U.S. ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF INSPECTOR GENERAL

Improving EPA research programs

EPA Needs a Comprehensive Vision and Strategy for Citizen Science that Aligns with Its Strategic Objectives on Public Participation

Report No. 18-P-0240 **September 5, 2018**

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Abbreviations

EPA	U.S. Environmental Protection Agency
GAO	Government Accountability Office
GSA	General Services Administration
NACEPT	National Advisory Council for Environmental Policy and Technology
OEI	Office of Environmental Information
OMB	Office of Management and Budget
ORD	Office of Research and Development
OSTP	Office of Science and Technology Policy
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan

Cover Photos: Photos involving various citizen science projects. *From left:* citizen scientists working with air monitoring equipment; a prototype open source sensor system used for water quality monitoring; EPA staff and local partners evaluating the effectiveness of vegetation and noise barriers near a school. (EPA photos)

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U.S. Environmental Protection Agency
Office of Inspector General

18-P-0240
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At a Glance

EPA Needs a Comprehensive Vision and Strategy for Citizen Science that Aligns with Its Strategic Objectives on Public Participation

Why We Did This Project

We conducted this audit to determine whether the U.S. Environmental Protection Agency (EPA) has developed controls to manage the use of citizen science results to meet the agency's mission.

Citizen science is a form of open collaboration in which individuals or organizations participate voluntarily in the scientific process in various ways, including collecting and analyzing data. Citizen science provides a way for members of the public to participate and support EPA programs.

On September 30, 2015, the White House Office of Science and Technology Policy recommended actions to build citizen science capacity and directed agencies to take specific steps to advance application of citizen science. Within the EPA, a team in the Office of Research and Development facilitates citizen science projects implemented throughout the agency's program and regional offices.

This report addresses the following:

- *Improving EPA research programs.*

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Listing of OIG reports.

What We Found

Although citizen science is carried out throughout the EPA, the agency has not developed controls necessary to manage citizen science agencywide, including a clear vision and objectives for using results. Absent this, the EPA cannot undertake a systematic effort to analyze the risks and opportunities that citizen science presents.

Without uniform guidance and direction, the EPA will be unable to fully use citizen science data that could contribute to the agency's mission.

EPA staff identified barriers to effectively using citizen science results—including lack of a comprehensive vision and support/resources from senior management, and lack of understanding and buy-in for citizen science—that exist because EPA leadership has not developed a strategy for citizen science. Citizen science is evolving as advancements in technology provide greater access to the public, and as public involvement grows it will place pressure on the EPA to understand and determine how to use the data collected and provided to the agency.

Recommendations and Planned Agency Corrective Actions

We recommend that the EPA Deputy Administrator establish a strategic vision and objectives for citizen science, and direct completion of an assessment to identify the data management requirements for using citizen science data and an action plan. Further, we recommend that the Office of Research and Development finalize a draft handbook for citizen science and build the capacity for managing the use of citizen science. The agency concurred with our recommendations and indicated that it plans to convene an agencywide workgroup to oversee implementation of our recommendations, and it plans to complete corrective actions by December 31, 2020.

Noteworthy Achievements

Prior to the start of our audit, the EPA had begun to develop a checklist of administrative and legal considerations for citizen science projects. The EPA had also drafted an outreach tool that highlights a representative distribution of citizen science projects at the EPA. Additionally, the EPA has taken the lead among federal agencies in addressing a barrier related to the Paperwork Reduction Act by obtaining approval for an Information Collection Request (generic clearance for citizen science) for projects contributing to EPA research.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

THE INSPECTOR GENERAL

September 5, 2018

MEMORANDUM

SUBJECT: EPA Needs a Comprehensive Vision and Strategy for Citizen Science that Aligns with Its Strategic Objectives on Public Participation
Report No. 18-P-0240

FROM: Arthur A. Elkins Jr.

TO: Henry Darwin, Acting Deputy Administrator

Jennifer Orme-Zavaleta, Principal Deputy Assistant Administrator for Science
Office of Research and Development

This is our report on the subject audit conducted by the Office of Inspector General (OIG) of the U.S. Environmental Protection Agency (EPA). The project number for this audit was OPE-FY18-0002. This report contains findings that describe the problems the OIG has identified and corrective actions the OIG recommends. This report represents the opinion of the OIG and does not necessarily represent the final EPA position.

The Office of the Administrator and the Office of the Science Advisor within the Office of Research and Development have the primary responsibility for the issues discussed in this report.

In accordance with EPA Manual 2750, your office provided acceptable corrective actions and milestone dates in response to OIG recommendations. All recommendations are resolved and no final response to this report is required. However, if you submit a response, it will be posted on the OIG's website, along with our memorandum commenting on your response. Your response should be provided as an Adobe PDF file that complies with the accessibility requirements of Section 508 of the Rehabilitation Act of 1973, as amended. The final response should not contain data that you do not want to be released to the public; if your response contains such data, you should identify the data for redaction or removal along with corresponding justification.

We will post this report to our website at www.epa.gov/oig.

Table of Contents

Chapters

Appendices

Chapter 1
Introduction

Purpose

We conducted this audit to determine whether the U.S. Environmental Protection Agency (EPA) has developed controls to manage the use of citizen science results to meet the agency's mission.

Background

What is citizen science?

Citizen science is a form of open collaboration in which individuals or organizations participate voluntarily in the scientific process in various ways, including conducting scientific experiments, collecting and analyzing data, and solving problems.

Details on various citizen science projects are in boxes throughout this report and in Appendix A.

Federal and Agency Guidance on Citizen Science

The EPA defines citizen science on the EPA's "What is Citizen Science" website as "the involvement of the public in scientific research—whether community-driven research or global investigations. Citizen science mobilizes the public to participate in the scientific process to address problems."

"Environmental protection belongs to all of us, and participating in environmental science is one way that members of the public can have an impact. Citizen science broadens environmental protection by enabling people to work together with government and other institutions toward shared goals."

– Blog post by former EPA acting Deputy Administrator

On September 30, 2015, the White House Office of Science and Technology Policy (OSTP)[1] noted the benefits of citizen science, outlined principles agencies should apply, recommended agency actions to build capacity, and directed agencies to take two specific steps to advance these methods:

1. Identify an agency coordinator for citizen science.
2. Catalog agency-specific citizen science projects on a governmentwide online database and website—developed by the General Services Administration (GSA)—to make these projects easier for the public to

[1] Another White House memo from OSTP and the Office of Management and Budget from July 9, 2015, encouraged agencies to use approaches such as citizen science to foster innovation in scientific discovery.

discover, help improve collaboration within and across agencies, and reveal opportunities for new projects.[2]

The OSTP memo encouraged—but did not require—federal agencies to take actions in the areas of policy, resources and staffing, technologies and scientific instrumentation, diversity of projects, and rigorous research and evaluation to improve current practice. For example, the memo encouraged agencies to:

- Develop clear policies, procedures and guidance to encourage and aid agency coordinators in developing and carrying out effective citizen science projects.
- Devote resources to evaluating the effectiveness of citizen science projects in achieving agency objectives.
- Develop methods for validating data and results from projects.

On January 6, 2017, Congress enacted the Crowdsourcing and Citizen Science Act as part of the American Innovation and Competitiveness Act, which gave federal science agencies—including the EPA—the authority to use citizen science to conduct projects designed to advance agency missions.[3] Congress noted that citizen science projects have unique benefits, including accelerating scientific research, increasing cost effectiveness to maximize the return on taxpayer dollars, addressing societal needs, and connecting members of the public directly to federal science agency missions and to each other.

Measuring Air Pollution Mitigation Strategies at Schools

The EPA (Region 9 and ORD) and state and local stakeholders engage teachers and students in studying the effectiveness of roadside vegetation barriers. The project seeks to reduce exposure to vehicle emissions at an Oakland, California, elementary school that is adjacent to a busy road. This is an active project that started in the fall 2017 with $38,000.

EPA staff and local partners evaluate the effectiveness of vegetation and noise barriers near the Brookfield Elementary School in Oakland, California. (EPA photo)

Within the EPA, citizen science is not one centralized program. Rather, it includes projects implemented separately by the EPA's program and regional offices. The EPA's citizen science efforts are facilitated by the Office of Research and Development's (ORD's) Office of the Science Advisor, which provides cross-agency leadership on science policy development and implementation. Within the Office of the Science Advisor, a Chief Innovation Officer and a team of three staff (along with fellows and student contractors) support agency citizen science efforts, among other areas. According to the Director of the Office of the Science Advisor, in fiscal year 2017, this team had a budget of just over $1.4 million for investments in innovation projects, including citizen science.

[2] See the GSA Federal Crowdsourcing and Citizen Science Toolkit.
[3] The act addresses both citizen science and crowdsourcing, the latter of which is defined as a method to obtain needed services, ideas or content by soliciting voluntary contributions from a group of individuals or organizations, especially from an online community. While related/complementary, our review focused on citizen science.

