



National Advisory Council for Environmental Policy and Technology (NACEPT) Meeting

**1200 Pennsylvania Avenue, NW
William Jefferson Clinton Federal Building South, Room 2138
Washington, D.C.**

June 13 – 14, 2016

MEETING SUMMARY

Monday, June 13, 2016

Welcome, Introductions and Overview of the Agenda

Eugene Green, Designated Federal Officer (DFO) for the NACEPT, Office of Diversity, Advisory Committee Management and Outreach (ODACMO), Office of Administration and Resources Management (OARM), U.S. Environmental Protection Agency (EPA); William Ross, Jr., NACEPT Chair, Council Member, Gillings School of Global Public Health Advisory Council, University of North Carolina at Chapel Hill; and Donna Vizian, Acting Assistant Administrator, OARM, EPA

Mr. William Ross, Jr. (University of North Carolina at Chapel Hill) welcomed the new and returning Council members. He thanked the ODACMO staff members for their efforts in planning the meeting.

Mr. Eugene Green (NACEPT DFO) welcomed the NACEPT members and participants. When NACEPT last met in September 2015, the Council was issued a charge regarding citizen science. NACEPT's final report on the topic will be published in November 2016. He appreciates NACEPT's work and dedication in moving this effort forward. He asked the members and participants to introduce themselves.

Following the introductions, Ms. Donna Vizian (OARM, EPA) welcomed the members to EPA and thanked them for their work. She commented that her prior work in Region 2 has taught her the importance of data and exposed her to several examples of citizen science; she looks forward to the Agency advancing citizen science.

Ms. Bridgett Luther (Code Blue Innovations) asked whether other EPA advisory groups are exploring the topic of citizen science. Mr. Mark Joyce (ODACMO, OARM, EPA) explained that Mr. Ross and Mr. Jay Benforado (Office of Research and Development [ORD], EPA) are meeting with EPA's Science Advisory Board (SAB) the morning following this meeting to determine whether the SAB may be able to engage in any aspect of citizen science. Mr. Ross added that the U.S. Army Corps of Engineers (USACE) National Environmental Advisory Board is examining citizen science.

Dr. Patricia Gallagher (Drexel University) asked about the effects of the sustainability advice letter. Ms. Vizian responded that it had provided very helpful advice to ensure that Region 2 was taking the right actions to move forward successfully.

Mr. Ross noted that Robert Frost was a poet, citizen scientist and observant naturalist. He hopes that the NACEPT report will take the eloquent approach that the poet took in describing his observations. Citizen science presents a two-way flow of benefits and can help EPA meet its mission to protect human health and the environment.

Overview of EPA's Citizen Science Charge to the Council

Alison Parker, ORISE Postdoctoral Fellow, ORD, EPA, and William Ross, Jr., NACEPT Chair, Council Member, Gillings School of Global Public Health Advisory Council, University of North Carolina at Chapel Hill

Dr. Alison Parker (ORD, EPA) reiterated the goals of NACEPT's review of citizen science, which are to (1) help EPA realize the full benefits of citizen science approaches; (2) define roles for citizen science in environmental protection; (3) identify current and future efforts with the highest value; and (4) provide ideas on EPA's framework, strategy and partnerships in the area of citizen science. Citizen science provides a significant opportunity for the Agency to engage and empower the public. EPA needs a vision from NACEPT to realize the full benefits of citizen science. Potential outcomes of this effort include development of an educated and engaged public to help solve environmental problems, greater use of local data to support communities, a decrease in current gaps in environmental data, contributions to environmental research, and improved environmental governance.

Dr. Parker restated the three questions of NACEPT's charge: (1) How can we sustain and improve current EPA projects and programs? (2) How can EPA invest in citizen science approaches for the greatest gain? (3) How can EPA help to increase the impact of knowledge and data generated via citizen science?

Citizen science advances environmental protection by empowering communities to understand problems and advocate for solutions, creating useful monitoring data, supporting environmental and health research, and educating the public about environmental issues. In terms of potential future opportunities, EPA can build capacity through strategic investments but must address issues related to data quality and management and instrument evaluation. To increase the positive effects of citizen science knowledge and data, EPA can provide support for using them at the local and state levels. The Agency also can develop policies and guidance for using citizen science knowledge and data at EPA. Finally, EPA can work with the public to interpret citizen science data.

Each of NACEPT's citizen science workgroups is addressing questions related to EPA support and use of citizen science. The following questions guide the Strategic Opportunities and Research Workgroup: How can EPA strategically use citizen science to support environmental protection? How can limited investments in citizen science best support protection of human health and the environment? How can citizen science advance EPA research priorities and address gaps?

The Community-Driven Citizen Science Workgroup is guided by the following questions: How can EPA support community groups that want to collect data on an environmental concern? How can EPA support the use of knowledge and data generated by community groups? How can EPA provide an appropriate response to community groups who collect data indicating an environmental concern?

