lot of different topics came up, so we’re going to be adding those. It is working well.

We see that there are a number of scientific rewards for volunteer monitoring. There have been huge increases in the number of locations monitored, with as many as ten volunteer monitoring sites to one agency monitoring site. Many of our agencies aspire to get out and monitor a place once a year. Many of them actually, through rotating baseline monitoring, feel really good if they go out once every five years. Many of our programs are now in their second or third decade. I was really struck by the comment that Sam Droege made earlier in this conference, that research programs can be started to address an issue at any time, but a year missed monitoring is a year gone forever. That really resonated with me and I’m going to steal that and use that in most presentations I make from now on.

Many of our state environmental agencies focus on locations that are impaired—the impaired waters listing, the TMDL programs (Too Many Damn Lawyers)—and focus on plans for repairing these impaired waters. Many of our volunteers are interested in documenting the high quality waters, the resources that are wonderful now, so that they can go to their board, they can work with their communities, they can work with the agencies and say, "This is something we may need to protect, this is where we want to focus our land trust activities on enhancing and preserving before we have to get a TMDL program."

This is a quote that speaks so well to me and I am so glad that there
“It is in the marriage of credible data and increased stewardship behavior that the true potential and vitality of citizen monitoring begins to emerge.”

- Steven Hubbell, Colorado River Watch

Volunteer Monitors are Community Educators

Educational Rewards Youth to Seniors

- De-mystifying science
  - It’s not just for professionals!
- Science literacy
  - Learning the language
  - Appreciating the process
- Hands-on activities
  - Doing enhances learning!
  - Learning from mistakes

are people who can put these things in prose that I can’t. It is the data, it is the stewardship, and those are the important things in what we are doing.

When I talk about volunteer monitors I talk about them not only being citizen scientists, I talk about them being community educators, with rewards from children to seniors.

These are some of the things we’ve talked about and heard over and over again, and that we’ve seen some fine examples of here. Volunteer monitoring de-mystifies science and communicates the understanding that it is not just for professionals. It increases science literacy, and that is probably true of all of our programs whether it is stated or not. It enables the volunteers to appreciate the process and to understand that it is a process. Then there is involvement with hands-on activities, which is just so great.

One of the best things I ever did in my program was invite the president of the university to go through a volunteer training. This was early in his tenure at URI and he was not yet controversial. He came and he didn’t introduce himself as president of the university, just as Bob Carothers, and none of the volunteers recognized him. That was the smartest thing I ever did because he remembers that and it has really helped my program, and it is because of the experience of the doing as we all know. The experience of the doing is how you remember, not what you read in the book.

There are growing and very, very important rewards for our families as we increasingly see that folks are not playing outside. I was reading one of the papers this morning about how outdoor living rooms are becoming passé now because people realize they have to work to maintain their multi-thousand dollar decks and grills and outdoor furniture, and the kids want to be inside.
All of these activities we’re seeing here get people outside and connect us with our natural world, which is so important. Rather than being on the sidelines and cheering your kid out on the soccer field or some other sports field, you are out together enjoying it. We see a growing number of people becoming involved in our programs for that reason, for family activities that keep them together and keep them talking. And the kids love to teach the parents and help them understand how to use the gadgets. Someone made the comment earlier, “E-mail is for old people.” That is really scary to me. My daughter explained to me, using that exasperated daughterly voice, “I can’t believe you don’t know how to text message! All you do is this, this and this.”

There are also a number of societal awards for all of our citizen-based activities: to build community partnerships, to help our communities make decisions, to involve hands-on science, civic activity, and to reach our underserved audience, which is very, very important.

I’m going to move ahead to one of my favorite quotes.

**Challenges: Is It All rosy?**

So is it all rosy? Is everything just great? Are we all holding hands and singing “Kumbaya”? Oh no, I don’t think so. Again, from our folks at Alabama Water Watch: Our program goals, our activities, have a powerful influence on who participates, how long they stay active, and data credibility. We need to keep it real to the people involved in it.

We need a sustainable program. We need groups

Data credibility depends on a sustainable monitoring program and groups of dedicated volunteers who see the program as relevant and enjoyable in meeting their group’s overall objectives of achieving clean water.

- Alabama Water Watch
of volunteers who see the program as relevant, enjoyable and meaningful to meet the objectives of our program.

What we see often with agency programs, with EPA programs, with research programs, with hypothesis-based programs is the need to answer big questions, and these are questions that need to be answered: What is the condition of the resource? Is it changing over time? What and where are the causes? Are the programs and the many millions of dollars we are putting into these programs making a difference? Are our goals being met? These are kind of top-down, very important programs.

You have that in contrast to what we see from many of our community-based programs, that enlightened self-interest: What’s going on with the water? Why is this stream drying out? Why are we having flooding now? Is it safe to go in the water? Will my grandkids be able to swim in this stream?

So we recognize all these concerns and realize we need to find a way to mesh them together. There are inevitable conflicts in which you end up with the residents against the community leaders. Who here works on local community boards, conservation boards, zoning, or planning boards? Bless you. It is very, very challenging. It often becomes the community leaders versus the experts, and the experts may come in with jargon-laden explanations of why this is what it is, but they don’t want to commit unless they’ve got that ninety-five percent confidence interval to make sure that they are one-hundred percent correct. Our community leaders don’t rely on one-hundred percents to make their decisions (as a matter of fact, I think many of them rely on much less to make their decisions). We need to realize that this tension exists and we need to work together to try and work around some of these things to get people involved.

I now have a number of environmental professionals who work in the R.I. Department of Environmental Management who are volunteers in

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**Agency/Research Questions**

(hypothesis-based / probabilistic)

• What is the condition of the nation’s surface, ground, estuarine, and coastal waters?
• Where, how and why are water quality conditions changing over time?
• Where are problems related to water quality and what is their cause?
• Are programs to address problems working effectively?
• Are water quality goals and standards being met?

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**Community and Individual Concerns**

(targeted monitoring)

- I want to find out what’s in my water.
- I think there’s something wrong with my lake.
- How do I get rid of these weeds?
- Why does the stream go dry now?
- Will my grandkids be able to swim here?
my program, which is kind of fun. They say it’s the only way they get out on the water, but what it has done is enable them to see the steps involved in the process, and it has enabled them to meet the residents of the area and learn of their concerns. That has been very helpful for the program also.

So we’ve got this combination of top-down and bottom-up that we need to address. What many people and many programs want to do is answer this question: What’s in it for me? I use this when I’m talking to monitoring organizations that are interested in forming a monitoring council to get people to leave their personal hats at the door and come to the table and meet together as a collaborative group. But as you’re working together you still need to address the question, what’s in it for me?

We end up with a model that Candie Wilderman talked about earlier at this conference, the Community-based Participatory Research Model, in which we work together to build consensus, the communication, the coordination, the collaboration—the three C’s—and empower communities, recognizing our capacities and our limitations.

**Conclusion**

I wanted to leave you with these quotes.

They underscore the recognition that volunteers were the hub of the wheel that made the project a success...They provided the factual data on which decisions were made.

> "the ‘hub of the wheel’ that made the project a success...They provided the factual data on which decisions were made."

> -Sherry Godlewski, NHDES, University of New Hampshire Cooperative Extension

"...it is this type of model project that we at the EPA want to support and continue to see occur..."

> -Warren Howard, EPA-NE, University of New Hampshire Cooperative Extension
Volunteer Water Quality Monitoring Programs...

- Educate the public on water quality or watershed issues, how to protect and restore resources
- Encourage citizens to adopt "watershed-friendly" behaviors and policies
- Bring university science to the community and the community to the university
- Gain valuable water quality data that is distributed to community decision makers in a usable format
- Enable communities to take action to protect and restore their waters

Relevance to Citizen Science Toolkit/Web Site

- Since I have my laptop here I was able to look a little more deeply at that Web site (www.usawaterquality.org/volunteer) as you were going along. It is awesome. I think we're going to rename it "Citizen Science Central" and we're done. All of the things that we've talked about at the Lab about needing to know more about volunteer retention and recruitment is there. It's too bad you don't have the hot link to the funding module yet.

For me what was coming up during this presentation is that water quality monitoring is a pretty discrete area and it is easy to wrap a Web site around that. Citizen science is so big, so complex, with so may different disciplines, maybe we really don't want to have a community or a Web site around that. Or should there be separate ones housed within it? I don't know the answer to that. We can include that in our later discussions. - Rick Bonney, Director of Program Development and Evaluation, Cornell Lab of Ornithology

age our citizens to adopt watershed-friendly practices. They bring science to the community and the community to the science. They provide data in a way that people can understand, and enable us to take action to protect, restore, and maintain our waters.

Thanks!

Linda Green
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engaging cooperative extension volunteers in citizen science

Lori Bushway
Senior Extension Associate - Leader of Adult Outreach
CCE’s Garden-based Learning Program
Department of Horticulture, Cornell University
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

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http://www.citizenscience.org
Engaging Cooperative Extension Volunteers in Citizen Science

Overview: Cooperative Extensions

One hundred percent of my effort is outreach for Cornell Cooperative Extension’s Garden-based Learning Program, which includes coordination of the Master Gardener Volunteer program for New York State. What I do is attempt to create opportunities for the County Cooperative Extension education to connect with research-based information, people, and experts so that they can work to enhance the quality of life for individuals, families and communities in their towns. The focus is specifically on garden-related activities as a tool for enhancing environmental literacy, science literacy, and community building, as well as social integration and human well being.

How many of you are currently partnering with some aspect of Cooperative Extension? By a show of hands I see that a large number are, about half. And how many of you have tried, but it hasn’t worked out? How many of you are not quite sure what Cooperative Extension is?

Cooperative State Research, Education and Extension Services (CSREES) is a federal agency within the U.S. Department of Agriculture. Within that we have the outreach branch of the agency, our Cooperative Extension. Cooperative Extension works with land-grant universities. In New York State, our land-grant university is Cornell. There is a Web site you can refer to if you have additional questions about Cooperative Extension.

The confusing thing is that within every state, Cooperative Extension takes on very different shapes. Sometimes the counties have their own things going on, sometimes it is a statewide effort and there aren’t so many county offices. For example, I know that Rhode Island is probably very different from New York because of the size of the state. While it is very confusing, hopefully I will be able to clear up a little bit about Master Gardener Volunteer portions of Cooperative Extensions. Actually, I really hope that I can share with you some information to entice you to consider trying to partner with some of the Cooperative Extension networks throughout the country.

When I look at our Cornell Cooperative Extension mission statement it says that the “...educational system enables people to improve their lives and communities through partnerships that put experience and research knowledge to work.” When I think about that and then think about the citizen science definition, which talks about engag-
Cooperative Extension (CE) Master Gardener Volunteer Program

- 35 years old and every state has a program (see www.ahs.org/master_gardeners/index.htm)
- Currently ~ 90,000 active volunteers in U.S. and Canada
- Volunteers are most often county-based (some counties have 6 volunteers, some 300)
- Up to 20,000 participants are selected to attend 40 to 80 hours of basic/core horticultural training annually
- Most pay for the training ($100 to many hundreds)
- Training focuses on research-based knowledge and train-the-trainer model
- Provide >2.5 million hours of service for community educational projects such as fielding public inquiries, leading workshops, writing articles, creating demonstration landscapes in broad range of subject areas
- Volunteers work with diverse populations from prison inmates, youth, nursing home residents...
- Volunteers often required to pursue 5-15 hours/year advance training in addition to volunteering
- Next International Master Gardener Conference will be held in Las Vegas March of 2009

ing the public and advancing scientific knowledge, I think that we have lots of things in common. We want to engage the public and we are focused on research information.

That is why I want to entice you to consider working with the network, but I also want to entice you to work with our network because I think we can benefit from partnering with citizen science projects in accomplishing our mission as well as helping you accomplish your mission.

Cooperative Extension Master Gardener Volunteer Program

We have Master Gardener Volunteer programs in every state and they have been going on for thirty-five years, so it has a pretty long history. Currently there are 90,000 active Master Gardener volunteers throughout the U.S. and Canada. That is a lot of volunteers. Maybe even more exciting is the fact that we train about 20,000 additional Master Gardener volunteers in our core training. You may well worry about our retention rate with those figures, but we are training that many people and they don’t just get a little bit of training. Generally the training is 40 to 80 hours basic/core horticultural training, and they pay for it.

The training really focuses on research-based knowledge. We have that connection to the Land-Grant University System, and at Cornell our Cooperative Extension in general is always talking about research-based knowledge, so our volunteers are hearing a lot of research-based knowledge language. We use the train-the-trainer model. They are being trained so that they can go out and do public education. I think those are important things to know in terms of what happens in that Master Gardener Volunteer system.