The ORD's Chief Innovation Officer serves as the agency's coordinator for citizen science and holds a monthly meeting with the EPA's citizen science community of practice group. The Chief Innovation Officer also co-chairs—with an Innovation Specialist from the U.S. Geological Survey—the federal community of practice on citizen science. In addition, two EPA regional offices—Regions 1 and 2—have appointed citizen science coordinators to facilitiate communication and coordination of citizen science in their regions.[4]

The EPA has both public and internal websites on citizen science that provide links to citizen science resources at the agency. These EPA sites also link to resources on the federal citizen science website, managed by the GSA, including the Federal Crowdsourcing and Citizen Science Toolkit, and governmentwide databases on citizen science projects.[5]

> "Citizen science is much more than collecting data. It provides a way to engage all parts of society in gaining a deeper understanding of human environments, build an informed population that can advocate successfully for environmental protection, and more effectively protect human health and the environment."
> – NACEPT

In 2015, the EPA tasked the National Advisory Council for Environmental Policy and Technology (NACEPT)—an EPA advisory board—to assess the agency's approach to citizen science. NACEPT issued a report in December 2016, *Environmental Protection Belongs to the Public: A Vision for Citizen Science at EPA*, that made several recommendations, including articulating and implementing a vision for citizen science at the EPA, dedicating funding, and building technical capacity. The 2016 NACEPT report included the following spectrum depicting the variety of uses of citizen science data:[6]

Figure 1: Spectrum of citizen science uses

Source: OIG-generated image based on 2016 NACEPT report.

NACEPT issued its second report in April 2018, *Information to Action—Strengthening EPA Citizen Science Partnerships for Environmental Protection*. The EPA's fiscal years 2018–2022 Strategic Plan—dated February 12, 2018—includes broad strategic objectives on public participation and robust science, and mentions citizen science in Objective 3.5 ("Improve Efficiency and

[4] The Region 1 citizen science coordinator position is a temporary detail.
[5] The Federal Crowdsourcing and Citizen Science Toolkit helps federal employees use crowdsourcing and citizen science in their work. It provides five basic process steps for planning, designing and carrying out a crowdsourcing or citizen science project.
[6] NACEPT describes "community engagement" as including awareness, partnership, development, stakeholder engagement and public outreach. NACEPT describes "education" as including STEAM (science, technology, engineering, art and math) literacy. ORD's Chief Innovation Officer added that he views education as one-directional where community engagement goes beyond that in terms of participant involvement.

Effectiveness") by noting that the "EPA will develop a comprehensive data management strategy that addresses the collection, management, and use of data generated both internally and from external partners including … citizen science."

Federal and Agency Guidance on Internal Controls

Office of Management and Budget (OMB) Circular A-123, *Management's Responsibility for Enterprise Risk Management and Internal Control* (July 15, 2016), states that federal leaders and managers are responsible for establishing goals and objectives around operating environments and managing both expected and unexpected or unanticipated events. Additionally, managers are responsible for implementing management practices that identify, assess, respond to and report on risks. Risk management practices must be forward-looking and designed to help leaders make better decisions, alleviate threats, and identify previously unknown opportunities to improve the efficiency and effectiveness of government operations. The circular requires agencies to implement enterprise risk management coordinated with the process for strategic planning and internal controls. It also requires that federal managers establish and maintain internal controls—based on the U.S. Government Accountability Office's (GAO's) *Standards for Internal Control in the Federal Government*—to achieve specific objectives, and that risk management be considered when designing and assessing internal controls.

The GAO's *Standards for Internal Control in the Federal Government* defines internal control as a process that provides reasonable assurance that the objectives of an entity will be achieved. Internal control comprises the plans, methods, policies and procedures used to fulfill the mission, strategic plan, goals and objectives. A key factor in improving accountability is to implement an effective internal control system that helps an entity adapt to shifting environments, evolving demands, changing risks and new priorities. Management is responsible for an effective internal control system by setting objectives, implementing controls and evaluating the internal control system.

The GAO identified five components that must be effectively designed, implemented and operating in an integrated manner for an effective internal control system:

1. ***Control Environment.*** The foundation for an internal control system. It provides the structure to help an entity achieve its objectives.
2. ***Risk Assessment.*** Assesses the risks facing the entity as it seeks to achieve its objectives. This assessment provides the basis for developing appropriate risk responses.
3. ***Control Activities.*** The actions management establishes through policies and procedures to achieve objectives and respond to risks.
4. ***Information and Communication.*** The quality information management and personnel communicate and use to support the internal control system.

5. ***Monitoring.*** Activities management establishes and operates to assess the quality of performance over time and promptly resolve the findings of audits and other reviews.

EPA Order 1000.24 CHG 2*, Management's Responsibility for Internal Control* (July 18, 2008), implements OMB Circular A-123 and outlines agency senior managers' roles and responsibilities for developing, implementing and assessing internal controls. The order requires all EPA organizations to establish and maintain internal controls to achieve objectives, evaluate controls on an ongoing basis, and take prompt action to correct any vulnerabilities identified.

Responsible Offices

Within the EPA, the Deputy Administrator (within the Office of the Administrator) and the ORD's Office of the Science Advisor have the primary responsibility for the issues discussed in this report.

Noteworthy Achievements

Prior to the start of our audit, the ORD's innovation team had begun to develop a checklist of administrative and legal considerations for citizen science and crowdsourcing projects at the EPA. Additionally, the team drafted an outreach and communication tool that highlights citizen science projects at the EPA, selected to provide a representative distribution across the agency. The team intends to link the document to the citizen science intranet site to help EPA staff understand the breadth of projects underway at the agency.

The EPA has taken the lead among federal agencies in addressing a barrier related to the Paperwork Reduction Act by obtaining OMB approval for an Information Collection Request (generic clearance for citizen science and crowdsourcing). This clearance expedites the OMB approval process for the collection of information. It is limited to collecting information for projects contributing to EPA research, not regulation and enforcement activities.[7]

Scope and Methodology

We conducted this performance audit from October 2017 to July 2018 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform our work to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objective. We believe that the evidence obtained provides a reasonable basis for the findings and conclusions in this report based on our audit objective.

[7] This generic Information Collection Request was approved by the OMB for a 3-year period (April 2016–April 2019). As of December 2017, the EPA has submitted, and the OMB has approved, six information collection titles under this generic Information Collection Request, and three additional requests are pending approval.

We reviewed federal laws and guidance on citizen science as well as EPA materials, including strategic plans; websites; and policies, procedures and regulations on quality assurance. We reviewed the NACEPT reports and other relevant external reviews. We also reviewed journal articles and attended webinars and other presentations to obtain various perspectives. We interviewed key ORD staff and managers responsible for innovation and citizen science, as well as each national research program director and laboratory/center director on the extent to which they used citizen science.

To obtain agencywide perspectives on citizen science, we:

- Queried Deputy Assistant Administrators in six headquarters program offices[8] on the ways they use citizen science and factors that impact use.

- Interviewed staff and managers in the offices of the Administrator, Air and Radiation, Water, Environmental Information, and Enforcement and Compliance Assurance; and within Regions 2 and 9, given their history and experience with citizen science. We also interviewed a staff person within the Office of General Counsel on federal criteria.

- Issued a survey to 253 targeted agency contacts, including the EPA's citizen science community of practice and regional science liaisons. We received 113 responses—a response rate of 44.66 percent. In developing the survey, we received input from the ORD's innovation team and from federal community of practice members.[9] We also worked with the ORD's innovation team to judgmentally target our survey to those within the agency who would most likely have knowledge of and use citizen science. We cite survey results in Chapter 2.

- Developed a draft inventory of 83 likely EPA citizen science projects,[10] spanning from 2000 onward, from which we selected 11 projects to review for evidence of controls to manage results. Sampled projects included one each from seven program offices and, for geographic diversity, one each from EPA Regions 2, 4, 7 and 9.[11] For each project, we sought information on the EPA's intended uses of results and any evidence of controls in place to manage use. While we reviewed documentation for evidence of controls (e.g., Quality Assurance Project Plans and peer reviews), we did not review the scientific or technical quality of provided

[8] The offices of Air and Radiation, Chemical Safety and Pollution Prevention, Enforcement and Compliance Assurance, International and Tribal Affairs, Land and Emergency Management, and Water.
[9] We received input from the Intelligence Advanced Research Projects Activity, National Oceanic and Atmospheric Administration, National Science Foundation, and National Aeronautics and Space Administration.
[10] This is not a complete universe of the EPA's citizen science efforts but, rather, reflects projects we identified through the GSA Toolkit, our survey responses and other sources. We provided our draft inventory to the ORD.
[11] Our review of sampled citizen science projects found some attributed to different offices than we thought initially. Our sample of 11 projects ended up with more from regional offices (e.g., addition of projects in Regions 6 and 10) than headquarters program offices.

materials. We also interviewed some project leads and, in one case, a community organizer of a citizen science project. We highlight projects throughout this report and in Appendix A.

- Separate from our sample, we conducted a site visit to Region 1—a region active in citizen science—to meet with EPA staff and external officials on four additional projects that include citizen science:
    - EPA Preparing for Extreme Weather (Mattapoisett, Massachusetts).
    - Mystic River Watershed Association Report Card Baseline Monitoring Program and Annual Report Card.
    - Casco Bay Estuary Partnership and Friends of Casco Bay.
    - Cyanobacteria[12] Monitoring Collaborative.

We also interviewed citizen science leads in other federal agencies to benchmark best practices, including measures to address barriers to using citizen science.

