Enabling Citizen Science Programs at Environmental Agencies
Recommendations to the U.S. Environmental Protection Agency
October 2020

BACKGROUND & INTENT

The U.S. Environmental Protection Agency (EPA) has been working to support the use of citizen science through collaborative relationships with state, tribal and local environmental agencies. In September 2018, the Office of Inspector General (OIG) at the U.S. Environmental Protection Agency (EPA) released findings of an audit to determine whether the agency has controls in place to effectively manage the use of citizen science. A key finding of this audit was that the EPA needs a comprehensive vision and strategy for citizen science and without one, the EPA would be unable to systematically analyze the risks and opportunities that citizen science presents.

The Office of Research and Development has the primary responsibility for charting this new pathway and recognized a need to explore and understand the current uptake of citizen science in environmental protection programs. The Environmental Law Institute (ELI) was commissioned to undertake this study. The objectives of this research were to: characterize current and new citizen science approaches at environmental agencies, define the best practices, and identify strategic steps that can be taken to support the use of citizen science for environmental decision-making. This research culminated in two key reports:

- Citizen Science Programs at Environmental Agencies: Case Studies (October 2020)
- Citizen Science Programs at Environmental Agencies: Best Practices (October 2020)

This paper reflects the third research objective, to outline the key issue areas and make strategic recommendations to the U.S. EPA and other potential partners on how to facilitate the uptake of citizen science and sustain the use of citizen science across agencies and programs. The ideas presented here reflect lessons from current initiatives as seen in the case studies, as well as the thoughts and perspectives of many others, including state, tribal, local and federal agency officials, state associations, non-profit groups, community-based organizations, and academic research institutions.

AN OPPORTUNITY FOR ENVIRONMENTAL AGENCIES

It is a well-known fact that at least half of U.S. states rely on the efforts of volunteer monitoring networks to assess the quality of state-wide water resources. This long-standing model of an agency led citizen science program continues to evolve and spark new opportunities for volunteer involvement in water protection. State agencies are presently adopting citizen science as a tool to support wetland

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health evaluations, tracking and reporting cyanobacteria blooms, and reporting fishkills. Many of these efforts are in an early start-up phase, with agencies exploring further applications, such as, monitoring stormwater management controls, restoration, emerging contaminants, and climate change impacts. Though these applications vary, the lessons and successes of volunteer water quality monitoring can be harnessed to advance these and other programmatic uses.

Looking beyond the success and opportunities of citizen science in water programs, a variation of citizen science has emerged among local air quality programs. Advancements in low-cost air sensing devices and the heightened awareness of the general public have given rise to community science. In contrast to the volunteer water quality monitoring model, community scientists seek to gather their own neighborhood level data for an agency response. Some local air agencies have thus developed new strategies to leverage this external air quality data for trend analysis of air pollutants and for public education. Community science also often reveals the environmental burdens of communities and highlights broad social inequalities, changing the way communities and environmental agencies engage. In this context, the collaborative work of local agencies and community groups, has led to established air monitoring networks and community emission reduction plans.

Some local agencies have also made recent and significant strides in applying citizen science to compliance and enforcement programs. Two such examples of this include crowdsourcing potential violations of local anti-idling regulations and pesticide application requirements.

A common challenge relating to the use of data for regulatory purposes is data quality. The integrity and quality of data submitted must follow stringent guidelines to ensure that the data can be used effectively. Some state water programs have adopted a tiered set of data quality standards, ranging from stringent requirements for formal reporting under the Clean Water Act, to flexible standards for monitoring, or public education. Air programs are challenged by a backdrop of new and emerging sensing technologies that are not regulated for use in agency programs. Some local air agencies are responding by providing technical resources to build public understanding of these technologies, and to help communicate the agency's data quality requirements. Though it is likely that data quality will continue to be a concern among agencies, strategies from existing citizen science programs have proven to be successful in abating this concern.

An institutional challenge that most agencies face with citizen science is the budget or resources needed to sustain a program. Many citizen science initiatives, with the exception of state water quality monitoring programs, are undertaken as public outreach or community engagement projects, and are tangential to the core work of agencies. As such, they are rarely well funded or adequately resourced which leads to once off and short-term programs. Citizen science programs that align with agency needs and demonstrate an economic and substantive value are more likely to gain long-term governance support.

Though challenges do persist, the opportunities that citizen science presents to both agencies and the public are substantial. Citizen science has already demonstrated an ability to create shared value for the public and for agencies alike. The next steps involve harnessing its full potential, by assessing all the ways citizen science can be employed for environmental protection, by expanding the uptake of existing models, and by collectively addressing the risks and barriers to its use across agencies and programs.