It varies from state to state, but many states are organized by county, so in New York, for example, I don’t work directly with the volunteers, I work with the county educators who work with the volunteers. It is those counties that decide how they are going to engage those Master Gardener Volunteers. In other states they do have more of a centralized system, with a state person working with volunteers from across the whole state.

Those 90,000 Master Gardener Volunteers spend 2.5 million hours doing community education work. That is a lot of hours, and what they do is varied, and I imagine some of it is monitoring. Very often they are fielding public inquiries, answering questions that come in via e-mail, via phone, and at booths at fairs. They often lead workshops as well as write articles, and they create demonstration landscapes in a broad variety of subject areas from ecological lawn care, growing flowers, and perennials to creation of wildlife habitat and monitoring invasive species. We actually were thinking about invasive species monitoring in New York state and just did a quick poll of the counties to ask whether there were
Master Gardeners engaging in basic species monitoring. We received positive responses from twenty counties. So there is quite a broad range of things that our volunteers are doing that are very similar to the citizen science projects you have been sharing.

They also work with diverse populations, though our Master Gardener Volunteers in general don’t reflect the population. They are a little more homogenous than the populations they work with, but they do reach a lot of different populations.

Generally they are required to do advance training every year. This is where I think some of you might step in. There are educators out there who are working with their volunteers and they want to offer advance training, and you may be able to offer some of that training to get them engaged in your work. There is also, on an international level, a Master Gardener Volunteer conference held every other year. That might be another opportunity for you to connect with this network.

I want to share some factors that motivate Master Gardener Volunteers, and those working with volunteers know that these are probably similar to the motivational factors that your volunteers have. When it comes to Master Gardener Volunteers, there is really a passion about gardening, and often a passion about a particular type of garden. For example, we have a lot of volunteers who are passionate about worms, a topic that keeps coming up at this conference also. About seven years ago we decided we wanted to engage Master Gardeners in citizen science projects and we did some focus groups with gardeners comprised mostly of Master Gardener Volunteers because we wanted to find out what their interests were before we decided on a citizen science project. Worms came up more than once, but nobody was studying worms at Cornell at that point so it didn’t make it into the final project that we chose.

So the things they are interested in are really broad and it might be challenging to find the right individuals for your project, but once you find those people who are interested they can really be quite a benefit to your program. They also have a strong desire to share their passions with others. We all know how wonderful and how effective that can be in getting motivated volunteers interested. And they have a strong desire to contribute back to their community. In fact, when most states and counties are accepting Master Gardener Volunteers they go through an application process, and as part of that application process they are told, “We expect you to do public education,” so again you are working with a population that is expecting to give back to the community.

Volunteers also really enjoy the social aspect of it, as well as having a desire to pursue lifelong learning. In fact there was a study that came out fairly recently in the *Journal of Extension* that said Master Gardener Volunteers demonstrate equal interest in learning about local ecology and plant communities as well as home gardening skills. You can see that when

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Some Factors Motivating Master Gardener Volunteers

- Passionate about gardening, often particular types or aspects of gardening
- Desire to share their passion with others
- Desire to contribute to their community
- Enjoy the social aspects
- Pursuit of lifelong learning

1A study noted MGV demonstrated equal interest in learning about local ecology and plant communities as home gardening skills (www.joe.org/joe/2006december/rb5.shtml)
we talk about gardening in the Master Gardener program, the interpretation of gardening is really very broad.

I have listed some key benefits to engaging Master Gardener Volunteers. Again, I think they would love to do the monitoring, but I think they could really step up and be key leaders or ambassadors for many programs. They are familiar with academic types because that is usually who does the training for them and they are associated with a university so they are familiar with that aspect as well as with research-based information. They are trained to transfer information to the public. They have been cultivated to be key leaders in their communities. They are also outside, observing their landscape. They even take notes, they keep journals, they enter information about their landscape on spreadsheets that they keep for themselves. They share that information with friends and neighbors, and they will also sometimes share it with broader audiences. So they not only take observations, they like to share observations with others.

They are also a built-in network. The USDA Forest Service has used Master Gardener Volunteers for Rapid Response Education programs for Sudden Oak Death syndrome. They wanted monitoring to occur and they decided to use the MGV network, which could be quickly mobilized, to address their problem. They are already in place; you don’t have to expend effort organizing them. Also they often are working with a paid coordinator for their program, which is also helpful for volunteer development activities, and they have connections with their local communities.

I want to take the last couple of minutes to share with you how you can connect with these groups. You could connect on the county level if you can find someone in your county, but if you could connect with a state person within the Cooperative Extension office who coordinates the MGV program that would most probably be the most profitable because they have a connection with the national network as well as a connection with their state offices. These state coordinators will often know about workshops and professional development opportunities involving their volunteers or staff that you may be able to fit into.

I have focused on the Master Gardener Volunteer program, but perhaps the MGV programs aren’t the best fit for you. There are other cooperative Extension volunteer programs including the Master Naturalists you heard about earlier at this conference, Master Forest Owners, and Master Watershed Stewards. One thing about the MGV program is that they are active in all states, and some of them are doing some of the activities that these other groups are doing in other states. If you want to learn more about the MGV program, feel free to get in touch with me.
Citizen Science Toolkit Conference
June 20 - 23, 2007

astronomy for citizen scientists and citizen scientist educators

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This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

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http://www.citizenscience.org
Astronomy for Citizen Scientists and Citizen Science Educators

Introduction

We’ve heard about birds and water and bugs and worms, and I’ve come to let you know that there is a whole universe of other citizen science projects going on. As people have been talking about their projects I’ve been thinking that I know an amateur astronomer like the person mentioned, or I know someone who is doing a project similar to the one described. As you have talked about scaling factors and the communities that you are working with, I have been thinking that the amateur astronomy community is very similar to many of the communities that you are dealing with. Some of them are making discoveries on their own, and some are working in what we call “Pro-Am collaboration,” which is what I want to talk about today.

I am from the Astronomical Society of the Pacific. Until I understood what was meant by the term “citizen science,” I didn’t realize that we were born out of a citizen science project.

Born out of Citizen Science

On February 7, 1889, a diverse group of men gathered in a meeting room in downtown San Francisco. They included a high school science teacher who was also director of a civic observatory, a Spanish gentleman from Catalonia who was a civil engineer, a professional astronomer educated at West Point, a distinguished corporate lawyer, a railroad clerk who was an avid amateur photographer, an insurance broker, a homeopathic physician, a college professor, and more than thirty others. The outcome of the meeting was the creation of the Astronomical Society of the Pacific whose aims — as admirable today as a hundred years ago — were set forth clearly in its very first bylaws: “…to advance the Science of Astronomy, and to diffuse information concerning it.”

This fellow was the founding director of the Lick Observatory. There was a total solar eclipse in the Bay Area in 1889 and he decided to gather together people from the community—not professional astronomers, but amateur astronomers, professional photographers, and other members of the community to document this astronomical event. He decided he wanted to continue this partnership and it was out of that partnership that the Astronomical Society of the Pacific
CITIZEN SCIENCE Toolkit Conference

was founded: "...to advance the Science of Astronomy, and to diffuse information concerning it."

Our mission has evolved over the past hundred years, but at its core it is still about spreading that excitement about astronomy. Today we focus more on educational programs, and in this talk I wanted to give you some examples of citizen science in the field of astronomy because as I've said I can see parallels with other projects I've been hearing about here and I want to take this opportunity to let you know some of the things going on in astronomy. I'm then going to talk about a program that we are just starting that I think is the one that is most relevant to everyone here, which is an NSF-funded project called Sharing the Universe. Martin Storksdieck, who is here, is the co-PI and he can tell you a little more about the key research part of that project, which is just starting.

Examples of Citizen Science in Astronomy

We already heard a presentation that included one example of astronomy citizen science, and that is the GLOBE at Night project. What it is most noted for is that it has these key educational goals.

GLOBE at Night
www.globe.gov

Educational Objectives:
- Engage students worldwide in observing the nighttime sky
- Encourage citizen and family science with a hands-on learning activity outside of the classroom
- Gather light pollution data from an international perspective

During the 2007 event there were 8,491 observations reported from 60 GLOBE countries, almost doubling the observations from 2006. The final data is being analyzed.

For me what made it most exciting was that the aim was to reach students worldwide, getting them out looking at the night sky. It wasn’t just science that was being addressed, it was motivating them to get out and to be aware. Just as many of you are trying to make them aware of the water, the birds, the trees, the ecology around them, we are trying to get them to look even farther up at the night sky and become aware of a resource that is dimming. Because of all the light pollution that is here, we have lost a lot of that resource.

There are amazing individuals doing projects. This fellow is a Methodist minister in Australia and he loves astronomy. He goes out with
his Dobsonian telescope, which looks like a big cannon, a cardboard tube with an eyepiece, and looks at these funny little galaxies, and he has seen thousands of them. He looks through the galaxies for that little thing you see in the upper left corner of this picture, a supernova, a giant star that has exploded at the end of its life. He knows how to find so many of these that he has discovered more supernovae than any professional or amateur astronomer. He just does this for fun, and when he discovers them he reports them and then the professionals can follow up with spectroscopy and all of the other data gathering. You can’t predict when these things are going to go off, so he just goes out and looks through gobs of galaxies.

Then there is a friend of mine, David Levy. I used to work with him at a planetarium in Tuscon. His passion is comets. He would never go out with the rest of the staff after work. Instead, he would go home and look for comets. And sure enough, the man has discovered twenty-two comets. He is an amateur astronomer. He eventually paired up with some professional astronomers and he discovered this bizarre thing pictured here, Comet Shumaker-Levy 9.

It was the ninth comet that team had discovered and it’s the one that crashed into Jupiter. It was a new discovery since we’d never seen anything break up like this and become multiple comets and actually impact on a body, so that was a remarkable thing that he discovered. He is up there in third place in the history of folks who have discovered comets. Historically, most comets have been discovered by amateur astronomers and again, it is for the love of it. Once they make the discovery they often turn it over to the professionals to do all the calculation of the orbital circumstances and the like, but the initial discoveries are made by the amateurs.

There are also more formal relationships out there, and in the astronomy world we call them professional-amateur (Pro-Am) collaborations. Pro-Am collaborations permeate the entire culture of astronomy.
It started quite a while ago back in 1911 at Harvard College. They started the American Association of Variable Star Observers (AAVSO). The basic idea is that professional astronomers don’t have enough telescopes and enough time to look at all of these variable objects. They started this network that uses all of these amateurs who do, and not all of them have high-tech equipment—a lot of it is just putting your eyeball to the eyepiece.

Pro-Am Collaborations

American Association of Variable Star Observers (AAVSO)
- Founded in 1911 at Harvard College Observatory
- Members in 45 countries
- Over 12.5 million observations
- Professional astronomers have neither the time nor the telescopes...
- Amateur astronomers do
- They submit their observations to the International Database
- The AAVSO coordinates, evaluates, compiles, processes, publishes, and disseminates variable star observations to the astronomical community throughout the world.

They go through a training process in which they look at little finder charts like the graphic above [middle left], and they do comparisons. They have comparison stars and decide: Is it brighter than that? Is it dimmer than this? Then they can make an estimate. So it doesn’t matter if Luna is out, it doesn’t matter if you are in a light-polluted sky, they can do this anywhere by relying on their training and comparing a target star with ones in the field and making an estimate of the brightness.

Often professional astronomers will call and say, “I’m going to be observing this star next month, can you give me some baseline data?” They want to make sure that it’s not doing anything kinky before they do their observations, that it is in a stable period, and amateurs will provide that data. So it is a long-standing professional-amateur collaboration that has been going on through the AAVSO, and the amateurs get credit when the research is published.

This goes beyond variable stars. Sky & Telescope is one of the most popular trade magazines and it and Astronomy are the two main astronomy magazines in the U.S. The Chief Editor, Rick Feinberg, has started an AstroAlert system, which is an e-mail system in partnership with research astronomers. He will send out an e-mail saying, “There is an event happening that we want lots of data on. Can you observe
it?” When I was putting together this talk last week, this was the most recent e-mail posting on the Web site.

**Recent AstroAlert: Occultations by Possible Rings of Pluto, May 11, 2007**

At about 4.7h Universal Time on May 12, 2007, Pluto will occult the 13.3-magnitude star UCAC2 25822467 in a path passing over much of Antarctica and Patagonia. But in addition, Walker Vaning believes that rings of very small particles will also occult the star for observers in the whole hemisphere of Earth facing Pluto, which includes all of Central and South America, most of the Atlantic Ocean (including the Canary Islands), the Caribbean Sea, eastern Mexico, eastern USA, and eastern Canada. The star is at right ascension 17h 53m 32.0s, declination 16° 22’ 47” (equinox 2000.0).

