Citizen Science Toolkit Conference

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models of community science: design lessons from the field

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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 as part of the session titled "Citizen Science Project Design" on day one of the Citizen Science Toolkit Conference

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Models of Community Science: Design Lessons from the Field

Candie C. Wilderman, Founder and Science Director, ALLARM; Professor of Environmental Science, Dickinson College, Carlisle, PA

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. I guess we're probably stuck with the term "science." People have different definitions of that, but I'm not sure they're doing science.

The roles in which ALLARM engages citizen-scientists has 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

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The roles in which ALLARM engages citizen scientists have varied over the past 21 years.

since 1986, but we started as the Alliance for Acid Rain Monitoring. Our original mission was to study acid deposition on Pennsylvania's waterways with the help of community volunteers. In 1996, ten years after we started, we shifted our focus to provide technical and programmatic support to community organizations that were interested in broader issues beyond the acid deposition issue. We have twelve to fifteen Dickinson College students and we also have professional staff, and we work with about fifteen watershed associations right now on water quality monitoring assessment.

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 water 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 College 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.

ALLARM Staff, Spring 2007

Here is our staff as of this last spring. We have about twelve or thirteen students here. I'm the Science Director, and our Director is here as well. We also have an Assistant Director who is not in the picture.

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 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."

Community Consulting Model (Science for the People)

Who defines the problem?	Who designs the study?	Who collects the samples?	Who analyzes the samples?	Who interprets the data?
Community	Professional scientists	Professional scientists	Professional scientists	Professional scientists

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

Categorizing the various models for community science can be based, in part, on answers to five questions:

- Who defines the problem?
- Who designs the study?
- Who collects the samples?
- Who analyzes the samples?
- Who interprets the data?

The Mully Grub Restoration Project conducted by ALLARM:

Dickinson college was the primary consultant, providing student research which documented the problem, writing the grant, and coordinating the parties involved in the restoration.

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.

Watershed-based Integrated Field Semester (Luce Semester)

Under the Consulting or "Science Shop" Model, all students do an independent research project on an issue defined by ALLARM's partner groups.

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

Who defines the problem?	Who designs the study?	Who collects the samples?	Who analyzes the samples?	Who interprets the data?
Professional scientists	Professional scientists	Community	Professional ~~scientists~~ Community	Professional scientists

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.

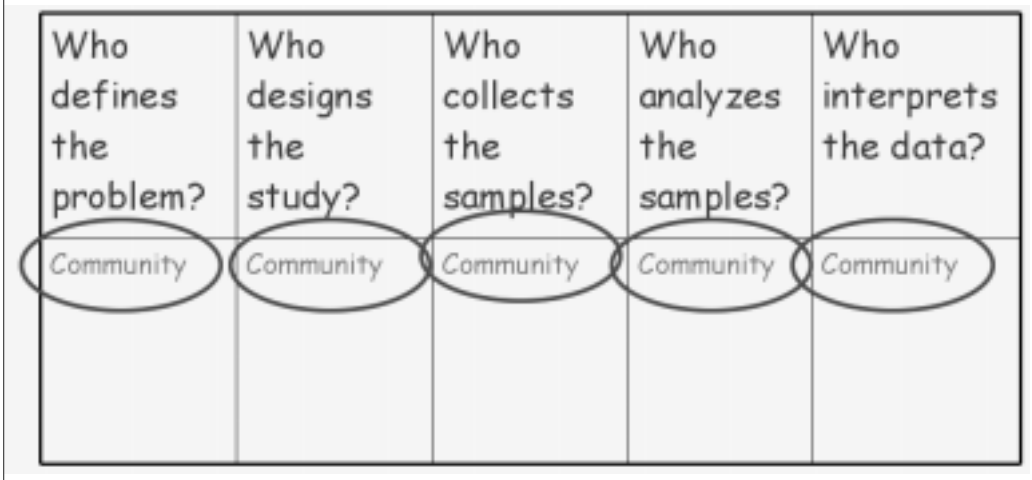
Community-based, Participatory Research Model

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.

Examples of Community-based Participatory Research Model

- ALLARM watershed-based projects: students, faculty and staff teach community members to collect and analyze their own data.