Finally, the Data Quality and Data Management Workgroup is attempting to address the following: How can EPA ensure that citizen science data are high quality and suitable for their intended purpose? How can EPA build capacity for managing and maintaining citizen science data?

Discussion

Mr. Donald Trahan (Louisiana Department of Environmental Quality [DEQ]) asked about the definition of the term "citizen science." Dr. Parker responded that the definition is under discussion because citizen science only recently has become a formalized field. A citizen science approach invites and engages public participation in research; it is an open collaboration in which the public participates in the scientific process. Crowd-sourced services and content are included in this field. Mr. Ross added that NACEPT will use a broad definition to guide the Council's work.

In response to a question from Mr. Ross regarding the ability of health research to advance environmental protection, Mr. Benforado explained that this is an emerging area without neat boundaries and definitions. Many projects address multiple issues; the best address them all.

Dr. Irasema Coronado (University of Texas at El Paso) asked about examples in which citizen science has informed decision making. Ms. Deb Szaro (EPA Region 1) cited the examples of the Ironbound Community in New Jersey and the town of Tonawanda in New York.

Dr. Emmanuel Crisanto Battad Liban (Los Angeles County Metropolitan Transportation Authority) noted the citizen science efforts of advocacy groups, academia and communities and indicated that he is excited about NACEPT's charge. Mr. Benforado said that EPA is interested in the full scope of citizen science at all scales.

Mr. Ross reminded NACEPT that it has been charged with making practical, effective recommendations regarding how EPA can implement citizen science to fully realize the two-way flow of benefits. EPA would like NACEPT to develop a coordinated framework that the Agency can use to embrace citizen science as a tool to protect human health and the environment. Mr. Benforado added that the group should consider the incoming, although as yet unknown, EPA Administrator when writing the report and making recommendations. Citizen science can be a foundation for the next Administrator, but the Agency must shift its thinking regarding environmental data collection and interpretation, especially in terms of including the public.

Ms. Luther asked about changes in EPA when the incoming administration takes office. Mr. Benforado explained that a new EPA Science Advisor will be appointed. Mr. Ross asked the NACEPT members to consider the most effective, proactive recommendations that the Council can make to EPA and the incoming Administrator.

Progress Report on NACEPT Citizen Science Workgroups

Strategic Opportunities and Research Workgroup

Mr. Robert Kerr, Workgroup Lead, Pure Strategies, Inc.

Mr. Robert Kerr (Pure Strategies, Inc.) reported on the progress of the Strategic Opportunities and Research Workgroup. The workgroup's charge was to consider the following questions: How can EPA strategically use citizen science to support environmental protection? How can limited investments in citizen science best support protection of human health and the environment? How can citizen science advance EPA research priorities and address gaps? To address this charge, the workgroup met biweekly via teleconference, reviewed a report on citizen science and schools, surveyed EPA national program directors regarding environmental data gaps and areas in which citizen science might fill those gaps, and conducted discussions with EPA staff.

The workgroup's first major finding is that EPA has a variety of citizen science projects underway, but these activities seem *ad hoc*. This finding led to Recommendation 1: Create an EPA strategy, including a unifying vision and framework that encompasses the full range of citizen science projects. EPA should consider targeting large environmental issues, exploring data gaps, and engaging EPA program and regional office staff. The Wilson Center study on the potential role of citizen science in public decision making, titled *Clearing the Path: Citizen Science and Public Decision Making in the United States*, provides examples of policy domains and types of decisions that represent opportunities for engaging citizen scientists in decision making. EPA Region 2's equipment loan program is an example of current EPA engagement with citizen science groups. The Citizen Science Association is an online community of practice dedicated to advancing citizen science. Industry also is playing a role in advancing citizen science through the development of data platforms.

The workgroup's second major finding is that EPA has a wide range of methods that it can use to support citizen science, from community-driven citizen science projects to research endeavors to large-scale monitoring. This finding led to Recommendation 2: Define EPA's unique role in supporting partner organizations. EPA should consider building capacity by providing tools, training and guidance; aligning efforts with states, tribes and other organizations; establishing partnerships; and defining an EPA-wide approach. An example of a partnership at the state-agency level is the alliance that the California Environmental Protection Agency has formed with the California Water Quality Monitoring Council, which helps to identify the types of questions that citizens want answered regarding water quality.

The workgroup's third major finding is that many citizen science efforts struggle from lack of information on how to design and operate effective projects. This finding led to Recommendation 3: Invest in a citizen science infrastructure that supports EPA's critical mission areas. EPA should consider using citizen science beyond direct regulatory applications, ensuring that data can be integrated and linking citizen science to decision making. As an example of the elements of such an infrastructure, tools for community groups are available on a federal website designed to accelerate the use of citizen science across the U.S. government (www.citizenscience.gov).