They think there might be rings around Pluto, and by watching a star as Pluto goes near that star, they look for that starlet to flicker as the dust from the rings goes in front of the star, and they asked people to observe that.

So there are a variety of observations that are requested and amateurs have the equipment to do it. Some of it is very low-tech, some of it is high-tech with the CCD cameras, which are charge coupled devices. It is a CCD chip that is in all of your digital cameras, but this is a bigger unit with which they can take long time exposures and then analyze the data.

The Lab of Ornithology was talking about watching birds in their nest boxes using nestcams. This next project is probably similar to that. With the nestcams you don’t have to go out and observe the birds, you can just go online. Stardust@Home is a fascinating project. Did any of you ever participate in the SETI@Home project? That didn’t require you to do anything but let them use your computer time. This one was modeled after that in terms of the idea of having many computers in use, but you have to do the work here.

This amazing spacecraft flew through the tail of a comet and it has this substance they call aerogel. The tester is pictured at right, and in all of those cells is the aerogel, which they describe as “frozen smoke.” It is an amazing material, and this panel came up as it flew through the tail of the comet and all of the comet material whacked into the aerogel and got captured. Then the panel went back down and got protected. At that point, when it was far away from the environment of the comet and wasn’t influenced by that, it opened up again and on the other side it was exposed to interstellar medium, dust coming from other stars that enters our solar system. We’ve never been able to capture these particles before.
On January 15, 2006, sample return capsule safely returned to Earth with bits of Comet Wild 2 and tiny particles of interstellar dust that originate in distant stars, light-years away. They are the first such pristine particles ever collected in space, and scientists are eagerly waiting for their chance to “get their hands” on them. Before the particles can be studied, though, they have to be found. If this project was taken on twenty years ago, the search for the tracks in the aerogel collector would be through a high-magnification microscope and the search would still be going on. Are using an automated scanning microscope to collect images of the entire Stardust Interstellar collector. These stacks of images are focus movies. All in all there will be nearly a million such focus movies. Stardust@Home users around the world view them with the aid of a special Virtual Microscope (VM) that works in a Web browser to accomplish in months what would have taken years.

In recognition of the critical importance of Stardust@Home volunteers, the discoverer of an interstellar dust particle will appear as coauthor on any scientific paper by the Stardust@Home collaboration announcing discovery of the particle. http://stardustathome.ssl.berkeley.edu/_tutorial_start.php

It was finally returned to earth, and now we have to find these particles in this gunk, and that is a challenge. Even with an automated microscope scanning through all of this aerogel material, they think it would probably take about twenty years. Instead, what they are doing is asking you all to do this. They are using an automated scanning microscope to collect the images, but now they have to go through them very carefully to look for what might be a particle of interstellar medium, of stardust from another star not our own. What they have done is to set up a program in which they have a little test that you can take.

They put you through this entire training program and above is an example of what one of these slides would look like. What you would do, thousands of times if you were so motivated, is look at these tracks and move your cursor. In a training exercise you move your focus from being above the surface to at the surface, and then as you go below the surface they point out where there is a track. You can see where there is a very distinct ring, and that has to do with the way they travel through the medium. They give you bunches of these to practice on (ones where it doesn’t say “track”) and then you have to take a test. If you pass the test they let you participate.

You can go to the “Community” section on their Web site where you will find rankings and a list of the top hundred people, including one guy who had nothing better to do than scan 170,000 of those slides. Even the hundredth person has done over 18,000. This doesn’t require any equipment except Web access, and what they do is give you recognition. They also have a community bulletin board where you’ll find fabulous ideas being exchanged.

I haven’t heard of reports yet on particles that were found, but as they begin to study the ones that are found they will give full credit to the person who discovered them. Basically you could find one that you think has a track, and then the researchers will flag that as a slide they should spend more time on and see if they can recover that particle of interstellar medium and find out what it’s made out of. If you are one of the people who flags that piece, then you will
get coauthorship on any research papers that are published. That is the way that they recognize their volunteers.

**Night Sky Network**

Night Sky Network is how the Astronomical Society of the Pacific works with amateur astronomers. The National Science Foundation gave us a planning grant to discover what amateur astronomers wanted or thought they needed to do more and better outreach because we knew they were out there doing all sorts of outreach.

I found the list of motivating factors for joining Master Gardeners interesting. We know that there are a variety of things that motivate people to join the club. Some are observers, some come because of the social interaction, some want to learn more, and some want to share their passion for the night sky. Those are the ones that we wanted to know more about.

NSF gave us a planning grant and we found out what they wanted was training, materials and to be networked with other people who share that passion. NSF didn’t fund us to give them that, but NASA did. What NASA didn’t fund us to do was investigate more about the community. They were concerned whether or not these guys knew their stuff. I say “guys” because really it was mostly men who were in the amateur astronomy clubs. NASA was concerned about how we were going to deliver the training because it’s very expensive to run workshops. They were giving us a lot of money and it takes a long time to develop each one of these toolkits, about sixteen months with all of the testing and beta testing. They wanted to make sure that it was going to be used.

We did a study and found that the amateurs who step up to do outreach know their stuff. They’re not going to volunteer to be talking about it if they’re not knowledgeable. In fact, there is a study that

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**Highlights from movie clip about Night Sky Network:**

- Membership is free and open to all astronomy clubs in the US and provides toolkits, training, and access to online resources.
- In return, clubs are asked to log at least 5 outreach events each year.
- Member clubs receive toolkits and materials to explore a variety of astronomy topics, from the scale of the solar system, to how telescopes work, to black holes.
- Toolkits have hands-on activities and outreach presentations for all ages and for small and large groups, accompanied by training video and user manual.
- There is interaction and exchange with other members and exclusive access to teleconferences.

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Concerns:
- Amateur astronomers are free agents. Their outreach activities are relatively unmonitored.
- Training amateurs across the country to have maximum impact could be prohibitively expensive.
- How can we insure they will be used?

Why This Works:
- Amateurs who choose to do outreach are very knowledgeable. (Astronomy Diagnostic Test)
- Training is delivered via a DVD demonstrating uses of the toolkit contents and best practices for facilitating the demonstrations.
- To maintain active status, clubs must log at least 5 events per year. The benefits of active status are receipt of new toolkits as they are developed, newsletters, and participation in telecons with NASA scientists discussing the latest discoveries.

The ASP, in partnership with the Institute for Learning Innovation, has received another NSF ESI award to:
- study the culture of amateur astronomy clubs;
- determine what factors support active, sustainable outreach programs;
- identify what if any interventions can be developed to affect the club culture in such a way to create a more sustainable outreach effort.

used the Astronomy Diagnostic Test and the only people who scored better on the test were university professors who teach astronomy, so the amateurs are very knowledgeable. The training is delivered via DVD, and the more outreach events you log the more you get. You can win prizes, you can get the next toolkit of materials. So we definitely have success.

We have something like McDonald’s—so many millions served—and when they log in an event on the Web site it shows up. We are coming up on that half-a-million people served by Night Sky Network materials.

Results:

As of Monday, June 18, 2007, the Web site counter displays the following as an indicator of the impact the Night Sky Partnerships are having:

| Events held since March 2004: 5806 | People Reached: 488917 |

But NASA hasn’t paid for us to develop a sense of community.

But NASA didn’t fund us to find out more about the community and that is why we are now in partnership with the Institute for Learning Innovation to do what is really an anthropological study of this group of people. Martin Storksdieck is taking the lead on that to study the culture of these clubs. We want to find out what factors within that club culture support an active, sustainable outreach program. In our discussions, one thing that came up was the idea of "the power of one." What if there was one charismatic, ambitious person who was doing all the outreach? That is only sustainable as long as that one person is out there, but what kind of legacy are they leaving?

After we find out more about the culture we are going to try to develop interventions to help see which ones are healthy, what aspects of that culture made them healthy to sustain outreach, and if we can plant those seeds in other clubs that are struggling with their outreach and give them the same kind of healthy climate that we see in the successful clubs. At this point I don’t have anything to report, but what we learn in a very general level may have relevance for your programs, so as we start learning about the culture, hopefully we will be able to share it with the rest of you.
audubon’s christmas bird count
from 19th century conservation action
to 21st century citizen science

Geoff LeBaron
Director, Christmas Bird Count
National Audubon Society
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

Note that this document did not originate as a formal paper. Rather, it combines an oral presentation with accompanying PowerPoint slides and reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

Documentation of the conference is meant to serve as a resource for those who attended and for others in the field. It does not necessarily reflect the views of the Cornell Lab of Ornithology or individual symposium participants.

The following is one of three focus point presentations delivered on day three of the Citizen Science Toolkit Conference as part of the session titled “Community Building for Citizen Science.”

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org
Audubon’s Christmas Bird Count
From 19th Century Conservation Action to 21st Century Citizen Science

Overview and Background

I have been constantly involved here in the presentations and case studies over the past few days and it has been fascinating to talk to everybody and learn what others are doing. It has been a wonderful experience, and I find that this presentation refers back to things that others have said about their own programs and citizen science.

I’m going to talk about the Christmas Bird Count, and it has been interesting being in charge of it for twenty years. I want to give you a brief overview of the program itself and its history and the way that it is used. What I want to focus on is what I think a program like the Christmas Bird Count brings to a conference like this on citizen science, the challenges of rewarding and maintaining your audience, your participants, and your diverse users.

Long, long ago there was a fascinating, wonderful gentleman named Frank Chapman, who was an ornithologist at the American Museum of Natural History and editor of what was basically his own magazine, Bird-Lore. At the turn of the nineteenth century into the twentieth, he realized there was over-hunting, really excess hunting of resources, especially birds, and he thought it would be a great idea to propose an alternative activity to over-hunting during the holiday season and rather than going out and shooting birds during the holiday season, to actually go out and count them. That was how the Christmas Bird Census came about.

The millinery trade was thriving and birds were being harvested all over the place by literally tens of thousands at a time. This is the way that a lot of colonial waterbirds ended up in people’s hats. Budding conservationists
during this time were realizing that there were real problems and birds were in decline. This is what begat the various different Audubon societies that took the name from John James Audubon, who really began the way we perceive bird artwork and natural history artwork now.

In the fall issue of *Bird-Lore* in 1900, Frank Chapman proposed what was then called a Christmas Bird Census rather than a Christmas Bird Count. Literally every year now for a hundred and seven years during the holidays people have been out counting birds during the Christmas Count season.

The methodology has evolved a little bit, but basically the number of participants has skyrocketed as you might guess. There were twenty-seven people for the first season. All of those counts were done on Christmas Day, by the way, with good representation all the way across the continent, including in Canada, during that first season. That was twenty-seven people then and the 106th count from two years ago had just over fifty-seven thousand observers involved.
The number of counts, obviously, has gone up also. There were twenty-five the first year, and we have 2,041 right now completed this season online. Last season we had 2,060.

The Christmas Bird Count is fun, it’s social, traditional, educational, and finally, even the scientific community is realizing that it is valuable. Even in its first year, as I’ve said, it was an international program. Of those first twenty-five counts, I think two were in Canada. Now of the roughly 2,000 counts that are submitted every year, the vast majority are in the United States and Canada. Of the 2,060, we will get roughly 1,700 in the U.S., 300 or 400 in Canada, and another fifty or sixty throughout Latin America, the Caribbean, and the Pacific Islands.

We have been talking about partnerships at this conference, and what has been happening recently is that we are increasingly involving partners in the Christmas Bird Count. For the first fifteen years or so that I was in charge of the program I was the one person communicating with the organizers of the individual counts, which tends to be quite a job. It helps with the growth in other countries to have partners on a local level involved.

I would say that the conservation value of the Christmas Bird Count has really come to the forefront in the last ten years. Scientists are finally embracing citizen science and what they view as popular science kinds of data. Scientists like to be able to design and take care of every
little bit of variation in the data that they are analyzing and be able to give you that 100% or at least 99.5% certainty that what they are saying is true based on their study. You can’t do that when you’ve got thirty or forty thousand people out there and two thousand different locations, each counting in slightly different ways in each count circle during a count period that runs for three weeks, which is also very much affected not only by the weather on count day, but during the count season as well as the preseason early in the fall. All of those factors affect where the birds are on a given day at a given time.

What we are learning is what we can do to account for this variation. Even if there is an intercount variability in the way that the count is specifically run, each individual count is run the same way over time. It is usually the same people doing it, sometimes for fifty or seventy years, doing the same count the same way every season. So even if there is a little bit of difference from count to count, they are each individually done the same way over time and you get good trend data.