Community-based, Participatory Research Model (Science by the People)



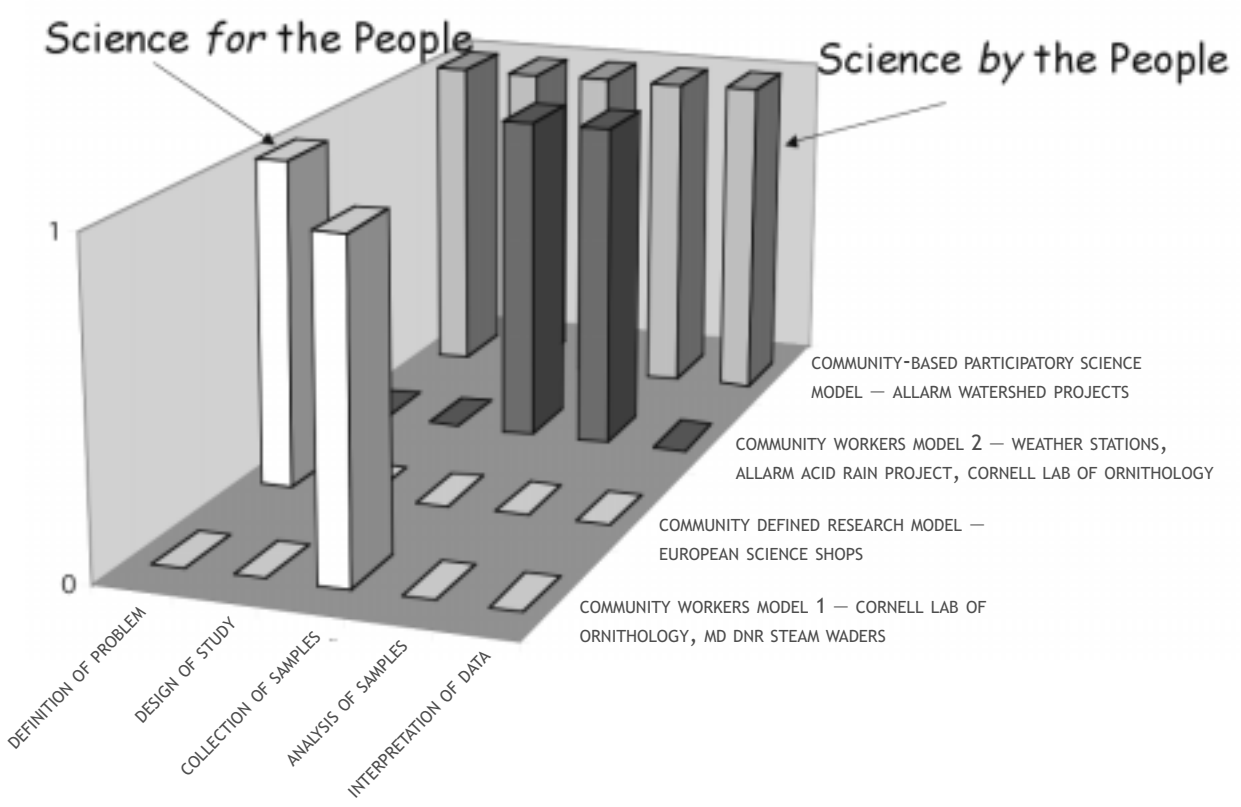
An example of the Community-based, Participatory Research Model is our watershed-based projects in which students, faculty and staff teach community members to collect and analyze their own data. This model is also called "Participatory Action Research" (PAR).

This model is also called "Participatory Action Research" (PAR)

Comparison/Summary of Models

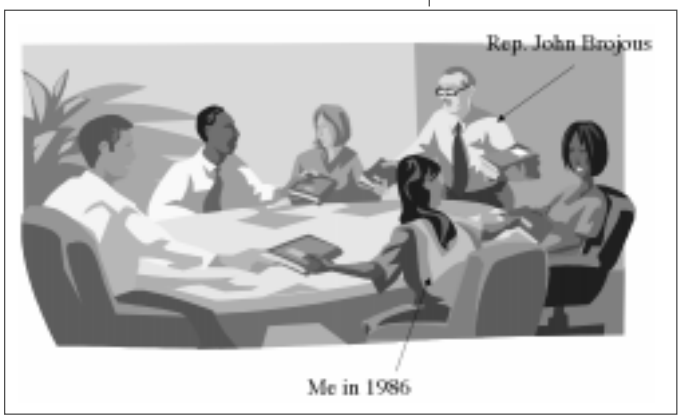
This is just a little summary for those of you who are visually inclined. Basically, on the X axis we have the five questions to ask. If the question is answered by the community it is a tall stack, and if it is answered by professional scientists it is a short stack.