Cyanobacteria Monitoring Collaborative

The Cyanobacteria Monitoring Collaborative—a project for EPA Region 1 and ORD—is an active project started in May 2015. It has three components to allow for participation from the public (BloomWatch), trained citizen scientists (CyanoScope) and environmental professionals (Cyanomonitoring), as follows:

- BloomWatch is a crowdsourcing, citizen science smart phone app tool the public can use to identify and report potential cyanobacteria blooms, along with photo documentation.
- The CyanoScope project uses citizen scientists to collect and analyze samples with microscopy kits and then send the images to a central database that records details on location of the sample, date and time of collection. Experts then update the database with the identification of species in captured images. The initial effort proposed developing the microscopy kits, training volunteers, and piloting the program as an enhancement to existing monitoring programs in New England and the Great Lakes regions.

A CyanoScope field kit used by citizen scientists. (EPA OIG photo)

- The Cyanomonitoring component engages trained citizen scientists and environmental professionals in cyanobacteria monitoring using a hand-held field fluorometer to test water samples.

[12] Cyanobacteria are photosynthetic bacteria. Cyanobacteria and their associated toxins are of concern from a human and ecological perspective. Increased nutrient loads to aquatic systems can lead to recurring algal blooms, and wildlife and pet deaths have occurred from ingestion of these algal toxins.

Chapter 2
EPA Does Not Manage Citizen Science from an Agencywide Perspective and Should Complete Actions to Address Barriers

Although citizen science is carried out throughout EPA program and regional offices, the EPA has not developed controls necessary to manage it from an agencywide perspective. The agency has not established a clear vision and objectives for using citizen science results from an agencywide perspective. Consequently, the EPA cannot undertake a systematic effort to analyze the risks and opportunities that citizen science presents. Both Congress and the White House's OSTP encourage citizen science. EPA staff identified barriers to effectively using citizen science results in the agency's work. Key barriers include lack of a comprehensive vision and support/resources from senior management, and lack of understanding and buy-in for citizen science. These barriers exist because EPA leadership has not set a specific strategy for citizen science. Citizen science is evolving and will take on a greater role as advancements in technology provide greater access to the public. As the public's involvement grows, it will place pressure on the EPA to acknowledge and address the environmental data collected and provided to the agency.

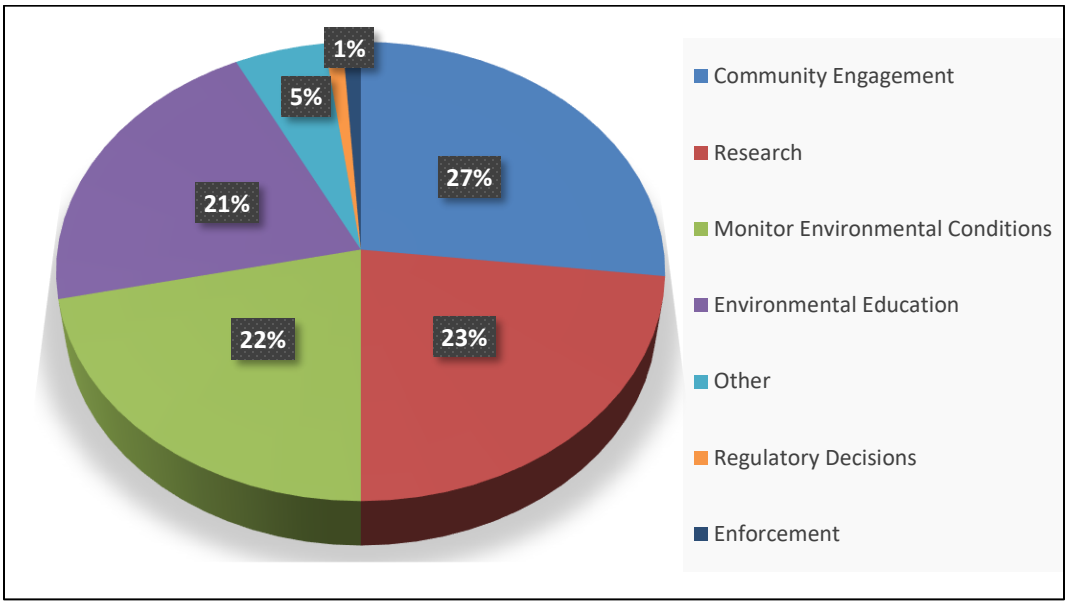
EPA Uses Citizen Science Primarily for Community Engagement, Research, Monitoring and Environmental Education

OSTP directed agencies to catalog agency-specific citizen science projects in a governmentwide online database, which the EPA did. However, the EPA's voluntary data entry into the federal database did not reflect all of the agency's citizen science activities; rather, it only reflects those projects EPA staff sought to highlight.[13]

Absent a complete inventory capturing the EPA's uses of citizen science, we queried program and regional offices—via a survey instrument, interviews and a project sample—on the extent to which they use citizen science results. Over 70 percent of survey respondents indicated that their programs use citizen science to some extent, primarily for community engagement (78.5 percent), research (68 percent), monitoring environmental conditions (63 percent), and environmental education (61.5 percent).[14] A further breakdown is in Figure 2.

[13] The citizen science coordinator within the National Aeronautics and Space Administration described a similar approach to how their agency catalogued its projects. We understand that GSA is currently in the process of working with federal agencies' citizen science coordinators to update the catalog with more projects.
[14] In response to a question asking whether their program uses citizen science, over 70 percent of respondents (79 out of 112 individuals) answered "yes." In response to another question asking respondents to describe ways citizen science is used in their respective programs, 65 respondents provided answers.

Figure 2: Survey responses on uses of citizen science



Source: OIG analysis of survey results. Percentages are out of a total of 65 responses to a question asking respondents to describe ways their program uses citizen science.

All six Deputy Assistant Administrators that we queried indicated that their program offices use citizen science for community engagement, environmental education or research. For example:

- The Office of Enforcement and Compliance Assurance Deputy Assistant Administrator said that the office uses citizen science data as a starting point to assess the need for further enforcement monitoring/investigation.

- The Office of Water Deputy Assistant Administrator said that states use citizen science data as part of water quality assessments, and some data is shared via the agency's water quality exchange system.[15]

- The Office of Air and Radiation Deputy Assistant Administrator said, "Citizen science offers a way to further evaluate new air quality sensor technologies; to collect information in areas where EPA does not have regulatory measurements; and to greatly help educate the public about their local air quality."

Within the ORD: two of six National Research Program directors said they embrace citizen science efforts, two said they use it minimally mostly to guide the direction of their research, and two do not use it given the nature of their work.

[15] The Office of Water said that it is building tools to integrate water data from a myriad of sources including citizen science. The office is championing the Interoperable Watersheds Network project, which is focused on defining a common set of data formats and standards, and testing and validating both the standards and new methods of sharing data. When completed, the network is expected to expand data sharing and use, thereby streamlining surface water quality assessment, restoration and protection activities at all levels of government.

Ironbound Citizen Science Air Monitoring Collaboration

The ORD and EPA Region 2 partnered to help the Ironbound community (in New Jersey) to collect data on environmental conditions. The EPA designed sensor units and trained community members. This resulted in an Air Sensor Toolbox, an online resource with information on low-cost technologies for measuring air quality. This project was completed in 2015 through funding of $100,000.

Citizen scientists working with air monitoring equipment. (EPA photo)

Additionally, the ORD's National Center for Environmental Assessment is monitoring citizen science as an "emerging area" for its possible use to monitor and/or observe ecology, and the ORD's National Exposure Research Laboratory is embracing the opportunity for using citizen science in exposure science facilitated by advancements in sensors and new technologies.

Interviews with program and regional office staff indicated that whether the agency "uses" citizen science varied depending on the definition of "use" akin to the spectrum of uses noted in the 2016 NACEPT report described in Chapter 1. Our sample of citizen science projects noted various uses that we describe below and in project summaries in Appendix A. We found—similar to what the Deputy Assistant Administrators described—that our sampled projects fell mostly on the side of NACEPT's spectrum that includes community engagement, education and research. In general, we did not find any examples where the EPA has used citizen science data by itself to inform decision-making, although we did hear of examples of states acting in response to citizen science information.

We identified anecdotal benefits to the EPA and its state partners from using citizen science:

- In Region 1, we learned that many states rely on citizen science organizations to collect data used in meeting the states' water monitoring and reporting responsibilities. Region 1 staff said that limited state resources prevent the states from conducting effective, long-term monitoring of water systems on their own. Region 1 staff said states use citizens to supplement the data collection needed, and universities/non-profits to analyze data.

- The Virginia Department of Environmental Quality described its return on investment from volunteer water monitoring and noted that it receives over $750,000 worth of data collected for its $200,000 investment in citizen science (i.e., through state grants and staff support), for an over 275 percent return on investment of agency resources.

In addition, two projects that we sampled continue even though the initial EPA funding supporting each project has lapsed:

- ***Gardenroots.*** Community members living near the Iron King Mine and Humboldt Smelter Superfund sites in Dewey-Humboldt, Arizona, worked

with a researcher to investigate the uptake of arsenic in commonly grown vegetables, evaluate arsenic exposure and potential risk, and report results in an effective and meaningful way. As a result of the study, community members could make educated choices about the type of garden vegetables they would eat and leveraged the results to encourage government officials to act and be more stringent in their cleanup efforts. An ORD grant of $15,000 helped fund this study, and though the study ended in 2012 the program continued by expanding to three additional counties with over 100 citizen scientists trained.