Sam Droege, who is at this conference, is one of the first people who started playing with the Christmas Bird Count data, as well as a group down at Patuxent. They have led the charge in embracing the Christmas Bird Count as well as the Breeding Bird Survey and other citizen science data that they assess.

What we have recently been able to look at is what has happened on a population level at national and regional levels and the effects of West Nile virus, for example. You can see the evidence as well as the numbers on a continental basis and track the spread of diseases and how birds are reacting to those diseases. We’ve also partnered with the Boreal Songbird Initiative to try to get a handle on what is happening to birds in the boreal forests. More recently, with the big hullabaloo about global climate change, the Christmas Bird Count kit and kaboodle is right there, ready for analysis to see how we can track range shifting in bird species during the early winter period and correlate that with what is happening with global climate change.

Right now we are about to finish up the first large-scale analysis that is combining Christmas Bird Count and Breeding Bird Survey trend data to come up with uniform trend data for all species that are well sampled both by the Breeding Bird Survey and the Christmas Bird Count. Once that is complete, which we hope will be done by the end of this year or early next year, we are going to move into something people here at the Lab have been interested in for a while: tracking how these birds are changing or shifting their range during the Christmas Bird Count period, which runs from December 14 to January 5 each year now, and if they are range shifting in response to global climate change.

Here are just a few examples of range shifting and how you can track what is going on. The Christmas Bird Count was really brought into the

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online world by a collaboration between the Cornell Lab of Ornithology and Audubon. The first ninety-eight years of the Christmas Bird count it was strictly paper-run. Since then it has basically been an online project. These are animated pieces that are on the Web site, developed for BirdSource. This shows you the spread of two different species, Boat-tailed Grackles along the eastern Gulf Coast and along the East Coast, and Great-tailed Grackles in the west. You can really see how these birds are expanding northward, at least during the Christmas Bird Count period. It is a real expansion of both of these and not only can you see that Great-tailed Grackles are continuing to expand up the west, but Boat-tailed Grackles seem to have reached an impasse as they're coming up the East Coast, right about at Long Island.

The other is a sort of classic example that shows the way it all works. And with both of these examples we are not only showing where the birds are, but where the counts were that did not find the birds. So in the graphic below the light gray dots show where birds were not seen, and the dark gray dots show where birds were seen.

This is the Tufted Titmouse, one of the classic southern birds expanding northward during the winter season, or in this case year-round. Tufted Titmice are taking over the East Coast, and many of you who feed the birds know that.

Christmas Bird Count data doesn't necessarily tell you why birds are moving. What it does is document if and in what measure birds are responding to different catalysts. Birds really are one of the best
indicators of the quality of the environment and whether things are changing environmentally.

So the Christmas Bird Count is sort of the great-granddaddy of citizen science, though during this conference I now have learned that it is not the oldest citizen science project. And I suspect, based on the numbers that I’m hearing, that we’re not going to be the biggest for long, if we still are, in terms of numbers in the database. We have millions and millions of records, but at the rate that eBird is growing right now I think it will soon, if it hasn’t already, surpass the total number of records in our database. However, if you compare the Christmas Bird Count on a hemispheric basis as well as the amount of time that data has been collected, it is still a wonderful tool to track what is happening with bird populations.

The Challenge: Rewarding and Maintaining Participants

But if we don’t have the buy-in of the people who are actually doing the program, we could falter or fail. The scientific user community has really embraced the Christmas Bird Count in increasing numbers, almost exponentially in terms of the number of data requests that we get for CBC data for people to do analyses of all sort of different things on a regional, continental or local basis.

What is also great is that the observers and compilers often do their own analyses of their own CBC data on a local basis. If they’re interested in protecting a wetlands, they might look at the CBC data to see if wetland species have been declining or not, or if wetland species in their area have been declining when others around it have not. You get an idea of how the habitat quality within the count circle is doing compared to other counts on a regional basis.

However, in order to keep them engaged we really have to start giving something back other than just the ability to use the data and some entertaining output on the Web site, which we are doing, and we know we need to improve that. You can go to the Christmas Bird Count Web site and download anything into your computer that you can view on the screen.

The buy-in of the constituency is the important thing. There are two critical aspects to the Christmas Bird Count. It’s not only the data that we are generating for scientific and conservation use, it is the traditional and social aspect. And I don’t know if you’ve noticed, but bird watchers are a little competitive, and field people don’t like to be questioned when they say they’ve seen something. With the Christmas Bird Count data you’ve got thirty or forty thousand people out there and the real meat and potatoes of the Christmas Bird Count, the true value, is about counting the common birds and finding out about how the common birds are doing, how the birds that are supposed to be there are increasing or decreasing in number or changing their range.
So everybody going out on the count will be counting Starlings and Robins and Titmice, but the key that really gets them out there is, what am I going to find this year that we’ve never had in our count circle before? For example, are we going to get a Cape May Warbler in Ithaca this year, which is really supposed to be down in Latin America or the Caribbean? It’s the rarity that sort of provides the catalyst and the thrill (or the potential for a thrill) of something new and different on the Christmas Bird Count. It is also a feature or one of the key things that compilers report every year, the total number of species that were recorded for that year on their count in addition to the total number of birds and numbers of each type of bird. That species total is one of the important benchmarks that people going on Christmas Bird Counts are really interested in. It is a competitive and social thing that really is important to them.

We need to keep their interest, to keep buy-in of our volunteers. We need to keep them engaged in the program and we need to keep them caring about our programs for the programs to continue. One of the great challenges that Audubon faces right now is developing new ways of maintaining that buy-in. We used to publish in print every single bird and species and the complete results of all counts that were submitted to Audubon and give those to compilers. Those are now only available online after the hundredth count.

We have a results report on the CBC Web site so that basically in real time people can see the results, but not a lot of people want to look at their results on the Web including a vocal group of people comprised mostly of compilers. These are the ladies and gentlemen out there who are doing the individual work for each Christmas Bird Count, the ones that we are tasking with going out and organizing the volunteers, getting everyone to do what they’re supposed to do, giving on-the-ground training if necessary, submitting the data, compiling it for us at that level, and submitting it to us online, hopefully in an expeditious manner.

One of the things about the Christmas Count that might be a little bit different than many of your programs is that they actually pay to do the Christmas Bird Count. It is a five dollar participation fee. That fee really is the biggest impediment to the growth of the Christmas Bird Count program at this point. Some people don’t feel that Audubon should be charging them to do a volunteer activity when they’re already out there spending their money on gas to participate in the Christmas Bird Counts. The average CBC observer goes on two CBCs. Many people will go out on ten or fifteen. There is one guy in Iowa
Funding the Christmas Bird Count

- Current funding method—participation fee
- Participant fees provide ~75% of annual program costs (exclusive of IS needs)
- Fee is biggest impediment for growth of CBC
- Some counts, especially in certain regions, conducted but not submitted as a protest
- Reduction—or elimination—of fee critical to future expansion
- Most viable source of funding: endowment

who tries to go on twenty-three counts in twenty-three days. So we need to fund the Christmas Bird Count, ideally by endowment. That is a dream, and that is really at the forefront of what Audubon is trying to do for the CBC right now. We also need to find something to give back to compilers to reward them for all their work.

Part of the exciting business about the acceptance of the CBC recently is that we had a scientific peer review, as was done with the Breeding Bird Survey a few years back. Basically it was embraced by its scientific users, and the 104th CBC issue of American Birds contains a whole list of recommendations of what we’re doing right, what we could do better, and how to embellish the database within the CBC to make it more useful for these types of long-term studies. Mostly it involves tweaking the methodology because we don’t want to radically change what has been going on and create something new and lose the continuity.

So these are the two challenges that we are facing right now. The first is developing new ways of rewarding the compilers. We used to be able to give them that 700-page booklet that was the printed results of everything. And they not only want to be able to track the birds, but also the people who are participating, and we also have a complete participant list. We have all of that now on the Web site but as traditionalists say, “You can’t curl up with a computer in bed.” Well maybe you can, but it’s not the same going through individual screen pages as it is thumbing through a book.

We really do hope the future of the CBC is like the Merlins shown here, not the Rusty Blackbirds, in terms of its popularity and increase. And finally, this is a representation of where we have CBCs, which as I said is mostly in North America, but it correlates very nicely to the human centers of population.
group discussion on community building

Moderator:
Eleanor Ely
Editor, The Volunteer Monitor
This presentation took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

This following discussion has been edited for clarity. The participant comments are not exact quotes.

Documentation of the conference is meant to serve as a resource for those who attended and for others in the field. It does not necessarily reflect the views of the Cornell Lab of Ornithology or individual symposium participants.

The following took place on day three of the Citizen Science Toolkit Conference at the conclusion of the session titled “Community Building for Citizen Science.”

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org
Group Discussion on Community Building

Involving and Motivating the Larger Community

- I am going to give most of this time to all of you for discussion, but first I will say a few words myself. The topic for this session, “Community Building for Citizen Science,” wasn’t necessarily that prominent for me in these talks, but here are some of the things people said that touched on the theme of “community.” We heard how the Master Gardeners educate the larger community and answer questions for people. We heard about how amateur astronomy clubs are doing more teaching of the public. From the Christmas Bird Count we heard about the need to reward the community of participants who are involved in this bird count.

Right before this session, Candie Wilderman and I talked about what “community” means and how the different citizen science programs interact with the larger community, the community beyond the program participants. As I was listening to the presentations I was thinking, okay, we are talking about teaching the larger community, we are talking about teaching our community of volunteers, but what about something beyond teaching? This goes back to some of the things that Candie Wilderman and Linda Green said about actually getting the volunteers motivated to take action, to become activists.

In discussing this with Candie, we realized that certain types of citizen science lend themselves more readily to that type of community involvement than other activities. We recognized that water is something that many people in the community use for swimming or fishing, and everyone uses it for drinking. There are human health concerns there, and concerns about things like flooding. It may be a more natural medium for getting the larger community really involved and active than something at the opposite extreme like astronomy or birding.

So I guess I will just pose the thoughts that were going on in my mind: What does it mean to involve the community? Who is the community? Is every type of citizen science going to be able to involve the community in the same way?

“Which Came First: Citizen Science or Community Building?”

- One of the thing I noted was that the topic of this session was “Community Building for Citizen Science,” and I always viewed it as “Citizen Science for Community Building.” - Linda Green, Program Director, URI Watershed Watch, University of Rhode Island Cooperative Extension

Moderator:
Eleanor Ely, Editor,
The Volunteer Monitor
is the community? Is every type of citizen science going to be able to involve the community in the same way? I will turn it over to you at this point. - Eleanor Ely, Editor, The Volunteer Monitor

Problem Solvers or Pleasure Seekers

Two Models/Types of Volunteers:

- There are two discrete groups of volunteers. One is very much based on addressing an issue, solving a problem, and that is the group I have been working with. The thought that people would go out and monitor birds for a hundred years and not have any output or any effect is just fantastic to us. How do you get these people? There are bragging rights involved, there is sociology involved. It is sort of bringing purpose to a pleasure, I think. We saw that in an earlier presentation about divers going out and surveying fish, which may give some sort of meaning to what they already love to do.

So I think the birding model, the Cornell model, may be skewed, or maybe it is something we have to integrate with ours, because the power of giving bragging rights and the pleasure of being involved is something we haven’t used as effectively as we might. But it seems there are these two models, which Candie Wilderman pulled together in a very productive way. - Hague Vaughan, Director, Environment Canada’s EMAN Coordinating Office

Giving Purpose to the Pleasure

- I want to build off what Hague said. What he said about many of these programs is true in that early on there really wasn’t any output. An interesting period in here is the development of the home computer, which has produced a shift. Now we are seeing much more of an emphasis on analysis, and now there is a culture that places an importance on output and we are going to see that more and more.

There is something about the participant’s point of view that I know from personal experience. I started doing the Christmas Bird Count in 1974 as a kid. After a while, just going out and looking at birds, you don’t have that same motivation when you are just seeing the same things over and over. These kinds of scientific activities give our passions a purpose. We really can’t say that the Christmas Bird Count gave us a ton of feedback regarding how our
counts were really being used in those earlier years, though there were summaries, but I felt like I was part of something. I think a lot of people feel that just by counting fish, just by counting stars, their hobby has meaning. And now computer software is changing what can be done with those observations.