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.

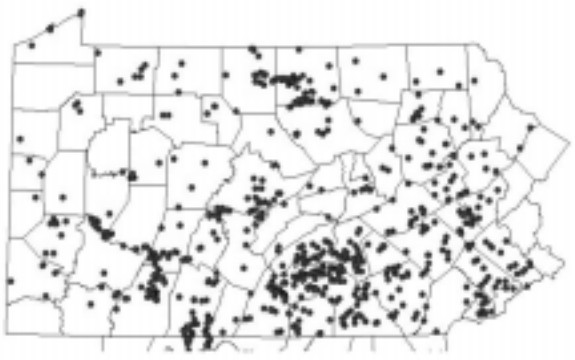
The scientists went home and they basically said, "No, no, no, we can't do this, blah, blah, blah."

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.

Sites Monitored by Volunteers

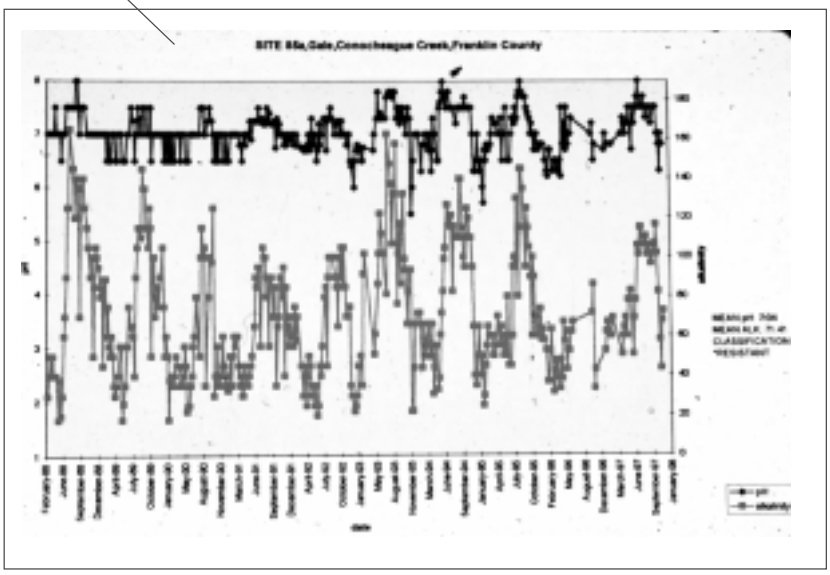


Data Analysis and Interpretation

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)

We did the analysis and interpretation with the help of students, and here is an example of a graph over fifteen years of pH and alkalinity in Conocheague Creek in Franklin County.



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.

Community Workers Model

Who defines the problem?	Who designs the study?	Who collects the samples?	Who analyzes the samples?	Who interprets the data?
Professional scientists	Professional scientists	Community	Community	Professional scientists

Which model?

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

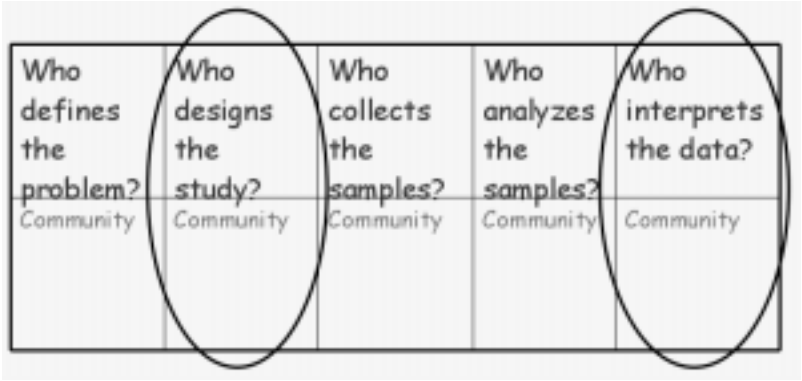
We wanted to keep the acronym ALLARM, and I challenged the students to find another name. They decided to call it the Alliance for Aquatic Resource Monitoring, rather than Acid Rain Monitoring, so we kept our acronym and we expanded our focus, and in expanding our focus we changed the model that we were 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.")