STRATEGIC RECOMMENDATIONS

The EPA offers various forms of support for citizen science efforts, including funding for state volunteer water monitoring programs, grant-making for community-oriented monitoring projects (e.g. EPA Urban Waters Federal Partnership), demonstration projects, and sensor loan programs across regional offices. The EPA has also commissioned several studies to research the opportunities of citizen science. The strategic recommendations proposed below are intended to expand and build upon these current efforts.[1] While the Office of Research and Development will play an overall coordination role on this work, it is anticipated that specific actions will be led by the EPA Program Offices and EPA Regional Offices and supported by the relevant state associations and other external organizations.

In addition to these recommendations, many valuable suggestions were made by stakeholders including state, tribal and local officials, representatives of citizen science nongovernmental organizations, academics and others. These suggestions address specific operational aspects of citizen science projects, and may be of great interest to those working in the field. They can be found in the companion document, "Building Agency Capacity for Citizen Science: A Summary of the Online Discussions (July and August 2020)."

Recommendation 1: Recognize and Harness the Value of Citizen Science

Citizen science is still an unconventional approach for most programs. Caution about using data from external sources is understandable, but experience shows that potential benefits exist if agencies look for ways such data might be used and "meet the public halfway" by helping outside groups and individuals generate usable information.   Therefore, a consolidated effort needs to be made to promote current efforts and encourage uptake by other agencies. The collective experiences of agencies that are already piloting and/or operating long-term citizen science programs can help to shift thinking and advance the use of citizen science in environmental protection. Building on that experience, each EPA program office should take leadership in exploring how external data can be used, and what needs to be done to address current barriers; regional offices can take initiative as well, and the Office of Research and Development can continue to provide overall leadership.   Implementing actions should include:

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[1] Many of these recommendations are consistent with and build on those made by the National Advisory Committee on Policy and Technology in its 2016 report, "Environmental Protection Belongs to the Public." See https://www.epa.gov/sites/production/files/2020-04/documents/nacept_cs_report_final_508.pdf

1. **Expand Understanding -** Each program office should (to the extent it has not done so already) familiarize itself with existing efforts by EPA, states, tribes and local governments as well as independent programs.
2. **Identify Opportunities -** Program offices should identify the potential uses for citizen-generated data, and steps that could be taken to encourage citizens to generate usable data. A useful starting point is the spectrum of uses identified by NACEPT.
3. **Citizen Science Project Repository** - Each program office should leverage the use of existing online platforms (e.g. E-Enterprise Community Inventory Platform) for state, tribal and local agencies to voluntarily report information on the contribution of citizen science to agency programs.
4. **Multi-Stakeholder Outreach -** EPA regional offices should identify opportunities to communicate citizen science efforts, with the intention of creating partnerships and collaboratives for local and state citizen science programs.
5. **Recognition -** Program offices with the support of the Office of Research and Development can highlight innovative citizen science programs through an annual award or event.
6. **Funding -** Program offices should seek to leverage existing funding streams to support pilot projects and multi-year programs.

Recommendation 2: Establish Leadership Hubs for Coordination and Information Sharing

Programs using citizen science generally operate independently from each other. Though there are mechanisms in some areas for sharing information and learning, there is generally little centralized leadership to coordinate, provide advice and assistance, and capture and share the collective knowledge of those in the field. Central hubs in each EPA national program office and region (and possibly in state associations or other organizations) should be created to pool and build on the expertise of state, tribal and local agencies to provide support in many ways. Similarly, each region should consider a citizen science coordinator to work with state volunteer programs and localized community science projects. A central point of leadership can take a variety of steps to expand the use of citizen science by agencies, such as:

1. **Technical Guidance -** assemble and share information on the diverse programs that currently exist, such as:
    a. Descriptions of the variety of programs and the forms they take
    b. Examples of successful strategies used by different programs
    c. Success stories and quantified results
2. **Best Practices -** provide advice to state, tribal, and local programs on best practices, based on the national experience, and connect experts in those programs to each other. In particular, develop recommendations on key issues such as data use and data quality, derived from leading

programs. Successful state approaches could be adopted as consensus non-binding guidelines that could be used in other states.

3. **Program Support-** provide direct assistance to programs, including grants or equipment.
4. **Evaluation -** assess the current ways in which citizen science is being used, evaluate those programs, and identify those that could be adopted more widely.
5. **Application -** identify new areas in which citizen science is not being used, where it could be valuable.
6. **Legislation** - identify ways in which citizen science could be incorporated into governing statutes (primarily at the state level).