- Sam Droege, Biologist, Native Bees Survey, USGS Patuxent Wildlife Research Center

Shifting the Motivation of CBC Volunteers

- I’d like to address a couple of comments made by Hague and Sam. There is a beauty in the process of people going out over time on Christmas Bird Counts and doing the same count every year. Initially they are only doing it because they hope they’re going to see more birds than they did last year, and because they’re going to see friends from last year’s count. But as they are doing it for five, ten, fifteen, twenty-five years, we are starting to see changes. We’re seeing birds dropping out, more robins, more bluebirds, and it starts to raise questions: What is the pattern? What is happening? Where are all the wetlands species? And that starts to raise awareness that there is something going on.

I think the challenge for the birding community (and Audubon and Cornell have been talking about this for years) is getting birders, many of whom are in it for the lists, not the birds, to shift to be into it for the birds and be concerned about how the birds are doing. Then we can use these outputs that we have, and Sam was exactly right. It is the home computer that is allowing people to have access to this incredible amount of information that is out there, and they can start asking their own questions online and either get answers to their questions or get even more concerned.

- Geoff LeBaron, Director, Christmas Bird Count, National Audubon Society

Addressing Multiple Categories of Volunteer Motivation and Needs

- In our experience we have three different main aspects in all of our different types of participant groups. We list our top surveyors in each region on our Web site, and there are people who strive to be at the top of the list for their region, so there are some people to whom that really matters. If they get overtaken, they’re planning a trip to find some more fish. Having that simple list on our Web site and in our printed materials is driving that group. But that is not a whole lot of people, that is a sort of subset of a really fanatic group. They care about their individual lists also, so we have a very simple “Show Me My List”

Competitive/Ranking as Motivational/Community-building Tools

- I was thinking how absolutely brilliant it is to have lists of rankings online so that volunteers can see how others are doing. Instead of thinking about how technology has lessened community, we actually have opportunities to create communities among people participating in the project. And that is a need out there that your project is solving. I think competition is a huge motivation to get involved.

- Sarah Kirn, Vital Signs Program Manager, Vital Signs, Gulf of Maine Research Institute

- We do that also with the Night Sky Network outreach activities, and it is called the Stars of the Night Sky Network. You click on that on our Web site and you see the rankings, but of the clubs, not of individuals. The top few clubs are very competitive, and it is fascinating to see how that little bit of competition made public encourages them to do more.

- Suzanne Gurton, Education Manager, Night Sky Network, Astronomical Society of the Pacific
on our Web site that summarizes individual data. That appeals to a far larger group of people. They don’t really care how they rank against others, but they want to keep track of their own individual lists, and technology has helped fulfill that need.

Then there is a larger group, probably the bulk of them, who are motivated by having a purpose. That is what keeps bringing them back. Some of them have been diving for years and this kind of renews their passion—"Yeah, this is why I became a diver!

Then there is a third group, though of course there are overlaps between all three groups. This third group ranges from people who have been diving a lot to relatively new divers. They are starting to notice changes. They can see that fish populations are changing, and they want to know what is happening with the data that they are collecting. We try to keep our Web site up to date, reporting back to our membership when data are used.

So we are trying to fulfill the needs of three different broad categories of divers in terms of volunteer participation. - Christy Pattengill-Semmens, Director of Science, Reef Environmental Education Foundation

- I haven’t seen competition as the motivating factor. I’ve had folks who have been monitoring now for twenty years and this is in their free time, and it is because it has become part of who they are. And there is a certain trust level that you will be taking their monitoring data and results and it will be used to good purpose. We find that our volunteers aren’t interested in socializing. They will monitor in any kind of weather. I’ve had to call them in because there was a hurricane coming. But if you try to get them together for a social event, it’s a "No." I always serve food any time people gather because that’s what you do, but getting them together for breakfast was not a big deal for them. They do it because it’s part of who they are.

In many cases we try to help our volunteers increase their community activity, so we do use volunteers as a stepping stone to community activity, but we also know that we need to honor people who want to monitor but would rather die than go and speak in front of a town council. And we have to engage people who think that monitoring is the most boring thing they’ve ever done in their life, but they are so alarmed by the results that they will take those results and they will run with them. So there is a whole different sociology
involved in trying to work with all of those different needs. What we haven’t tried is going the competition route to see if that works. - Linda Green, Program Director, URI Watershed Watch, University of Rhode Island Cooperative Extension

A Mismatch in People-Project Characteristics

• To get back to what Martin was saying about excluding people from projects, when we designed a smaller project looking at birds migrating through Milwaukee County, the people who wanted nothing to do with it and showed no interest were the listers. They didn’t want to spend time in areas that they knew wouldn’t have birds they wanted to see. There are a couple of them who see the value in what we are doing in conservation, but for the most part that was pretty much an audience we realized we wouldn’t get with that project. They are the ones who are doing the bird counts on a yearly basis. I think it is the competitive nature that they are into with that. - Timothy Vargo, Research Coordinator, Neighborhood Environmental Project, Urban Ecology Center

Moving Volunteers to the Data Interpretation Step

• I agree really strongly that it has been my observation in the groups that we work with that there are people of all different types. There are people who are doing it for pleasure, for scientific knowledge, for the fun of it; there are people who are doing it because they are really concerned about a problem and they want to see some action.

What I would like to encourage all models to do is spend some time thinking about how to train the volunteers to actually do some interpretation of the data. That is something that is really challenging and difficult to do. From what I can tell on some of these projects, they don’t know what questions they’re asking, they don’t even care, they just want to go out and do the data collection, which is fine. But if you could sort of push them a little in terms of: “These are the kinds of issues that we’re concerned about. We’re concerned about the birds disappearing. We’re concerned about visual pollution because of the light and so on. There are ways to look at this data and find the story, and you guys might be able to do that.”

I think some of them, not all of them, will hate that and not even want to go there, but some of them might go there and if they do, you are really educating them beyond being data collectors into really being scientists, into being able to look at

Who Are We Excluding?

• We’ve talked about these various motivations that people have. I think we can see that people come to citizen science with various perspectives. The question is, when we serve certain motivations of people coming in, who are these people? And another question follows, who are we excluding?

- Martin Storksdieck, Senior Research Associate, Institute for Learning Innovation

• In the Night Sky Network that is definitely an issue. There have been individuals who have contacted us who have said, “But that’s not fair, you have people connected to a planetarium who can do an outreach event after every show and I’m just here in my small town trying to do this. There’s no way I can compete.” Our response is, it’s not about competing, it’s about who you can reach in your small town. We encourage them to think about the impact that they’re having locally, not necessarily the kudos that are on the Web site. - Suzanne Gurton, Education Manager, Night Sky Network, Astronomical Society of the Pacific
data and make some interpretations. You may also empower them a little bit to take some action.

I don’t hear a lot of people talking about trying to push that data interpretation step, and I think that’s a step that would be useful for us to take.  - Candie Wilderman, Professor, Environmental Sciences; Chair, Environmental Studies Department; Founder and Science Director, ALLARM

Capitalizing on Identity (Birder, Diver, etc.)

- To me this comes back to identity—if we can identify the identity of the group. Our group is pretty easy, they’re all divers. There is such a strong identity with this, they are willing to spend literally hundreds of dollars to say, “I’m a dive master.” We can tap into that and use a training model in which they go through classroom and then in-water training and end up with a certificate. Well guess what? For our reef surveyor certification they go through classroom training and then in-water training and then get a certificate. If you can identify what the identity is and then tailor the program somewhat to that, I think you’re going to keep them longer and keep them more interested. To me this is also an American phenomenon. Americans are so into identity they put bumper stickers on their cars saying what they do in their spare time. That is so strong, and we can take advantage of that and carry it even further.  - Leda Cunningham, Executive Director, Reef Environment Education Foundation

- That’s also very important to amateur astronomers. They get pins now. Our annual award is that if you stay active for the whole year your club gets these pins. These guys are covered with their astronomy pins, with their comets or whatever, and now they get a Night Sky Network pin. - Suzanne Gurton, Education Manager, Night Sky Network, Astronomical Society of the Pacific

Rewarding Mastery and Achievement

- I want to confirm the potential benefit of giving certificates. In South Africa we have established a training system for tracking in which people can go through levels one, two, three, and then senior tracker and finally master tracker. Getting to level one is attainable in one year. About ninety percent make it to level two. The master tracker level is a lifetime honorary status. The benefit of this system is that it is achievable even for beginners who start at the first level, but it encourages you to take the next step and gives long-term incentives for people to work towards increasingly higher levels. They may be qualified to work in ecotourism, where levels one, two, or three are sufficient, but go on to strive for
more and improve their skills to reach senior and master levels.

The benefit of that is that if you have that part of your metadata in terms of the expertise of the tracker, you can assess and improve the quality of your database. It is valuable from the individual point of view in terms of being able to gain access at level one, so it doesn’t exclude, but also being able to continually work to improve your skills. And the scientific value is that you can actually measure the accuracy of the data.  - Louis Liebenberg, BioBlitz 2006, CyberTracker Conservation

**Bringing Scientists into the Sense of Community**

- In terms of bringing scientists into the community, I had a really embarrassing moment. I have a citizen science advisory board with about thirty professionals in the Milwaukee area who come and evaluate the research project. We just had a meeting and as they were leaving we were getting ready for our volunteer recognition event. There were stragglers who stayed late to finish up conversations and as they were leaving they asked what was going on, and we said we were recognizing our volunteers at the Center and they said, "Hmmm, aren’t we volunteers too?" It was embarrassing and brought it to my attention and now all of our researchers get all of our volunteer e-mails and have started coming to our volunteer events and are being recognized as volunteers.  - Timothy Vargo, Research Coordinator, Neighborhood Environmental Project, Urban Ecology Center

- I work with a lot of scientists and they’re trying to think of how to get the scientists interested in more citizen science. I can think of a lot of educational reasons and outreach and all of those factors that we have talked a lot about. Some of the reasons why they are starting to get more interested in it are things like robust sample sizes and large amounts of data, if they can be sure of the methodology—if there is a way to get volunteers to use what they consider standardized and scientifically valuable methods, or that the methods are very transparent and they can see how it was done and that the data is valid. The idea of sustained data collection for less money is also getting them very interested, and the ability in the bird world to direct birders who are already out and doing it anyway to collect data in areas where there are big knowledge gaps. Those are some of the reasons scientists are interested in joining citizen science efforts.  - Melissa Pitkin, Education and Outreach Director, Point Reyes Bird Observatory

- That is exactly why the American Association of Variable Star Observers (AAVSO) was started, because amateur astronomers are

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What Do We Mean by “Community”?  
- We are all talking about community in some sense, but there is something I got out of conversations with Eleanor Ely when we were writing this agenda. We had some title on there such as “Audience Identification and Techniques for Reaching Particular Audiences.” She said, "I think the way you’re using the word ‘audience,’ you’re talking about the volunteers, but the way we use ‘audience’ in water monitoring often means the scientists—how can we get the word out to scientists?"

We changed the term to “community building” and I see community as much broader than just the volunteers. I wonder what folks’ thoughts are along the lines of things like, how do we keep the scientists involved?  - Jennifer Shirk, Project Leader, Citizen Science Toolkit Project, Cornell Laboratory of Ornithology
out there looking every night and vast quantities of data can be gathered by people who are out there already. It’s not expensive, it’s a lot of data, and it is also quality data because they have to go through a training process. - Suzanne Gurton, Education Manager, Night Sky Network, Astronomical Society of the Pacific
Citizen Science Toolkit Conference
June 20 - 23, 2007

working group report outs
These report-outs took place on day three of the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York, which was held June 20-23, 2007.

The following report outs represent informal presentations by working group members. They are not transcribed verbatim but have been paraphrased and/or edited for clarity.

Documentation of the conference is meant to serve as a resource for those who attended and for others in the field. It does not necessarily reflect the views of the Cornell Lab of Ornithology or individual symposium participants.

The following report outs were delivered on day three at the conclusion of the conference. They summarize the discussions that took place in five separate breakout groups, which met periodically throughout the conference to focus on key Citizen Science themes and topics that emerged during conference presentations and plenary discussions.

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org
About the Conference Working Groups

Catherine McEver, The Bureau of Common Sense, Conference Documentarian

Throughout this three day conference, participants periodically separated into working groups to discuss questions related to the plenary presentation sessions. Those questions may be found at the start of each chapter in this document related to a conference session theme. Groups were assigned based on individual interest as well as by expertise. Because the conference conveners recognized the multidisciplinary nature of citizen science projects, as well as those who work with them, the expectation was that participants would employ their cross-disciplinary expertise to help keep broad interests in mind while working towards their working group’s goals.

The intent of these working groups was to ensure that the needs and perspectives of various aspects of citizen science were fully explored in order to inform the framework of the Citizen Science Toolkit. White papers or working notes were produced by each group and continue as living, editable documents online that are expected to change and expand as we work towards finalizing the Citizen Science Toolkit. This conference documentation includes brief report outs from each of the working groups.