- ***IDAH20 Master Water Stewards.*** This EPA grant project, which launched in 2010 and was funded through 2014, provided $77,000 for the training of 50 volunteer water quality monitors to adopt a stream that they would monitor regularly. Monitoring includes habitat, biological, chemical and physical assessments. The project, which involved Region 10, is still active and has now increased to 150 volunteer monitors. The final report said: "Budget cuts have forced the elimination of Idaho governmental efforts to conduct statewide water quality monitoring in streams, lakes and rivers, with the exception of known problem areas. ... The IDAH2O program has expanded its network of volunteer monitoring to help fill the gap in gathering water quality data."

Additionally, NACEPT noted that:

> Citizen science can play a role in complementing EPA's ongoing policy, regulatory and enforcement work through careful design and open partnerships between external groups and EPA. Ultimately, citizen science can improve the Agency's enforcement processes by helping to identify issues proactively.

Below we describe control measures to implement—and barriers to address—to move the EPA toward these opportunities.

EPA Has Not Developed Controls for Managing Use of Citizen Science, but Does Have Controls for Quality and Use of Environmental Data

The EPA does not have the foundation that would establish a control environment for managing the agency's use of citizen science, such as policies and procedures or clear objectives for how to use the tool in meeting the agency's mission. An OSTP 2015 memo (see sidebar) encourages agencies to build citizen science capacity by acting in such areas as policy.

"Develop clear agency-specific policies, procedures, and guidance to encourage and aid agency coordinators in developing and carrying out effective citizen science. … The policies, procedures, and guidance should address common legal and process steps, including data collection and management. …"

– OSTP memo

Objectives in the EPA's strategic plan signal the agency's intention to increase public participation platforms, which could include citizen science. However, the agency does not currently have a clear vision and objectives for using citizen science to meet those strategic objectives. Survey respondents and interviewees consistently noted that the EPA needs a vision, policies, procedures and/or guidance to provide the structure for using citizen science in the agency's work (see below and Appendix B for additional details). Moreover, EPA staff said a high-level vision could clarify how the agency works with state/local partners on citizen science as part of the cooperative federalism noted in the agency's strategic plan. One regional staff member added: "EPA should make it clear to states and local governments through consistent program policies, program guidance and training, that citizen science efforts are supported by EPA leadership."

The EPA has controls that cover the quality and use of environmental data, including citizen science data. For example, contract/grant awardees on citizen science projects are required to adhere to specific quality standards[16] identified in required data quality and data management plans. These requirements directly align with existing agency policies. However, these controls are not linked to any objectives or risk analysis on the use of citizen science results.

> "By prioritizing citizen science, the Administrator has the opportunity to increase the efficiency and effectiveness of EPA programs and empower stronger partnerships and collaborations for environmental protection."
> – NACEPT

Without a clear vision and objectives, the EPA is unable to systematically assess the opportunities and risks citizen science presents for the agency. Per the GAO, a prerequisite to an internal control risk assessment is the identification of goals and objectives. Once goals and objectives are identified, an assessment of risks associated with achieving those goals and objectives can be performed.[17] The EPA, in accordance with GAO standards, defines a risk assessment as the identification and analysis of relevant risk associated with achieving the agency's mission.[18]

Absent a systematic assessment, the EPA has made some efforts to identify opportunities and risks in using citizen science. For example, in 2015, the EPA charged NACEPT with reviewing the agency's use of citizen science,[19] and NACEPT noted some barriers. In addition, the EPA's Chief Innovation Officer has identified risks, such as the risk of receiving poor quality data and frustrating

[16] ANSI/ASQC E4-1994 identifies specifications and guidelines for quality systems for environmental data collection and environmental technology programs.
[17] Under the risk assessment component, the GAO notes that management should (1) define objectives clearly to enable the identification of risks and define risk tolerances; and (2) identify, analyze and respond to risks related to achieving the defined objectives.
[18] EPA Order 1000.24, CHG 2, *Management's Responsibility for Internal Control* (July 18, 2008), states that program managers should identify internal and external risks that may prevent the organization from efficiently and effectively meeting its objectives.
[19] In its response to our draft report, the EPA said it is the only federal agency that has taken this step (i.e., of seeking an advisory board review of the agency's use of citizen science).

collection efforts by citizens due to limited communication on data quality standards and requirements. The identification of these risks led, in part, to the development of a *Draft Handbook for Citizen Science Quality Assurance and Documentation* and establishment of a citizen science website to share guidance and information on relevant policies and available resources.[20] Development of this handbook is a collaborative effort between the ORD, Office of Environmental Information (OEI) and Region 1.

In the absence of EPA-wide direction on citizen science, the ORD's innovation team has taken steps to build capacity and maintain the agency's expertise on citizen science by, for example, communicating information about the potential for using citizen science, as well as quality standards and requirements for data quality. Additional information and communication efforts include the EPA's citizen science websites, as well as the EPA's citizen science community of practice meetings mentioned in Chapter 1. In addition, the ORD's innovation team provided short training sessions on citizen science to five EPA regions so far, and the ORD conducted three laboratory competitions that funded selected citizen science projects during 2015–2017. However, the ORD's innovation team noted that cuts to budget and staff could affect wider program implementation.

In our review of a sample of citizen science projects, we asked about five control measures that are required per agency policies for any EPA-funded project where environmental data is collected:

"Improving internal management controls will involve multiple offices, and EPA will need to move from a project-level orientation to an enterprise approach."

– ORD

1. Quality Assurance Project Plan (QAPP)[21] or equivalent documentation.
2. Quality Management Plan (QMP)[22] or equivalent documentation.
3. Peer review.
4. Training on data collection requirements and/or data quality.
5. Data assessment.[23]

We found that projects contained these control measures relative to the project's intended use and purpose for the data. The projects we sampled varied in the level of citizen involvement in the collection and generation of data and the intended use for the data. For some projects, the citizen component was limited to providing feedback on the usability of monitoring equipment or the management of the resulting data, while in other cases citizens collected and/or generated screening-

[20] EPA websites include those on citizen science generally as well as on collecting data and additional resources.
[21] A QAPP defines and documents how environmental data collection activities are planned, implemented and assessed during a project. EPA policy requires that all work performed by or on behalf of the EPA involving the collection of environmental data be implemented in accordance with an agency-approved QAPP.
[22] A QMP is a formal document or manual that describes the quality system in terms of the organizational structure, functional responsibilities of management and staff, lines of authority, and required interfaces for those planning, implementing and assessing all activities conducted.
[23] Data assessment refers to any checks of the citizen science data performed by the EPA organization sponsoring the project (i.e., program office or region).

level data.[24] This type of project variability aligns with NACEPT's spectrum of uses diagram noted in Chapter 1. We found examples where some measures were implemented although not required. For example, the grantee of one project developed a QAPP for its own use even though the data was not intended to be used by the EPA (IDAH2O Master Water Stewards). In projects where the EPA intended to use citizen-generated data, we saw evidence of the five control measures (e.g., Smoke Sense). Although a QAPP is not always required,[25] it can provide validity to the data. The EPA's citizen science website and draft guidance encourage groups to prepare a QAPP, even when not required, to aid in explaining how the data was obtained and the level of quality assurance applied.

Barriers Exist to Using Citizen Science Results in EPA's Work

An agencywide internal control system should address barriers as part of risk analysis to effectively use the results of citizen science in the EPA's work. Our survey identified several barriers to using citizen science, as discussed in the following blue box:

Survey Results on Barriers to Using Citizen Science

Two questions asked participants to identify barriers to their programs' use of citizen science. Question 8 asked respondents to identify, in an open-ended response, the most important barrier to use. Question 9 asked them to rank the extent to which eight specific barriers impact use; for this question, we provided a list of barriers identified by the ORD's Chief Innovation Officer. The top six responses were similar for both questions.

	Question 8	Question 9
1.	Data quality concerns	Resource limitations
2.	Resource limitations	Limited knowledge/experience with citizen science
3.	Limited knowledge/experience with citizen science	Data quality/data management concerns
4.	Lack of "buy-in"	Lack of guidance
5.	Technology issues	Lack of "buy-in"
6.	Lack of guidance	Technology issues
7.	Data management issues	Bureaucracy
8.	Quality assurance training needs	Legal/ethical issues
9.	Legal requirements	
10.	Complexity of some EPA work	
11.	Lack of coordination across the EPA	

Source: OIG analysis.

[24] Screening-level data refers to the use of citizen science data to provide context in identifying areas for future research or possible noncompliance.

[25] The implementation of the EPA Quality System is based on a graded approach, where the quality systems vary for different organizations and programs according to the specific objectives and needs of the organization. The need for a QAPP may vary based on the purpose or intended use of the data (research program versus regulatory compliance program). For example, a QAPP may not be required for data to be used in a screening level (though it could aid in explaining how data was obtained), and may not be required when used for community educational purposes only.

In addition, we found a relationship between identified factors for success (Question 10) and barriers to use. For example, respondents identified "senior leadership and management support" (i.e., "buy-in") as a factor contributing to citizen science success. This relates to the identified barrier "lack of 'buy-in,' strategy, or direction from leadership/management." In another example, "resources" was identified as a barrier as well as a contributing factor to success.

Image of Smoke Sense mobile app from EPA's Smoke Sense website.

Smoke Sense

This app—developed by the ORD and the EPA's Office of Air and Radiation—collects data on health effects of wildfire smoke on participants and what they are willing to do to lower smoke exposure. The EPA will use this data to determine the extent to which exposure to wildfire smoke affects health and productivity, and develop health-risk communication strategies. This is an active 5-year project launched in 2017 with $120,600.