Recommendation 3: Embed Citizen Science in Community Engagement Practices

Addressing the concerns of overburdened communities, and giving these communities a voice in shaping action, is an urgent priority for EPA and the states. In this context, citizen science (or community science as it is often referred to) is not the central focus but is often used by local residents as a tool in documenting their concerns and advocating for change.   Agencies will need to learn how to integrate community science into their efforts at building successful community partnerships, and to work with communities who are engaged in gathering data. This will require building skill in communication on environmental risk, agency authorities, potential uses of data, technical aspects of data gathering, and many other issues. While the specifics will depend on local circumstances, agencies must put as high a priority on developing these skill sets as they place on traditional program operations, by taking such actions as those below.   EPA can provide the leadership to make citizen science projects more inclusive and ensure that there is more diverse participation, particularly among EJ communities. State agencies, state associations and non-governmental groups will also play important roles in engaging more meaningfully with communities. Building capacity to collaborate with communities (in which citizen science is one component), can include:

1. **Share Successes -** identify and share successful practices, e.g.:
    a. Effective risk communication
    b. Setting clear expectations on potential data use
    c. Providing guidance on proper data gathering, data quality, new technology
    d. Identifying experts to advise and assist community scientists
    e. Engage communities in the analysis and use of data gathered
2. **Protocols -** through a stakeholder process, develop recommended protocols for community collaboration[2].

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[2] Proposed Elements for Community Air Monitoring Plans in California Air Resources Board, "Community Air Protection Framework," p. 26.   See https://ww2.arb.ca.gov/sites/default/files/2020-05/capp_concept_paper_february_2018_acc.pdf.

3. **Training/Networking -** provide training and opportunities for agencies to share and learn from each other's experiences and from established best practices.
4. **Data Tools -** provide tools to help community-based efforts generate data that is useful to agencies (such as those in Recommendation 4 on Data Quality).
5. **Funding -** establish grant programs (or if possible use existing grant programs) to help communities acquire equipment, for technical advice, and manage data gathering initiatives.

Recommendation 4: Strengthen the Quality and Use of Citizen Generated Data

Concerns about data quality are often an impediment to greater use of citizen-generated data. However, methods have been developed for ensuring that data from the public can be appropriately used by the agency. This benefits both agencies and citizen scientists who can be confident that their time and effort is well spent. Data quality issues are especially critical in the air program, where new low-cost sensors are less precise and reliable than regulatory monitors. Agencies should take steps to better capitalize on the availability of sensor data. Such steps might include:

1. **Data Guidelines -** address data quality concerns in both air and water programs by providing clear guidance, information and training to the public (and to agency staff) on potential ways agencies can use data, the types of data that are acceptable for each use, appropriate study design, and the technology most appropriate for each purpose. (As noted under recommendation 2, program-based leadership hubs can provide general guidance; state programs can apply the guidance locally.)
2. **Program Support -** provide direct assistance to citizen scientists in development of study designs, at the state, tribal or local level.
3. **Technology Development and Testing -** engage with technology developers to identify agency needs and encourage improvements for agency purposes. Expand existing work to evaluate new sensors and use the results to identify sensors that are appropriate for agency use.
4. **Analysis of Data Value -** commission an analysis on the relative quality of crowdsourced sensor data and use the results to refine understanding of the value of such data.
5. **Partnerships -** create public-private partnerships that can utilize the ability of technology firms and other nongovernmental entities to fund and carry out activities that are beyond the capability of agencies.

Recommendation 5: Coordinate the Sharing of Data Management Systems and Practices

Data management, the process of storing, analyzing and displaying vast amounts of data has seen dramatic changes due to the rapid development of new software technologies. Citizen scientists now rely on apps to report observations and interactive web platforms to interpret and visualize the data. Thus, citizen science calls on EPA and states to play a role as stewards of data generated by others,

which would be a significant change from the past. There is a plethora of data management tools used for citizen science, which can be used for that purpose. However, some of these tools and practices are often not shared due to proprietary ownership rights, limiting public access to the data. Data sharing can also be impeded by lack of uniform data standards or adequate metadata. The field of citizen science can benefit greatly from the sharing of data management practices and existing tools and platforms. Current EPA-state collaborative efforts such as E-enterprise could facilitate the following proposed actions:

1. **Data Guidelines -** set out guidelines for data management practices and the development of data management tools, that promotes:
    a. FAIR (Findable, Accessible, Interoperable, Reusable) data principles
    b. CARE (Collective Benefit, Authority to Control, Responsibility, Ethics) principles for the governance of indigenous data
    c. Proper metadata to avoid the potential misuse or misinterpretation of data
2. **Share Tools/Platforms -** Evaluate and share information on new and existing data management tools and platforms to guide agencies on its possible uses.