Alliance for Aquatic Resource Monitoring

Educate Engage Empower

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.

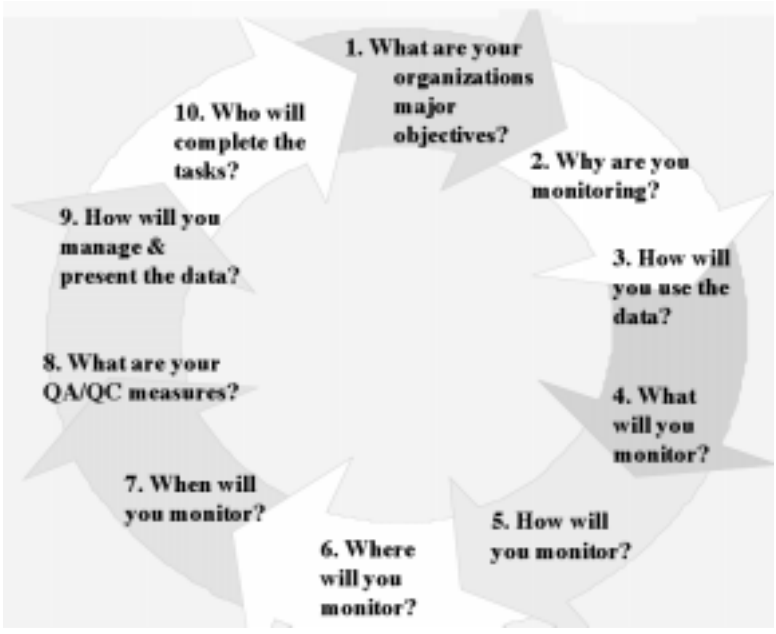
Study Design Facilitated Sessions

A study design is a written document that describes the choices you make about monitoring: the intended data use determines design.

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

Working through the Monitoring Study Design Process



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.

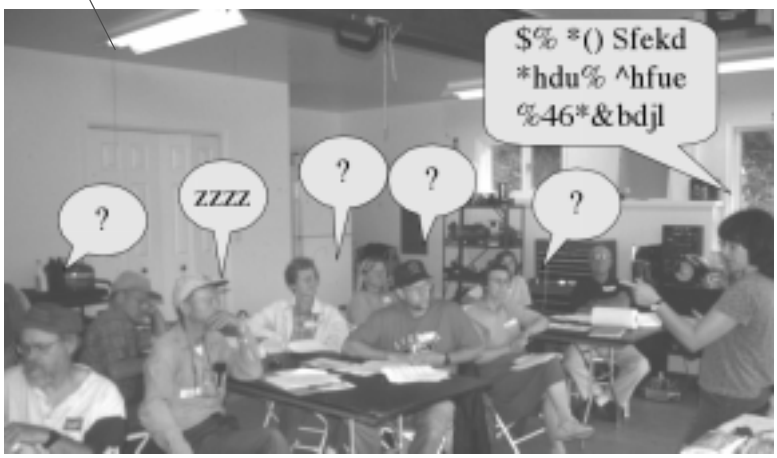
Rules for Successful Study Designs

- Data to be gathered must be able to answer the questions asked and meet the objectives identified
- Data quality must match the intended end use
- Design must comply with resource constraints (money and labor)
- Design must include a plan for data management and interpretation
- Design must include an action plan for data use
- Design sessions must include a potluck meal…

The Data Interpretation Step: Can Volunteers Climb the Learning Curve to Convert the Data to Information?

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.

Presenting the Story to the Group



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

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

Steps in the Data- to-Information Training Process[1]

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

[1]These workshops were developed in cooperation with River Network, the Stroud Water Research Institute, and the Delaware RiverKeeper

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

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 between **efficiency** on the one hand and **democracy** and **sustainability** on the other hand.

Operational Model	Efficiency	Democracy "knowledge is power"	Sustainability
Consulting or Community Workers	Immediate, measurable scientific results	Only experts can use the data; volunteers are dependent on them	Money runs out, scientists leave, activities end
Community-based, Participatory Research	Requires time, patience, and commitment for complex training process	Volunteers can shape the interpretations based on their own knowledge and can use the data; levels the playing field in decision-making	Builds community capacity to continue even after experts and monies are gone

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.

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For more information:

http://www.dickinson.edu/allarm