Our interviews with EPA staff across several offices and regions, as well as with NACEPT members, identified several barriers consistent with our survey results. We grouped the five most common barriers under the following categories:

1. ***Strategic Communication and Support/Resources.*** "Top-down" communication of the vision and direction for citizen science that ensures alignment with the administration's priorities is provided, along with support, coordination and resources for its use.
2. ***Understanding/Acceptance***. A receptive culture for using the tool to collect data.
3. ***Data Quality.*** The data meets quality standards for its intended use, including educating citizen scientists on quality requirements, validating that standards were met, and addressing misperceptions that may exist.
4. ***Data Management.*** Issues related to data storage and ownership, as well as challenges associated with large amounts of real-time data, are resolved.
5. ***Technology.*** Issues are addressed, such as needed evaluations of available sensor technologies and guidance for securing the data collected for use.

The first two barriers relate to our finding on the absence of a strategic vision and objectives for agencywide use of citizen science. Per NACEPT members we interviewed, the non-integrated approach to using citizen science at the EPA will continue until agency leadership initiates a systematic approach that provides a vision and strategy for a coordinated effort across the agency. Others we interviewed within the EPA shared this sentiment. Appendix B provides additional information and survey data on each category of barriers.

EPA Needs to Complete Actions to Mitigate Barriers

Completing a risk analysis would help the agency realize the challenges and opportunities citizen science presents. Absent an agencywide risk assessment for using citizen science, the EPA has efforts underway that could mitigate some barriers. For example:

- *Draft Handbook for Citizen Science Quality Assurance and Documentation*. This handbook will address some of the concerns for communicating data quality standards and requirements externally to citizen scientists. The handbook was developed by the EPA[26] and was reviewed by tribes and state officials and board members of the Environmental Research Institute of the States, and it is currently undergoing a review with targeted subject matter user groups familiar with citizen science. The EPA plans to pilot the handbook with community groups later this year. The EPA has already received some feedback from community groups on the handbook's usefulness and need for providing guidance.

- *Draft Communication Tools.* The ORD has developed two draft communication tools on citizen science for the EPA's internal use:

    - The first highlights a representative distribution of collaborations the agency has undertaken with various organizations to implement citizen science projects (in air, water, etc.).

    - The other lists potential administrative and legal requirements to consider when developing citizen science projects.

> "EPA needs to be more corporate, systematic and speak with one voice."
>
> – ORD's Chief Innovation Officer and agency citizen science coordinator

We also found that Regions 1 and 2 have each established a citizen science coordinator to facilitate efforts and establish regional networks. Region 1 has found it effective to have individuals to help coordinate and link efforts in the region with available resources at the ORD and within other program offices. Others have indicated that having regional citizen science coordinators in every region would be useful. For example, staff in the Office of Water and Region 9 both said that regional coordinators could work with their counterparts to facilitate communications and access to available agency resources for citizen science.

[26] According to the EPA, the OEI is leading the collaborative effort to develop the handbook with Region 1, along with support from the ORD.

Citizen science is evolving as advancements in technology bring the public greater access to low-cost tools and methods. Some in the EPA and NACEPT predict that citizen science will test the legitimacy of the EPA's work as the public places a greater demand on the EPA to acknowledge and address the environmental data collected by citizen scientists. The EPA will face this growing body of environmental data in the future and has the potential to do so now, in part by addressing barriers (identified above), to manage its future use of citizen science results.

> "NACEPT members strongly believe that a laissez faire approach by EPA will be insufficient. EPA must advance a positive, proactive agenda—to work in partnership with communities and state, territorial and tribal governments in ways that strengthen citizen science infrastructure and standardize citizen science methods. … One of the great benefits that citizen science offers EPA is the opportunity to leverage expertise, networks and resources of other parties."
>
> – NACEPT (2018)

The ORD's response to the 2017 NACEPT report states that the engagement of the public in the work of environmental protection is a priority for the EPA. An informed and engaged public can contribute to effective policy making and citizen science can help the EPA more effectively connect with the people it serves. The EPA faces potential difficulties stemming from the growing body of citizen science data, such as competing data issues, quality assurance concerns, and conflicts with state/local enforcement activities. With additional agencywide guidance and direction to enhance the quality and management of citizen science results, the EPA will be better equipped to use citizen science data in a manner that contributes to the EPA's work.

Conclusion

Citizen science is a potentially significant method for obtaining environmental data. Although the method itself is not new, it is predicted to take on a greater role in the future, especially given rapid advancements in low-costs sensors and other technologies for collecting and analyzing data. The EPA can be on the forefront of this effort and faces potential problems if it does not address this growing body of data in a systematic way. A clear vision or strategy for agencywide use of citizen science will acknowledge the tool's growing use and help address the agency's broad strategic objective on public participation. Further, clear guidance and communication will enhance the quality and agencywide management of results and help mitigate potential problems resulting from increased generation of citizen science data.

Recommendations

We recommend that the EPA Deputy Administrator:

1. Establish a strategic vision and objectives for managing the use of citizen science that identifies:

    a. Linkage to the agency's strategic goals,
    b. Roles and responsibilities for implementation, and
    c. Resources to maintain and build upon existing agency expertise.

2. Through appropriate EPA offices, direct completion of an assessment to identify the data management requirements for using citizen science data and an action plan for addressing those requirements, including those on sharing and using data, data format/standards, and data testing/validation.

We recommended that the Assistant Administrator for Research and Development:

3. Finalize, in coordination with the Office of Environmental Information and Region 1, the *Draft Quality Assurance Handbook for Citizen Science,* and communicate to agency staff and citizen science groups the availability and content of this handbook.

4. Build capacity for managing the use of citizen science, and expand awareness of citizen science resources, by:

    a. Finalizing the checklist on administrative and legal factors for agency staff to consider when developing citizen science projects, as well as identifying and developing any procedures needed to ensure compliance with steps in the checklist;
    b. Conducting training and/or marketing on the EPA's citizen science intranet site for program and regional staff in developing projects; and
    c. Finalizing and distributing materials highlighting project successes and how the EPA has used results of its investment in citizen science.

Agency Response and OIG Evaluation

The EPA concurred with our recommendations and provided acceptable corrective actions and completion dates. In its response, the EPA said the Office of the Administrator and ORD will collaborate with the EPA's programs and regions on the implementation of our recommendations. To oversee implementation, the EPA said it plans to convene an agencywide workgroup and it expects the workgroup to complete final products by December 31, 2020.

Appendix C provides the agency's full response.

Status of Recommendations and Potential Monetary Benefits

RECOMMENDATIONS

Rec. No.	Page No.	Subject	Status[1]	Action Official	Planned Completion Date	Potential Monetary Benefits (in $000s)
1	18	Establish a strategic vision and objectives for managing the use of citizen science that identifies: a. Linkage to the agency's strategic goals, b. Roles and responsibilities for implementation, and c. Resources to maintain and build upon existing agency expertise.	R	Deputy Administrator	12/31/20	
2	18	Through appropriate EPA offices, direct completion of an assessment to identify the data management requirements for using citizen science data and an action plan for addressing those requirements, including those on sharing and using data, data format/standards, and data testing/validation.	R	Deputy Administrator	12/31/20	
3	18	Finalize, in coordination with the Office of Environmental Information and Region 1, the *Draft Quality Assurance Handbook for Citizen Science,* and communicate to agency staff and citizen science groups the availability and content of this handbook.	R	Assistant Administrator for Research and Development	12/31/20	
4	18	Build capacity for managing the use of citizen science, and expand awareness of citizen science resources, by: a. Finalizing the checklist on administrative and legal factors for agency staff to consider when developing citizen science projects, as well as identifying and developing any procedures needed to ensure compliance with steps in the checklist; b. Conducting training and/or marketing on the EPA's citizen science intranet site for program and regional staff in developing projects; and c. Finalizing and distributing materials highlighting project successes and how the EPA has used results of its investment in citizen science.	R	Assistant Administrator for Research and Development	12/31/20	

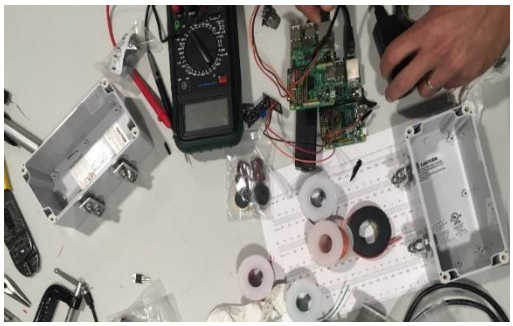
[1] C = Corrective action completed.
R = Recommendation resolved with corrective action pending.
U = Recommendation unresolved with resolution efforts in progress.

Information on Sampled Citizen Science Projects

Project Name and Summary: Smart City Air Challenge

- EPA conducted this contest for communities to develop plans for deploying hundreds of air quality sensors and making the data public in fall 2016. EPA awarded two $40,000 prizes to Baltimore, Maryland ("Greater Baltimore Open Air"), and Lafayette, Louisiana ("Lafayette Engagement and Research Network," or LEaRN), for their winning submissions. After a year, the EPA will evaluate the projects based on implementation and collaboration and award up to $10,000 for each project.