Working Group Participants

Education
Allee/Losey
Ayres
Bushway
Cunningham
DeBuhr
Dunckel
Lewis
McConnell
Pankratz
Pitkin
Prysbby
Remington
Vargo

Evaluation and Impact
Ellenbogen
Haley-Goldman
Henderson
Jordan
Little
Maldini
Vaughan
Wilderman
Krasny

Community Building
Ely
Green
Gurton
LeBaron
McCrinnmon
Miller
Morten
Penningroth
Raczko
Studer
Swarth
Treadwell
Tufts

Technology and Cyberinfrastructure
Carlson
Forman-Orth
Kern
Knauer
Lemberg
Liebenberg
Michener
Peters
Stevenson
Witzel

Research and Monitoring
Baillie
Crimmins
Doesken
Droege
Hale
Marburger
Murray
Oberhauser
Pattengill-Semmens
Taylor

Research and Monitoring Group

Report out by Nolan Doesken, State Climatologist, Community Collaborative Rain, Hail and Snow Network, Colorado Climate Center, Colorado State University

I am delighted to represent a diverse group. I guess we could call ourselves cats because we were only marginally herdable. We were young, old, and in-between, but we were definitely dominated by a

The Working Groups:
- Education
- Evaluation and Impact
- Community Building
- Technology and Cyberinfrastructure
- Research and Monitoring

The Report Out Task
Report outs from each group were to focus on three topics:
- A group revelation
- The most important recurring theme within the group
- A controversy that needs to be discussed or resolved to move the field forward

Working Group Papers
Synthesis papers based on working group discussions may be found at:
www.citizenscience.org
...we became very concerned about the fate of our data, the quality of our data, the security of our data, the documentation of our data, and the ownership of the data en route to the research result, which from a research point of view is a significant question.

Revelation

We had a group revelation that was never discussed until the last half-hour of our time together. We did not fully appreciate through all this just how valuable our data really are to us, because we became very concerned about the fate of our data, the quality of our data, the security of our data, the documentation of our data, and the ownership of the data en route to the research result, which from a research point of view is a significant question. It became in our minds a bigger deal than we had ever thought about as we ventured into the first couple of days of the workshop.

Recurring Theme

We didn’t have to be herded too much while discussing the following recurring themes. These are items that we really embraced. The first is the fact that we really believe there is an extremely important role for the scientists as participants in citizen science. We also believe project design needs to be placed at a very high level of importance if there are going to be research successes in citizen science. We also want to charge the scientists with the responsibility of making sure that not only are the results of the activity communicated through scientific journals and peer review, but also directly to participants and to a broader public, and that this is done in a very timely fashion.

Controversy

In terms of a topic of controversy, we did get into a discussion of the term “citizen science.” The feeling was, here we are at the end of the workshop and we are still, as a group, not feeling comfortable about “citizen science.”

I know personally why I have some discomfort with the term, even though I’ve embraced it in many ways and I think citizens really like it as well. But if you have somebody come up and say they can’t participate because they’re not a citizen, then the “citizen” part of the term is being interpreted to mean a citizen of the U.S.

Maybe it’s the scientists in us that says we should debate that, I don’t know. But if the focus is only education, then should it be “citizen science”? If the focus is only monitoring should it be “citizen science”? Does it have to be pure research to be “citizen science”?

Can we elevate volunteers to be more than volunteer monitors? Is it just being volunteer monitors? And indeed, you know the spectrum. There are many who are happy to be volunteer monitors. There are some who never thought of it whose encounter with us will lead them or their children or their neighbor into being scientists. So it is a
Community Building Group

Report out by Geoff LeBaron, Director, Christmas Bird Count, National Audubon Society

We spent the last few minutes of our time together trying to come up with a few sound bites for each of the topics below, and here they are.

Revelations

• A lot of programs and resources already exist, so we basically need to make sure that we are becoming a resource toolkit and not just a toolkit.

• The big bell that went off in our heads is that we really need some social science expertise when we are starting to think about citizen science.

• The last revelation is also a recurring theme: Citizen science means different things to different audiences.

Recurring Themes

• The first and perhaps the one that came up most frequently: Community, what is it?

• What also kept coming up in almost any part of our discussions is that you have to be aware of scaling issues in whatever we do, from small scale to large scale and all of the continuum in-between.

• For the toolkit, first and foremost, we need to make sure that we have a glossary included (e.g., “What is ‘community’?”).

• A “project marketplace” was proposed as a way of soliciting new input and new potential projects right through the online toolkit.

• Volunteer management tools was another recurring theme in terms of the toolkit, and we almost thought we should be renaming the whole Citizen Science Toolkit.

Controversy

• Does citizen science need scientists?

• Do the terms “citizen science” or “toolkit” need to be changed?
The Charge to the Technology and Cyberinfrastructure Group:
What opportunities exist for innovation, and how can the Toolkit remain current?

This Public Science Corps would provide implementation leadership, and the first task of this group would be to crystallize what we refer to as a “community of practice” ...

The Charge to the Evaluation Group:
What diverse outcomes and impacts should be considered in designing Toolkit evaluation materials? How can they be measured?

Evaluation Group
Report out by Rebecca Jordan, Assistant Professor of Citizen Science and Environmental Education, Volunteer Trail Monitoring for Invasive Plants, Rutgers University Department of Ecology, Evolution, and Natural Resources

I’m going to echo a lot of what has already been said, and probably that is not very surprising.

Making the Toolkit Useful
The first question we addressed was, what do we want to get out of this? What would be the most valuable aspect of this toolkit? We came up with three responses:

- The toolkit needs to be flexible in terms of the diversity of projects,
in terms of users’ areas of expertise, in terms of the time users are willing to spend, and in terms of their goals, audiences and partners. We want the toolkit to be flexible to meet the needs of diverse groups.

- We thought this should be dynamic in terms of evolving and growing and in terms of it being participatory.
- We agree with what was said by the Community Building group: With respect to the toolkit, we want to build on what already exists. There is really no reason to reinvent the wheel.

Recurring Theme
Evaluation is always dependent on your goals. This came up again and again in every one of our discussions. Project effectiveness needs to be measured in terms of your goals. This can be especially hard to deal with when you are thinking about practitioners who want ready-made programs. There is no real one-stop shopping or cookie-cutter evaluation tools. We need to find a way to accommodate the needs of these different people, making it manageable but stressing the fact that there really is no ready-made kit that we can just hand to them.

Revelations
We found that people are coming at this from such broad, diverse perspectives beyond the scope of what any of us originally thought when we first came together a couple of days ago. But we also found that there are cross-disciplinary concepts that we all have in common. While there are jargon differences, we need to find a way to speak a common language, and this holds true not just for evaluation but for every aspect of citizen science.

We also realize that effectiveness in science as a practice may not necessarily be intuitive for scientists, but that this evaluation of effectiveness really needs to be part of the process and part of project planning from the very beginning and throughout.

Controversy
For our controversial topic (as you might guess given the previous presentations) we talked about the term “citizen science.” First of all, we did discuss much of what the Research Group discussed in terms of volunteers being scientists, monitors, technicians. Overall, though, we also discussed whether we need the “science” in “citizen science.” Is it important for scholarship and credibility and funding, or is it simply promoting exclusivity?

Beyond this, how can we deal with defining citizen science as a field or a discipline? Where are the common elements of all of these projects? Or is it okay to say that these are different elements that might exist in differing degrees in different projects?
Another discussion that came up again and again was the degree of standardization. Again, while this question may relate to all aspects of citizen science, it is particularly relevant for evaluation: Can we standardize in terms of metrics or instruments? And again, our group was across the board regarding the extent to which we thought standardization was possible.

Education Group

Report out by Maureen McConnell, Senior Exhibit Developer, Boston Museum of Science

Kudos to Lab Staff

It was only shortly before the conference that our staff at the Lab knew that they were going to devote three days of their time to this conference helping to facilitate these working groups, and I would like to express a huge thank you to them for their efforts and their enthusiasm:

- Education - Colleen McLinn, Mike Powers;
- Evaluation and Impact - Tina Phillips, Jen Schaus;
- Community Building - David Bonter, Flisa Stevenson;
- Technology and Cyberinfrastructure - Paul Allen, Jeff Gerbracht, Roger Slothower, Chris Marx;
- Research and Monitoring - Caren Cooper, Kitty Gifford.

I would also like to thank the PI staff who saw the necessity of allowing the staff to take the time to do this. So to Janis Dickinson, Steve Kelling, Jason Mobley, and Ken Rosenberg, thank you for allowing this to happen and for guiding this process as it happened. And a huge thank you to Rick Bonney for having this vision to work towards. - Jennifer Shirk, Project Leader, Citizen Science Toolkit Project, Cornell Lab of Ornithology
citizen science toolkit and closing discussion
This discussion took place at the Citizen Science Toolkit Conference at the Cornell Lab of Ornithology in Ithaca, New York on June 20-23, 2007.

In the following discussion participant comments are not necessarily exact quotes and may have been paraphrased or edited for clarity.

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The following discussion was held during the final plenary session on day three of the Citizen Science Toolkit Conference.

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Citizen Science Toolkit and Closing Discussion

Citizen Science as a New Field or Discipline

- I would like to pick up on something one of the groups just said about “fields of discipline.” What I’ve been wondering during this whole conference in terms of where we go from here is, is citizen science (or whatever we decide to call it) a discipline? Is it an emerging field? If it is a discipline or an emerging field, how can it be organized? Will there be textbooks someday? Will there be a journal of citizen science someday? If so, is it time to start thinking about an association, like the Visitor Studies Association for people who are studying how visitors react to and interact with each other in museums, who got together and said, “We need to work together”?

Or is that the kind of thing that would kill something that is really kind of neat because it’s a little bit loose and woven together in a web? I would like to open the floor to that discussion and then come back to the nuts and bolts of the toolkit. - Rick Bonney, Director of Program Development and Evaluation, Cornell Lab of Ornithology

- This is not my idea, it was said in my group, but it stuck with me. It’s Science 2.0. - Rob Stevenson, Associate Professor of Biology, University of Massachusetts, Boston

- I took the position that I now hold believing that there is a field, there is a practice, there is scholarship behind this. Something like associations and journals are common to other practices and fields and I see no reason why they shouldn’t be common to this field. Certainly there are differences among projects and different approaches, but in any field you have different theoretical frameworks, so I think the field of citizen science can accommodate these differences. If we’re looking at the effectiveness of our practice, we are doing scholarship. We do have a field, no matter what we say it is called or what frameworks we operate under. - Rebecca Jordan, Assistant Professor of Citizen Science and Environmental Education, Volunteer Trail Monitoring for Invasive Plants, Rutgers University Department of Ecology, Evolution, and Natural Resources

- On the one hand I completely agree that it is an emerging field or discipline. I only caution us against using the term “discipline” because it is a very academic term, and the concept of citizen

An Existing Field
Transformed by the Internet

- I’ll play devil’s advocate. One of my thoughts throughout this conference has been that what you are seeing in citizen science vis a vis science really isn’t that different than what many other fields are seeing because of the structure of the Internet—whether it’s citizen journalism or what is happening to medical care and the disintermediation of doctors, or music.