Offices Involved: OEI, Office of Air and Radiation
Dates/Status: Active (October 2016 to Summer 2018)
Funding: $100,000



Sensor technology used by the LEaRN program. (Photo courtesy of LEaRN)

Project Name and Summary: Local Environmental Observer Network

- The Local Environmental Observer Network is an organization of tribal individuals in Alaska and Canada who share information about environmental events where they live, post observations on public maps, and coordinate with technical experts to identify appropriate actions. The EPA provided support via development of an app to facilitate recording of these visual observations.

Offices Involved: ORD, EPA Region 10
Dates/Status: App was launched in 2012 and the project is still active
Funding: Unable to Identify

Project Name and Summary: Gardenroots

- In partnership with community members near a Superfund site in Arizona, Gardenroots aims to: evaluate environmental quality and the potential exposure to contaminants of concern near active or legacy resource extraction and hazardous waste sites, successfully communicate the study results to all participating individuals and families, and disseminate the results broadly to appropriately influence community prevention practices and environmental decision making.

Offices Involved: EPA Region 9, ORD
Dates/Status: Completed (2008–2012)
Funding: $15,000

Project Name and Summary: Region 10 Making a Visible Difference in North/Northeast Portland: Engaging Communities Using Citizen Science to Assess and Address Children's Health from Transit and Air Pollution

- The objective of this project was to combine data from various citizen science tools with local knowledge to understand mobile air pollution concerns at bus stops used by students in north/northeast Portland, Oregon, and to design a workshop model to integrate data sources promoting problem solving of air pollution issues.

Offices Involved: ORD, EPA Region 10
Dates/Status: Completed (2015–2016)
Funding: $100,000

A hand-held air monitor that measures particulate matter in the air. (EPA photo)

Project Name and Summary: Amigos Bravos

- Non-profit group Amigos Bravos received two separate grants under the Urban Waters program to perform water quality testing by community volunteers and students in various New Mexico water bodies. One of the projects was completed and the other remains active.

Offices Involved: Office of Water, EPA Region 6
Dates/Status: Completed (July 2014 to March 2018)
Funding: $115,326

Project Name and Summary: Ironbound Citizen Science Air Monitoring Collaboration

- The EPA partnered on a toolbox to enable communities like Ironbound (in Newark, New Jersey) to collect their own environmental data and increase their ability to understand local environmental conditions. The EPA designed and fabricated the sensor units and trained community members in their use. This project resulted in the development of an Air Sensor Toolbox—an online resource that provides information and guidance on new and low-cost compact technologies used for measuring air quality.

Offices Involved: ORD, EPA Region 2
Dates/Status: Completed (2013–2015)
Funding: $100,000

Project Name and Summary: Low-Cost Water Sensors for Real-Time Continuous Water Quality Monitoring

- This project funds activities for the equipment hardware and calibration standards and maintenance for low-cost water quality sensors. The EPA collaborated with the Georgia Adopt-A-Stream program to host a workshop for watershed monitoring groups in open source water quality sensor design, programming and continuous monitoring. Participating groups build and deploy sensors with the intention to provide feedback to the EPA on the feasibility of incorporating this technology and monitoring into citizen-based monitoring programs. The EPA plans to conduct an evaluation of the low-cost sensor and develop a low-cost quality sensor toolbox for water quality managers and citizen scientists.

A prototype open source sensor system. (EPA photo)

Offices Involved: EPA Region 4, ORD, Office of Water
Dates/Status: Active (August 2017 to December 2018)
Funding: $27,000

Project Name and Summary: Kansas City Transportation and Local-Scale Air Quality Study (KC-TRAQS)

- EPA launched the Kansas City Transportation and Local-Scale Air Quality Study (KC-TRAQS) to learn more about local community air quality in three neighborhoods that have multiple air pollution sources from highways, railways and industry. A citizen science project is part of the study and will involve area residents and students in air measurement activities by using AirMappers. These lunchbox-size monitors developed by the EPA enable residents and students to collect local air quality data by carrying or attaching the devices to a bicycle while walking or biking around the study area.

Offices Involved: EPA Region 7, ORD
Dates/Status: Active (Fall 2017 to Fall 2018)
Funding: $150,000

Project Name and Summary: Building Capacity to Measure Air Pollution Mitigation Strategies at Schools (California)

- The EPA, in collaboration with the Bay Area Air Quality Management District and the California Air Resources Board, will engage teachers and students in studying the effectiveness of roadside vegetation barriers. The project seeks to reduce exposure to vehicle emissions at an Oakland elementary school that is adjacent to a busy road.

Offices Involved: EPA Region 9, ORD
Dates/Status: Active (started in the Fall 2017)
Funding: $38,000

Project Name and Summary: (Region 1 Project) EPA Preparing for Extreme Weather (Mattapoisett, Massachusetts)

- This project investigated how sea level rise and disruptive extreme weather events may affect the drinking water supply and critical infrastructure in the town of Mattapoisett. Modeling data was collected and analyzed by the EPA. The community was engaged and contributed to this project in the form of field investigation, historical storm surge, record retrieval, and impact to citizens in the project area.

Offices Involved: ORD, EPA Region 1
Dates/Status: Completed (January 2015 to September 2016)
Funding: $50,000

Project Name and Summary: (Region 1 Project) Mystic River Watershed Association Baseline Monitoring Program and Annual Report Card (Massachusetts)

- The Mystic River Watershed is a collection of rivers, streams, lakes and ponds that drain an area of approximately 76 square miles and 21 municipalities north of Boston, Massachusetts. In collaboration with the EPA, the Mystic River Watershed Association assembles and publishes data in an annual water quality report card on the Mystic River watershed. Association volunteers collect monthly baseline water quality samples, which are analyzed by the Massachusetts Water Resources Authority or a private lab for bacteria. The EPA uses the authority's baseline bacteria data, as well as additional bacteria data collected by the authority at other watershed sites, to determine a set of 14 report card grades for the Mystic River and its tributaries each year.

Office Involved: EPA Region 1
Dates/Status: Active
Funding: None at this time

Project Name and Summary: (Region 1 Project) Casco Bay Estuary Partnership and Friends of Casco Bay (Maine)

- A collaboration of agencies, organizations and individuals are working on behalf of the Casco Bay. For 25 years, the Casco Bay Estuary Partnership has funded the Friends of Casco Bay volunteer water quality monitoring program. Results from the Friends of Casco Bay data are used for the State of the Bay reports and to inform the Casco Bay Plan. The Casco Bay Estuary—a waterbody where rivers and the sea converge—encompasses 14 coastal communities, including two of Maine's largest cities, Portland and South Portland.

Offices Involved: EPA Region 1, and Office of Water's National Estuary Program
Dates/Status: Active (1992 to present)
Funding: The Casco Bay Estuary Partnership receives about $600,000 annually and the partnership provides Friends of Casco Bay with sub-awards.

Appendix B

Details on Barriers to Using Citizen Science Results

The following categories describe the five barriers cited most often in our interviews and survey.

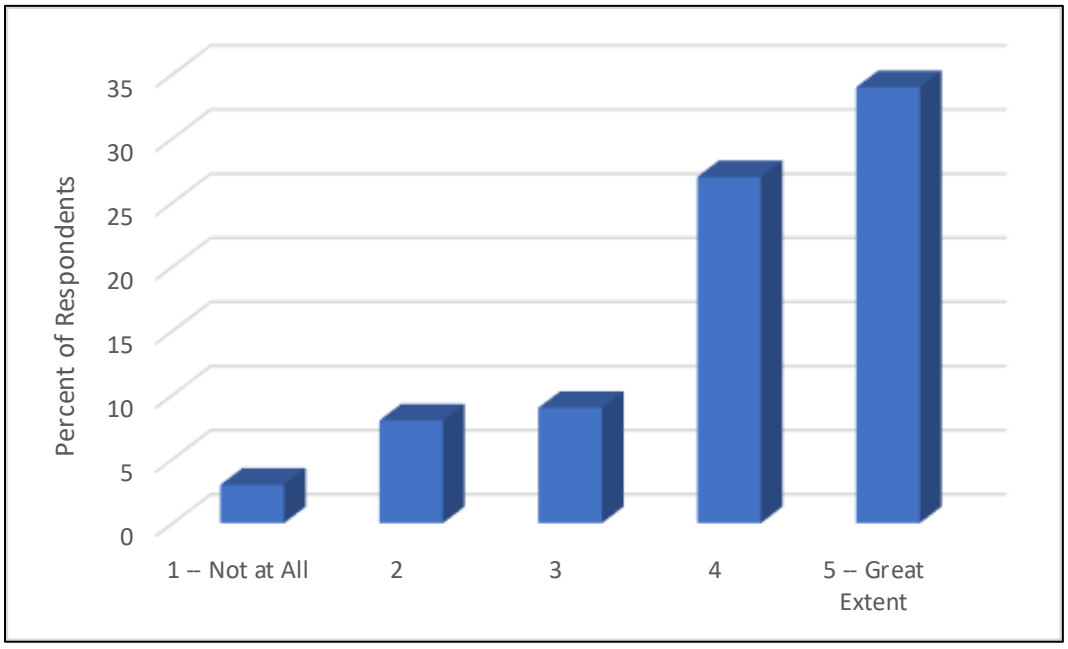
Strategic Communication and Support/Resources

The ORD's Chief Innovation Officer identified the lack of a strategic agencywide approach as a barrier to using citizen science—primarily as a barrier to developing opportunities for using the tool rather than as a barrier preventing its use. Survey respondents also identified barriers having to do with strategic communication, guidance and lack of resources. In an open-ended question on barriers:

- 15 percent of 73 respondents identified the lack of clear, top-level messaging and support (i.e., on the quality and use of citizen science data, prioritization of efforts, addressing data management issues, and ensuring alignment with EPA administration priorities).
- 10 percent of 73 respondents identified the lack of clear EPA guidance for using citizen science data (i.e., protocols for when and how to use/not use the data and established research frameworks that demonstrate the added value of data).

Many survey respondents cited "resource limitations" as a barrier (33 percent of 73 respondents). Survey respondents also ranked resources as a factor greatly affecting their offices' use of citizen science (Figure B-1).

Figure B-1: Extent to which resources affect citizen science use



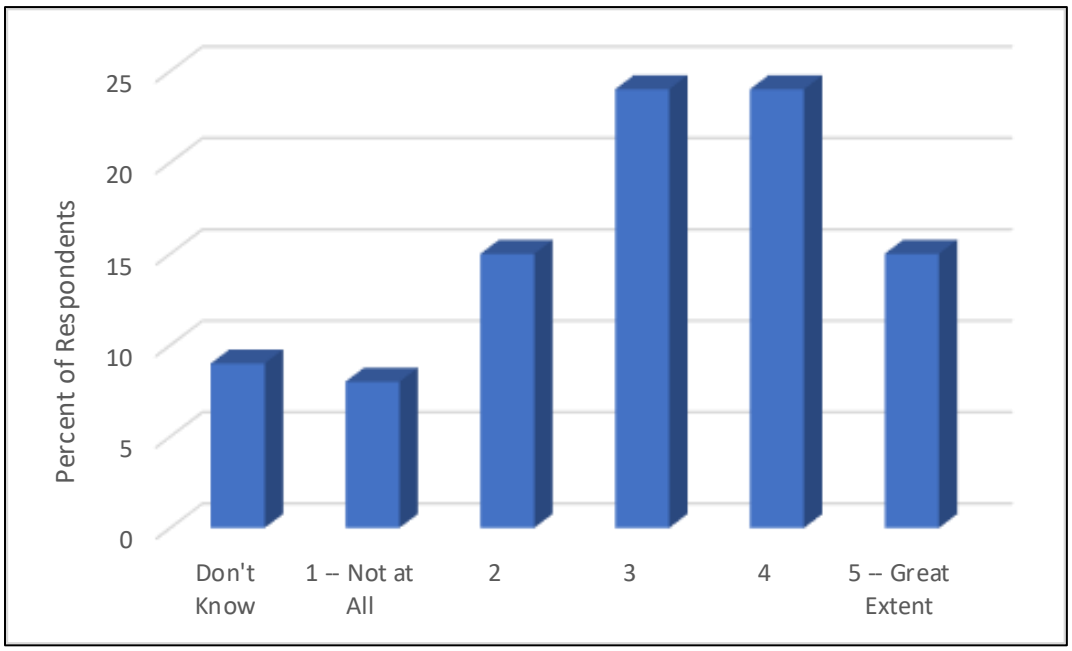
Source: OIG analysis of survey responses.

One Acting ORD lab director noted, "citizen science has a very strong future if we can get our policies [established] … so everyone knows what the ground rules are."

Understanding/Acceptance

NACEPT members we met with identified as a barrier the general acceptance of citizen science as a data collection tool. They noted the need for building a "cultural norm" that recognizes what citizen science can do for the EPA, integrating it into the EPA's "toolbox" for data collection, and valuing its utility for applications outside of regulatory and enforcement uses. The ORD's Chief Innovation Officer also identified as a barrier promoting a cultural understanding and "buy-in" for citizen science across the EPA. In addition, in response to a question on barriers, survey respondents pointed to the lack of knowledge and/or acceptance of the EPA's potential uses of citizen science data (18 percent of 73 respondents). We also asked survey respondents to rank the extent to which experience with or understanding of citizen science (e.g., lack of trust in citizen science data quality) affected their programs' use of citizen science, shown in Figure B-2.

Figure B-2: Extent to which experience or understanding affects citizen science use



Source: OIG analysis of survey responses.

Data Quality

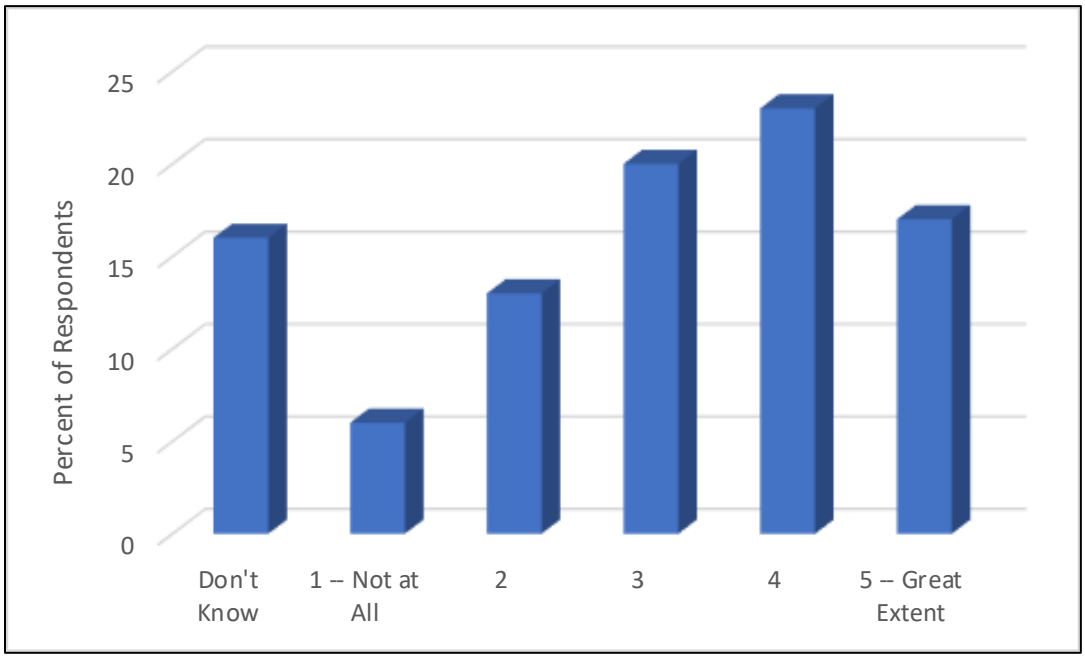
Strong data quality procedures promote confidence in the reliability of EPA reporting. The EPA offices we surveyed or met with identified uncertainty over data quality as a barrier to using citizen science. Similarly, data quality was the most common barrier identified by survey respondents in an open-ended question (44 percent of 73 respondents). The ORD's Chief Innovation Officer also identified various challenges associated with data quality, including insufficient awareness of data requirements. NACEPT members also identified the need for ensuring that data quality standards are communicated by the EPA and understood by those

gathering the data. Both the 2016 NACEPT report and our interviews with NACEPT members emphasized that building partnerships with leaders in the citizen science community will help "champion" the EPA's citizen science effort by providing training to those gathering the data and helping communities meet the EPA's data requirements and needs. Community groups we met with in EPA Region 1 also stressed the importance of complying with data quality standards on citizen science projects.

Data Management

Staff in several EPA offices raised concerns with the perceived inability of the agency's information technology systems to handle large data streams as well as addressing ownership and storage issues for citizen science. The ORD's Innovation Team said that, currently, the OEI does not have the capacity or resources to handle challenges posed by "big data."[27] OEI staff said that the problems stem from the volume, variety and velocity of the data; whether data formats are inter-operable; and whether the frequency of measurements are comparable for analysis purposes, among other challenges. Survey respondents also identified as a barrier data management issues related to the storage, ownership and access to "big data." Figure B-3 captures survey responses on the extent to which data and information management issues (e.g., cyberinfrastructure, data platforms, data ownership) affect their programs' use of citizen science.

Figure B-3: Extent to which data and information management issues affect use of citizen science



Source: OIG analysis of survey responses.

[27] "Big data" is an accumulation of data that is too large and complex for processing by traditional database management tools. Challenges include analysis, capture, data curation, search, sharing, storage, transfer, visualization, querying and information privacy.

While the EPA Strategic Plan for fiscal years 2018–2022 includes a statement on the proposed development of a "comprehensive data management strategy that addresses the collection, management, and use of data generated both internally and from external partners including … citizen science," we obtained some inconsistent messages regarding this strategy:

- The EPA's Office of the Chief Financial Officer informed us that the OEI is the lead for developing this comprehensive data management strategy and is in the early stages of developing a framework; however, the Office of the Chief Financial Officer said citizen science data would not be a part of this comprehensive strategy.

- We were informed that the OEI's Chief Data Scientist was not aware of this comprehensive data management strategy and has not been asked to provide input, although the OEI does have some efforts underway that could support this initiative.

- Citizen science leads in the ORD and Region 1 were not aware of this strategy and said they were not consulted about any potential citizen science elements in the planned comprehensive data management strategy.