In some sense, the scientists as the high priests of science are going to lose their role and become partners in the scientific process. In many ways, what I think we are seeing is a transformation of the field much more than a new subsection of the field. And it’s all Web 2.0, it’s interaction, it’s all because of that. - David Witzel, Managing Director, Backyard Jungle, Forum One Communication

- So maybe it isn’t about a new discipline. Maybe it is that things are becoming more public—science, journalism. I remember documents about the Iraq war being loaded onto the Internet and poring through them and reading analyses of what was really happening. - Rick Bonney, Director of Program Development and Evaluation, Cornell Lab of Ornithology
About that Word "Citizen"

• If you think of the word “citizen” in terms of being a citizen of the world, worrying about whether citizen is the right term is a very American perspective. Just define it as being global citizens and dispense with that debate. - Louis Lemberg, BioBlitz 2006, CyberTracker Conservation

• It’s not the Americas in general— I’m from Canada and we don’t fix on that. It’s a United States thing, this “citizen” business. - ZoAnn Morten, Staff, The Pacific Streamkeepers Federation

• I’d rather not get too involved in definitions and semantics and instead focus on the process. If you start worrying about what “citizenship” really means you’re going to miss an important point. I’ll point out something since we’re here at the Lab. The bird logo used for the Lab was controversial almost from the moment it showed up and people wanted to get rid of it. It’s still here because it works, and “citizen science” will work because it does work. Let’s get at the process of making it happen. - Donald McCrimmon, VP of Academic Affairs, Nature Network, Cazenovia College

• The analogy for me has always been GIS. GIS is a tool but it is also a field. There are people in another field who just use GIS as a tool, and there are people for whom that is their discipline and their field. - Michelle Prysby, Coordinator, Virginia Master Naturalist Program, Virginia Tech Department of Forestry

• Is it a reemerging field? Before there was science there were people who observed the world around them, thought about it, experimented, and tried to make it better in a variety of ways, and that is science. I think it’s a reemerging field. - Maureen McConnell, Senior Exhibit Developer, Boston Museum of Science

• As a scientist, I want to endorse yet again the scientist’s perspective that if a separate discipline called citizen science emerges, in my opinion that would be a handicap. I really like the idea, whether you call it Science 2.0 or whatever, that this is a new way of doing science, and it’s the way we need to do science to answer some of the big remaining scientific questions that are out there. I think that is the message that we need to rally around. We need all the different elements involved, scientists and nonscientists, and we need everything that is going on here, but we are not doing something separate from what scientists are doing. We are doing the remaining really big science that needs to get done, and it needs the world’s citizens to do that. - Ken Rosenberg, Director of Conservation Science, Cornell Lab of Ornithology

• I work with teachers. I teach teachers, and they go out and practice teaching. There is a whole discipline of study and research regarding teaching, but these teachers are not interested or trained in that. They are interested in what comes out of the research on teaching. When we talk about citizen science, at one level I can imagine researching the process of citizen science programs. That to me is academic, it is a discipline, it is scholarship. That is one aspect. But what people are doing and participating in as science may be a different aspect; perhaps more applied.

It is all part of the same thing, but I still see citizen science as a distinct discipline, an area of scholarship, an area in which a journal could exist that would publish papers by people working in different areas. Citizen science is an interdisciplinary area of
research, and these different disciplines could appear in a common journal so that I could find out about people’s research at one level and about what people are doing at a different level. That would be fantastic for those who are practicing citizen science and those who are researching citizen science. There is scholarship that is built around studying scientists and the philosophy of science and there is the practice of science, and this does not pose a theoretical problem. Why can’t there be a scholarship built around studying citizen science as well as the practice of citizen science? Again, an interdisciplinary citizen science journal could capture research and practice—I would endorse that. - Rebecca Jordan

• I didn’t mean to imply that the scholarship aspect of this is less than valid. What I am saying is that if the science that is done is labeled as citizen science, it will be handicapped, like it or not, by some within the scientific community. - Ken Rosenberg

• I’m trying to figure out what Ken is saying. I think Rebecca is talking about a journal in which people from different disciplines publish. That happens in science. If you look at the Journal of Animal Behavior or the Journal of Ecology, you’ll find trees and fish and mollusks. I guess you won’t find astronomy in there, but there are probably journals that have more of the physical sciences. That is already happening.

I am wondering if what you are saying, Ken, is that we actually run the risk of marginalizing citizen science by having an association like that because then the response could be, “Oh, that’s just citizen science that they’re doing over there.” I think people were applauding when you spoke about taking over the scientific enterprise and science being more of a public endeavor. But then there is a whole other set of discussions that we could evolve into because that happens a lot more in Europe, I think, although I am quickly out of my field here. I think in Europe the public has a lot more impact on science and I think it has both positive and negative consequences. - Rick Bonney

How Much of a Science Role Do Citizen Scientists Play?

• One of the things we discussed in our group is the fact that we’ve slipped into calling participants “citizen scientists,” and in fact we are not training them to be scientists. They are data collectors for the most part. They are participants in a process, but they are not scientists. For the most part, we are not directing our programs to create scientists out of our participants, nor do many of these people want to become scientists. So one of the difficulties of the term is slipping into the idea or the thinking, on our part and on
their part, that these people are in fact citizen scientists when most of them have no intention of being so, and most of us have no intention of teaching them to be so.  - Chip Taylor, Professor of Ecology and Evolutionary Biology, Monarch Watch, University of Kansas

• I don’t know if that’s really true that most of us don’t have that intention. I fundamentally agree with what you say and you know that because we’ve discussed it a number of times in the last couple of days. But there is “citizen science” and there is a “citizen scientist,” and those are different things. Citizen science can involve people at many different levels. I don’t think we call somebody a “citizen scientist” until and unless they are asking and answering their own questions.

I think that a lot of the programs that we are developing do hope to do that. You can go into the eBird database or the FeederWatch database, download the data, come up with a question, and answer and publish it in a peer-reviewed journal (if you can get it in there). That is somebody using these data, which they might have helped to collect, to really finish off that process. The problem is that it is hard to get people to do that. If anybody here really knows how to get people to do that, that is something we might have focused on integrally in the last couple of days. So I think there is a distinction there in when we call somebody a “citizen scientist.”  - Rick Bonney, Director of Program Development and Evaluation, Cornell Lab of Ornithology

• We had the same debate internally a while ago. We were kind of interchanging the terms “volunteers” and “citizen scientists,” and we thought we should standardize it. What we came up with is that it is more of a process. Volunteers are working towards becoming citizen scientists, just as anybody works towards becoming a scientist in their education, so it is more of a process than a definition.  - Timothy Vargo, Research Coordinator, Neighborhood Environmental Education Project, Urban Ecology Center

Next Steps?  
• Something that I would like all of you as practitioners to be thinking about is, what do you want from this group? One part of that question is, what do you want from the Web site? That is the only thing we have right now that is tangible, and that won’t come to fruit until we start including all the different models and all the Google Docs on there so that it becomes something from this group.

I’m also trying to think of where we go from here. I keep hearing, “When is the next conference?” which made me very happy. Who is going to sponsor it? Is this group going to come together and form an association? I don’t know about definitions, but I’m trying to move us in that direction.  - Rick Bonney, Director of Program Development and Evaluation, Cornell Lab of Ornithology

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Ideas for Next Steps Going Forward

Creating an Association, Curating Shared Assets  
• To advance the concepts and consolidate the vision under which many of us now operate, certainly those of us in the Cyberinfrastructure Group felt there is no question that this community is not only an association but something much larger. Right now we are really fragmented. Everybody is trying to get $20,000 here and $20,000 there to build something that somebody else has already kind of built somewhere else, whether it’s a program, a volunteer database, or whatever.
If we try to take a bold vision about where we want to be in five years and can get together and agree on that, we can communicate that vision, not to the standard funding sources, but the new money funding sources that Josh Knauer is familiar with and has some experience with, at least peripherally. If we could just explain the concept to them and what we are trying to do, which I don’t think we can do very well right now, there are some people there who will say, “Man, that’s great! I happen to have made my money by doing technological work. I see that lots of solutions need a technological framework so that all of these projects can use it.”

There’s more to it, but I think unless we want to keep scrabbling away piece by piece, the only way we can make this concept scale up is to at least create an association. But much bigger than that, make a body that actually curates shared assets.  - Paul Allen, Assistant Director of Information Science, Cornell Lab of Ornithology

- As a point of clarification, does the association involve the professionals, or does it involve participants, or key participants?  - Lori Bushway, Senior Extension Associate, Leader of Adult Outreach, Garden-based Learning Program, Horticulture Department, Cornell University

- To be determined, but my first thought was professionals in the field. Not the participants themselves because I think it is the individual projects that know how to recruit and embrace their participants, not an association.  - Rick Bonney

Cross-disciplinary Communication and Common Denominators

- I am hoping that the product of this conference is going to be that people from many different disciplines studying many different things are going to start talking and sharing and basically becoming more efficient as a group. I would love to challenge all of us in this room to figure out a way to do that with the hundreds of thousands of citizen scientists, or whatever you want to call them, that are already out there. How do we get the frog people talking to the bird people talking to the rain people talking to the astronomy people?

The only analogy I could come up with late at night are people who collect antiques. They all love antiques, but some collect coins, some collect furniture, and some collect paintings, and they all
Publishing Papers Based on Citizen Science Data

- We had a discussion in the Evaluation Group about papers that are published that come out of citizen science. They were produced using methods that you interpret as part of the paper. Those methods may differ from traditional research, but the two can benefit from each other, and those of us here can benefit from one another’s experiences in that regard. An important distinction to make when you are publishing a paper using citizen science data is how you validated your methods, how the citizen scientists were trained, how the data was gathered, analyzed, and interpreted.  
  - Martin Storksdieck, Senior Research Associate, Institute for Learning Innovation

- Yes. For example, Project Tanager resulted in a paper in Conservation Biology, and surely the methods section talked about how the volunteers were trained and sent out into the field. But then are we missing something? That paper doesn’t talk at all about the impact on the participants. It doesn’t talk at all about how those data might or might not have been used.  
  - Rick Bonney, Director of Program Development and Evaluation, Cornell Lab of Ornithology

Establishing a Group Identity - The Extension System

- I think the Extension programs, to some extent, are something you might want to look at. They have their own journal in which people from all of the different disciplines publish. They meet once a year. Each state has a totally different model in terms of how they engage people from all different backgrounds. It is a way to really get people involved, and what it has done is to give name recognition for this corps of individuals. And for better or worse, there is a kind of aura about it. I think it is good that there is some kind of identity there.  
  - Theresa Crimmins, Instructional Specialist, Sr., Arizona Master Watershed Steward Program, University of Arizona

Holding Another Meeting (and an Impressive Precedent for Doing So)

- I’m having a sense of déjà vu. In 1976 a group of us who were studying wading birds decided to have a conference and got some funding. We had the conference and it felt a lot like this one does now. At the end of the conference people were saying, “What next?” What we decided to do was have another meeting, not one that was funded necessarily. We said, “Suppose we held a meeting, who would show up?”

At that first conference I think there were eight people. For the first meeting, which was held at Northern Illinois University the next year—let me repeat that, Northern Illinois University in November—we had 125 people show up on their own dime.

I was thinking it may be the same kind of dynamics that are going on here. The question is, “What next?” My suggestion is (and thus the sense of déjà vu), maybe we could hold a meeting somewhere next year where those other eighty people and organizations who wanted to come to this conference (and probably a lot more that we don’t know about) could come and join in this discussion.

Let me point out what happened as a result of that second meeting. We created a new organization. We changed the name three times, which is why I’m not too concerned about names. We started a journal. For the first three issues of the journal it was done on an offset press; it wasn’t reviewed, anybody could watch Antiques Roadshow on PBS. That’s the one common thing they have. If we could find that one common denominator, or several, that bring all of the people involved, including those who are on the ground in the field, to start communicating with each other, that would put us light years ahead.  
  - Chuck Remington, Director of Field Support, National Audubon Society
put anything in that they wanted. That has morphed into what is now, at last count, one of the ten top ornithological journals in the world. It took thirty years to get there, but look what happened.

My sense, just from the feel of this group, is that this could happen here. But it isn’t going to happen overnight, it will take some time. That’s what my suggestion is: Let’s have another meeting. Blogs are good, social networks on the Web are good, but face-to-face is still, in my view, the most productive way to spend time. - Donald McCimmon, VP of Academic Affairs, Nature Network, Cazenovia College

- How many people in this room would go to a meeting a year from now in the United States on their own dime? There are a lot of hands up and as you pointed out, there are all of those other people who wanted to be here. - Rick Bonney

Aspects Warranting Attention
Influencing Policy, Studying the Process, and the Role of Scientists

- There are three things that I think are kind of orthogonal. What I find is that I want the scientific process introduced into the public discussion. I don’t really care about the academic papers or people, I want it in the policy decision-making process. So I think it’s important that science be delivered, and I think it’s important that we have citizens involved in the scientific process in order to do that successfully. That is one thing we’re talking about.

A different thing is whether we should be studying that process, and absolutely there should be a process for studying how citizens are involved in the scientific process.

The third thing is, what is the professional scientists role in that process? I think to a large extent it is a guiding role, but that is one of many roles. We also need data collection, we need darned good people disseminating, we need graphic designers, we need Web sites—they are all part of that scientific process that is going to be influencing societal decisions.