Technology

Another barrier is making technology accessible and understood. Per NACEPT members, some citizen scientists lack the technical understanding and capability for selecting the correct instrument for data collection that will validate data. In addition, the availability in the market of less expensive sensors and rapid advancements in technology present the EPA with the challenge of "keeping up." The ORD's Chief Innovation Officer agreed that issues need to be addressed related to information and sensor technology for collecting and securing the data for appropriate use. Survey respondents (14 percent of 73 respondents) also identified sensor technology/tool issues as a barrier (ranging from monitoring available technology, reliability for producing quality data, and accountability for the equipment; to the appropriateness of sensor measurements for use and how the measurement is represented in terms of environmental and health risks).

Agency Response to Draft Report

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

August 10, 2018

OFFICE OF
THE ADMINISTRATOR

MEMORANDUM

SUBJECT: Response to Office of Inspector General Draft Report No. OPE-FY18-0002 "EPA Needs a Vision and Strategy for Citizen Science that Aligns with Its Strategic Objectives on Public Participation" Dated July 3, 2018.

FROM: Andrew R. Wheeler
Acting Administrator

Jennifer Orme-Zavaleta, Principal Deputy Assistant Administrator for Science
Office of Research and Development

TO: Kevin Christensen, Assistant Inspector General
Office of Audit and Evaluation, Office of Inspector General

The U.S. Environmental Protection Agency welcomes the opportunity to review and comment on the Office of Inspector General's draft report titled "EPA Needs a Vision and Strategy for Citizen Science that Aligns with Its Strategic Objectives on Public Participation" (Project No. OPE-FY18-0002). The process used to collect information for this report was very thorough, including extensive interviews, surveys and more in-depth review of a subset of EPA projects. The draft report illustrates the diversity of citizen science-related work at the EPA and shows how citizen science touches all EPA programs and regions. Additionally, the site visit to Region 1 clearly provided a face-to-face opportunity to understand how citizen science works on the ground and the nature of EPA partnerships with states and other organizations.

The draft report reflects the goals and nuances of citizen science work at the EPA and the OIG's observations provide important insights. We appreciate the OIG's confirmation that the EPA has taken valuable steps to build capacity, invest in and maintain agency expertise in citizen science and concur with the recommendations. However, it is important to acknowledge the strides that the EPA has already taken toward developing a vision, strategy and controls for managing citizen science. The draft report identifies several examples of EPA building capacity and making progress toward developing a vision, strategy and controls for the use of citizen science, but these examples are not highlighted and not included as steps toward implementation of the recommendations. For example, the EPA is recognized as a leader across federal agencies on implementation of the 2015 Office of Science and Technology Policy memo that encouraged action to improve current practice. In addition, the EPA tasked the National Advisory Council for

Environmental Policy and Technology to assess the agency's approach to citizen science in 2015; the EPA is the only federal agency that has taken this step. An important concern to note is the title of the draft report, "EPA Needs a Vision and Strategy for Citizen Science that Aligns with Its Strategic Objectives on Public Participation," does not acknowledge the EPA's efforts toward a citizen science vision and strategy to date. Therefore, the EPA suggests the OIG consider inserting the word "Comprehensive" in front of "Vision and Strategy" to acknowledge recent progress.

Following the OIG's finding that citizen science should be more formally managed agencywide, the Office of the Administrator and the Office of Research and Development will collaborate with the EPA's programs and regions on the implementation of these recommendations. Implementation efforts will need to be closely coordinated with the EPA's programs, regions and state and tribal partners, as citizen science data and information will ultimately inform future work across all environmental protection programs. To oversee the implementation of these recommendations, the EPA will convene a one-year agencywide workgroup reporting to the Science and Technology Policy Council. We expect interim workgroup products by December 31, 2019, and final products by December 31, 2020.

Immediately below are EPA's responses to the OIG's specific recommendations.

Recommendation 1: "Establish a strategic vision and objectives for managing the use of citizen science that identifies: a. Linkage to the agency's strategic goals, b. Roles and responsibilities for implementation, and c. Resources to maintain and build upon existing agency expertise."

Response 1: The agency concurs with this recommendation and proposes the following corrective action and completion date.

Corrective Action 1: The EPA will establish an agencywide work group to establish a more formal strategic vision and objectives for managing the use of citizen science, including policies, procedures and clear objectives for how to collect, manage and use citizen science to support the agency's mission. ORD will assist the agency as the lead program office for implementing citizen science by coordinating and facilitating the efforts to link the strategic vision and objectives to the agency's strategic goals, outline roles and responsibilities for implementation and identify and designate resources to support EPA staff to maintain and build upon existing agency expertise. The agency's strategic vision and objectives will be guided by the findings and recommendations provided by the National Advisory Council for Environmental Policy and Technology.

Planned Completion Date: December 31, 2020

Recommendation 2: "Through appropriate EPA offices, direct completion of an assessment to identify the data management requirements for using citizen science data and an action plan for addressing those requirements, including those on sharing and using data, data format/standards, and data testing/validation."

Response 2: The agency concurs with this recommendation and proposes the following corrective action and completion date.

Corrective Action 2: The EPA will complete an assessment and action plan to identify and address data management requirements for citizen science. Development of this assessment and action plan will be challenging because it raises many issues that the EPA will need to work through with its partners (e.g. data ownership, legacy data management systems and storage capacity, data standards and integration, data sharing and privacy), and it will require resources for successful implementation. The process will involve consultation with multiple EPA programs and regions; states, tribes and other external collaborators; and will rely on consultation with experts in data management and citizen science.

Planned Completion Date: December 31, 2020

Recommendation 3: "Finalize, in coordination with the Office of Environmental Information and Region 1, the *Draft Quality Assurance Handbook for Citizen Science*, and communicate to agency staff and citizen science groups the availability and content of this handbook.

Response 3: The agency concurs with this recommendation and proposes the following corrective action and completion date.

Corrective Action 3: ORD and the Office of Environmental Information will jointly finalize the *Draft Quality Assurance Handbook for Citizen Science* because OEI has the responsibility for the agency's Quality System – including issuance of national Quality Assurance guidance – and ORD has the responsibility for building the agency's capacity for managing the use of citizen science. After issuing the report, the EPA will implement an external and internal outreach and communications plan to help EPA, states and tribes and citizen science groups to strengthen quality assurance practices.

Planned Completion Date: December 31, 2020

Recommendation 4: Build capacity for managing the use of citizen science, and expand awareness of citizen science resources, by: a. Finalizing the checklist on administrative and legal factors for agency staff to consider when developing citizen science projects, as well as identifying and developing any procedures needed to ensure compliance with steps in the checklist; b. Conducting training and/or marketing on the EPA's citizen science intranet site for program and regional staff in developing projects; and c. Finalizing and distributing materials highlighting project successes and how the EPA has used results of its investment in citizen science.

Response 4: The agency concurs with this recommendation and proposes the following corrective action and completion date for the OIG's review and approval.

Corrective Action 4: ORD will consult with the Office of General Counsel and other relevant EPA programs and regions to finalize the checklist on administrative and legal

factors for agency staff to consider when developing citizen science projects. ORD will conduct training and marketing for program and regional staff. Finally, ORD will have an active communication and outreach strategy that will include communications materials highlighting project successes and how EPA has used results of its investment in citizen science.

Planned Completion Date: December 31, 2020

If you have any questions regarding this response, please contact Jay Benforado, Chief Innovation Officer, Office of the Science Advisor, at Benforado.Jay@epa.gov.

Attachment

cc: Science and Technology Policy Council

Proposed Agency Corrective Action

Rec. No.	Page No.	Subject	Action Official	Proposed Corrective Action	Planned Completion Date
1	17	Establish a strategic vision and objectives for managing the use of citizen science that identifies: a. Linkage to the agency's strategic goals, b. Roles and responsibilities for implementation, and c. Resources to maintain and build upon existing agency expertise.	Deputy Administrator	ORD as the lead program office will coordinate efforts agencywide to establish a more formal strategic vision and objectives	December 31, 2020
2	18	Through appropriate EPA offices, direct completion of an assessment to identify the data management requirements for using citizen science data and an action plan for addressing those requirements, including those on sharing and using data, data format/standards, and data testing/validation.	Deputy Administrator	EPA will complete an assessment and action plan to identify and address data management requirements for citizen science.	December 31, 2020
3	18	Finalize, in coordination with the Office of Environmental Information and Region 1, the *Draft Quality Assurance Handbook for Citizen Science*, and communicate to agency staff and citizen science groups the availability and content of this handbook.	Assistant Administrator for Research and Development	ORD and OEI will jointly finalize the *Draft Quality Assurance Handbook for Citizen Science* because OEI has the responsibility for the Agency's Quality System	December 31, 2020
4	18	Build capacity for managing the use of citizen science, and expand awareness of citizen science resources, by: a. Finalizing the checklist on administrative and legal factors for agency staff to consider when developing citizen science projects, as well as identifying and developing any procedures needed to ensure compliance with steps in the checklist; b. Conducting training and/or marketing on the EPA's citizen science intranet site for program and regional staff in developing projects; and c. Finalizing and distributing materials highlighting project successes and how the EPA has used results of its investment in citizen science.	Assistant Administrator for Research and Development	ORD will consult with OGC and other relevant EPA programs to finalize the checklist on administrative and legal factors for agency staff to consider when developing citizen science projects. ORD will conduct training and marketing for program and regional staff. ORD will develop a communication and outreach strategy for citizen science agency-wide.	December 31, 2020

Appendix D

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