That is the big vision I found with all of this. I think we need this in order to cope with society’s problems going forward. - David Witzel, Managing Director, Backyard Jungle, Forum One Communication

The Tension Between Objective Data and Motivating Involvement in Political Issues

- I think you have to be quite careful when you get concerned in

A Concept that is Gaining Currency

- I think there is a risk in marginalization, but the idea of citizen science seems to be gaining credibility. E.O. Wilson just wrote a chapter on citizen science in his book, The Creation. In my experience in universities, I’ve run into people who will have nothing to do with it but they are the minority. - Timothy Vargo, Research Coordinator, Neighborhood Environmental Education Project, Urban Ecology Center

Existing Network/Journal for Citizen Science

- There is a group that focuses strictly on getting citizens involved with researchers from many universities and federal, state, and local organizations to do citizen science and publish it in their own journal. It is called Chicago Wilderness and they publish all of their information in that for policy use, for education, for informing the citizenry. It is a huge network of people. - Joy Marburger, Research Coordinator, great Lakes Research and Education Center, National Park Service
motivating people to get involved changing policy issues, that is, if you are concerned with monitoring the effectiveness of policy. I think the reason that our data are effective and well respected in the UK is that they are seen as being independent, they are not perceived as coming from a lobbying group. I think there are sometimes some tensions between a desire to gain objective data and a desire to motivate people to become more involved in the general process of political change or pressure for policy change. - Stephen Baillie, director of Populations Research, British Trust for Ornithology

Concrete Suggestions Beyond the Web Site

A Call for Concrete Suggestions

• The NSF grant that funded this was a conference grant. Those are capped at $250,000, and this proposal was $249,999. It is expensive to put on something like this, and we have spent most of that money already. We have a little bit of money left over and what we are committed to doing at this point is getting all of those Google Docs from your working groups edited and getting all of the comments up on the Web site where everybody can see them clearly; getting some models for discussion; getting some references on there, which we hope you will add to; getting the database gateway up on there; and getting all your projects on there. There will also probably will be a listserv that has RSS feeds built into it like most of them do.

That is really all the funding that we have available to us right now, which is to complete that Web site and get it going. I have no idea if people will use a listserv, or if people will talk to each other once we all leave here. I see very few models. There are stamp collectors, antique collectors, railroad people, but I’ve found that professionals just don’t seem to talk to each other so much on listservs. What I would like to hear are more suggestions about moving this forward beyond just finishing building the Web site. - Rick Bonney, Director of Program Development and Evaluation, Cornell Lab of Ornithology

A Call for Concrete Action

• I felt like a lone voice in the wilderness when I first came to this conference and since I have been here I feel like there has been a slightly broader acknowledgment that one thing we need to do is move forward in the next decade or so to give citizen science the status it needs and the infrastructure to support it. No one institution can do that. When you start talking about whether this is a discipline and about forming another organization and whether we want to have a conference, my answer to that personally is, if it is
CITIZEN SCIENCE
Toolkit Conference

a working organization that can make this actually come to fruition and produce these shared assets that will really support all of our programs, then you betcha. But if it just another concurrent session with everybody coming and talking about what they’re doing, then I’m not going to come. If it’s the former, I’ll pay on my own dime. If it’s the latter I won’t come at all. - Cindy Hale, Program Director, Great Lakes Worm Watch, Boulder Lake ELC

• If there are people here who agree with that, let’s hear some ideas of what that infrastructure might look like. What are some of the pieces that might be involved? - Rick Bonney

• We talked about concrete pieces in our group and it got really complicated really fast. Maybe we should just talk about suggestions concerning how we might explore what the pieces are and what it might look like. - Anon. Cyberinfrastructure Group Member

• I can appreciate that but there might be a couple of broad categories that I’m not thinking of or others haven’t thought of. Are there a couple of general infrastructure needs, interests, categories? - Rick Bonney

Lesson Learned from the Volunteer Monitoring World: A Newsletter as a Key Piece of the Infrastructure

• This is really eerily déjà vu of what the volunteer monitoring community experienced when we had our first meeting in 1988 and about fifty people came. In 1990 we had 120 people. We talked about forming an organization and made some motions towards forming an organization, but ultimately didn’t. One of our goals was what we called moving into the mainstream, to see our volunteer water quality monitoring accepted as a part of the water monitoring community in general. We didn’t want to be marginalized and have people saying, “Oh that’s what those people do out there, but their data isn’t any good.” I think we were successful with that goal. Now we are seeing a new generation of managers come through and we are reeducating them.

But I will tell you the one thing that kept the volunteer monitoring movement alive and moving and active is the Volunteer Monitor Newsletter. It really kept us going. It has been eighteen years and it is printed two to three times a year. A bunch of us are on the editorial board, it is topically oriented, and I really do believe that without that newsletter we would just break, we would not be where we are today. I think in terms of infrastructure and moving forward, that was really key to where we are now. - Linda Green, Program Director, URI Watershed Watch, University of Rhode Island Cooperative Extension

About Forming an Association

• I want to follow up on what Linda said about a national association of volunteer monitoring. There was a debate back and forth in the early years about that and I’m not so sure that was the right decision. I was kind of excited when we were talking about the possibility of an association, and I’m not sure whether this group should reject the idea because of what happened with volunteer monitoring.

We weren’t motivated to start an association because at the time we were getting a lot of support from the EPA and we had everything we needed—we had conferences, we had a newsletter, all of the things you would get from an association—so there wasn’t much motivation. Now that the EPA is supporting us less and less, maybe we would be better off if we did have one. I just didn’t want to leave you with the idea that the lesson you take away is that you don’t need an association. - Eleanor Ely, Editor, The Volunteer Monitor
• I don't want to let this idea of a newsletter die. For me, it offers a
direction to go forward. What if there were some kind of online
journal that included information about the tools in our projects
and offered different perspectives? If we are talking about forming
an association, an online journal might be a step on the way to
that. - Rebecca Jordan, Assistant Professor of Citizen Science and
Environmental Education, Volunteer Trail Monitoring for Invasive Plants,
Rutgers University Department of Ecology, Evolution, and Natural Re-
sources

• The first thing that you can do is e-mail me ideas like that so that I
can include them as questions in the follow-up survey to see if
there are people interested in helping them move forward. - Rick
Bonney

Developing (or not)
a Shared Data Infrastructure

More Lessons Learned from the Volunteer Monitoring World

• I'm curious why volunteer water monitoring doesn’t have more of a
shared software infrastructure. Could you comment on that? Each
monitoring group keeps their data in their own little system, right?
- David Witzel, Managing Director, Backyard Jungle, Forum One Communications

• No, and that’s very interesting, because when the National Water
Quality Monitoring Council was started in 1997, cochaired by EPA
and USGS, one of the reasons it was started was because we had
these two data warehouses and monitoring programs that were not
speaking to each other and barely acknowledged that each had
data that the other considered quality (and that was after a
number of years of an interagency task force on monitoring).

What we saw was a goal, not to try to get the data to agree with
each other, but to harmonize with each other because there are
many methods of doing things and many methods of doing things
positively. We see it as performance based. That was really the
goal, to try to get these two data warehouses and the agencies and
organizations that feed into those working on a common portal. It
has been a huge effort. Now, if you want to get water data, you
can go to this common portal and get data from EPA, you can get it
from USGS, and so forth. That whole thing all along has been a big
backdrop to everything in terms of the monitoring program.

When we started our facilitation program we had this great dream
that we’d have a database into which volunteers could enter their
data. Now we are realizing there are so many aspects and ques-
tions of who, what, when, and where. It would be better for us to
let people think of the questions they needed to answer and have

Volunteer Control over Data
Management and Mining: A
Step on the Road to Becoming
Scientists

• The other thing about data is that
we made a decision. We used to
have a common database for all
of our fifteen or twenty different
watersheds. We finally decided
that in order to teach volunteers
good science, it made a lot of
sense for us to teach them how
to manage data for themselves.

What we did is set up some
templates. We actually prefer
them to keep the data them-
selves. That way they can
manage it, they can graph it,
they can analyze it, they can
mine it, or whatever.

People have been talking about
moving people from being data
collectors to being scientists.
They don’t necessarily have to
mine the data and publish in a
scientific journal to move
towards being a scientist, but in
fact, what they can do is learn
how to manage data and learn
how to see the story in their data
and how to ask questions based
on the story that they see, and
then go back and ask new
questions. To me, that is being a
scientist and that is moving them
forward. What I am saying is that
keeping the data locally has
some advantages whereas if you
keep it in a big database,
volunteers sometimes feel
they’re putting the data into a
big black hole. - Candie
Wilderman, Professor, Environmental
Sciences; Chair, Environmental
Studies Department; Founder and
Science Director, ALLARM
them building their own rather than to have one kind of monolithic thing. Does that answer your question? - Linda Green, Program Director, URI Watershed Watch, University of Rhode Island Cooperative Extension

- It’s just a concern that we talked about in the Cyberinfrastructure Group, if we should think about facilitating that kind of an infrastructure. I’m just wondering what the real catches are. - David Witzel

- We’re not suggesting a big database, but as Candie said, they made templates so that people could do their own thing. That is what the Cyberinfrastructure Group would hope would be available. - Paul Allen, Assistant Director of Information Science, Cornell Lab of Ornithology

Ongoing Communication

- A lot of us have been talking about a lot of similar things that I think our working groups were approaching but didn’t necessarily summarize. A point of fact is that we have all had a lot of really exciting, interesting, engaging discussions. As a community-building group, we are a community now, those of us in this room, the people we represent, and others like us. I would hope that we will continue to be in communication as a community, and that we ourselves are one of the communities that we are building. This sort of echoes what Chuck Remington was saying about helping each other and continuing to communicate about things and how we can help others as well as ourselves. - Geoff LeBaron, Director, Christmas Bird Count, National Audubon Society

- I haven’t gone online to look at the Google Docs produced by the working groups yet, but I have been imagining that it is almost like a review group, and that we’re almost done but not quite. When you get home you can still go on there and adjust and change and modify and get your opinions in there. That is one way we will keep talking. How we will keep talking beyond that is important. - Rick Bonney

Concluding Remarks and Acknowledgments

- In a group that came together for a cross-disciplinary endeavor, I am incredibly impressed by the extent to which everybody in this room thinks outside their discipline, outside their box, and the amount of creativity and energy that we saw here in the last few days. I hope to continue to get to

Regional/Topical Groups/Data Within a National Scheme

- I want to make another comment about water quality monitoring. A program developed by Purdue University in cooperation with EPA called L-THIA is a long-term planning tool to demonstrate land use impacts on resources and hydrologic features of a region/community. Check out the following Web sites:
  - www.ecn.purdue.edu/runoff/lthia_index.htm
  - www.epa.gov/owow/nps/watershed_handbook

The Water Management Districts in Florida were developed in 1974 in an attempt to evaluate long-term watershed resources use. They were some of the first regional government organizations to use a watershed approach for water use planning. I’ve had experience with two of the five districts, St. Johns River Water Management District and the South Florida Water Management District:
  - www.sjrwmd.com
  - www.sfwmd.gov

I think water is a common theme for most regions now because of its importance for sustainable populations, and you need to have a common database that allows you to pull out information based on your location so that you can evaluate it in relationship to what the citizens want, or what the scientists want, or whatever.

Water quality is something that is a national effort. Some of the other topics here are more localized, so you almost have to have a regional or local group like the societies do—they divide up into regional societies that focus on the topics of their regions. - Joy Marburger, Research Coordinator, Great Lakes Research and Education Center, National Park Service
Thank You to Participants

- I want to thank you all once again for coming. I never, ever dreamt that there would be this much interest. I knew that we had an obligation to the National Science Foundation to put on a conference and I just thought it would be a whole lot of fun. Some of you I know, some of you I’ve known for a long time, some of you I’ve just met. The ones that I didn’t know all started out as these little essays, and it’s really hard to review those and decide, is this person going to really help or is this person going to be the one jerk that Chuck Remington noted you get at every conference? We didn’t get any of them this time. In fact, it was so much the opposite, with every single person engaging in a major way. Thank you so much. - Rick Bonney, Director of Program Development and Evaluation, Cornell Lab of Ornithology

- I will only take a moment because to be honest, after taking notes to try some summary comments at the end, I find that it has all been said. This is just the very beginning of the conversation and you all had an opportunity to add input here to the process of moving it forward. Not everybody takes advantage of that in a conference, and I am one of those people behind the scenes who will keep pursuing you after this conference and looking for your input. Please share it. We want your input, that is why we brought you here.

We brought you here to hold us accountable as we go forward with this endeavor, and whether or not it is a discipline or a field, I don’t think it really matters. As has been said by Chuck and others around the room, we are a community and we will meet again. I don’t know when or where, but building that sense of community has been part of this conference. I think the most powerful aspect has been getting to know all of you in this room, so thank you very much. - Jennifer Shirk, Project Leader, Citizen Science Toolkit Project, Cornell Lab of Ornithology

know you better. Most of all, I want to thank Rick Bonney and Jennifer Shirk for the outstanding job they did putting together this conference. - Janis Dickinson, Director of Citizen Science, Cornell Lab of Ornithology