The workgroup's fourth recommendation was for EPA to consider using citizen science to revitalize environmental education, both K–12 education and lifelong education. Citizen science has the potential to increase students' and adults' interest in science more effectively than traditional learning environments.

Discussion topics on strategic opportunities identified by the workgroup include the role of citizen science in global sustainability; an alternative structure for the report; current and future uses (i.e., case studies); how EPA program and regional offices can identify citizen science opportunities, including top-down and bottom-up approaches; and ideas on the tools, training and guidance that EPA can provide.

Discussion

Mr. Benforado asked the participants to provide feedback on the framework developed by the Strategic Opportunities and Research Workgroup, including the appropriateness of its recommendations.

Dr. Ronald Meissen (Baxter International, Inc.) noted concordance between fostering citizen science and the United Nation's Millennium Development Goals, which include education for girls and women. He added that the field of citizen science is expanding rapidly, and EPA needs to take a "cheerleading" role in endorsing its use or risk falling behind.

Ms. Barbara Jean Horn (Colorado Parks and Wildlife) cited the erosion of boundaries between citizens, academics and environmental regulators that results from volunteer monitoring programs. She indicated that she had written an addendum to the workgroup's framework that includes research websites and examples in which citizen science has influenced regulatory decisions. She spoke of the need for developing a lexicon for citizen science. Data uses and information needs (e.g., monitoring, regulatory enforcement), data users, intended impacts from data use (e.g., increasing basic scientific knowledge, changing behavior), and data quality exist on a continuum.

Ms. Shannon Dosemagen (Public Laboratory for Open Technology and Science) observed that citizen science is not just a mechanism for teaching science skills but part of a larger strategy for increasing citizens' participation in decision making.

Dr. Dale Medearis (Northern Virginia Regional Commission) expressed concern about the workgroup's first discussion point being too broad. Global sustainability is a large issue. He proposed instead a focus on challenges linked directly to EPA's priorities of protecting water and air quality, such as the drinking water contamination in Flint, Michigan. Dr. Caren Cooper (North Carolina Museum of Natural Sciences) cited Flint as a case in which citizen science could have been used by EPA to be proactive and address the problem earlier.

Dr. Coronado asked whether the participatory action research approach is considered part of citizen science. She noted that in the past, community expectations have been raised by research being conducted on local problems (e.g., arsenic in drinking water), but solving environmental problems has been a comparatively slow process. Dr. Coronado also raised the issue of how to incorporate traditional ecological knowledge into the decision-making process. Mr. Ross confirmed that participatory action research is considered part of citizen science.

Dr. Liban voiced concern about how local governments might react to EPA's endorsement of citizen science. Mr. Trahan expressed misgivings about gathering data for the sake of gathering data but recognized the potential of citizen science to foster local empowerment. Mr. Ross responded that the uses for the data will be a key issue that the Data Quality and Data Management Workgroup will address.

Community-Driven Citizen Science Workgroup

Mr. Jeffrey Mears, Workgroup Lead, Oneida Nation

Mr. Jeffrey Mears (Oneida Nation) reported on the progress of the Community-Driven Citizen Science Workgroup. The workgroup's charge was to consider the following questions: How can EPA support community groups that want to collect data on an environmental concern? How can EPA support the use of knowledge and data generated by community groups? How can EPA provide an appropriate response to community groups that collect data indicating an environmental concern? To address this charge, the workgroup met biweekly via teleconference, surveyed participants at the 2016 Region 5 Tribal Environmental Program Management Conference on what is working currently in citizen science and their general thoughts about citizen science, and interviewed environmental community organizations.

The workgroup's first major finding is that EPA's program and regional offices lack a unified approach to support community-driven citizen science. This finding led to Recommendation 1: Expand the availability of EPA resources to support community-driven citizen science. EPA should consider creating more funding opportunities, developing guidance to ensure communities are equal partners, and establishing a clear policy preference for open licensing in tool development.

The workgroup's second major finding is that EPA should determine how to increase the utility of community-generated data. This finding led to Recommendation 2: EPA should remove barriers to the use of community-driven citizen science data in decision making. EPA should consider determining how to increase the utility of community-generated data (e.g., addressing such barriers to community-generated data use as the requirement for Quality Assurance Project Plans), focusing on improving data quality, and improving access to data management tools.

The workgroup's third major finding is that many communities need support to access technical experts, as well as more resources, tools and approaches, to remove barriers to citizen science. This finding led to Recommendation 3: Build capacity in communities to use citizen science on their issues of concern. EPA should consider working with organizations that are best equipped to support communities; providing technical support and training (e.g., tribes are ideal candidates to conduct citizen science but vary in capacity); and providing opportunities that involve communities in design and practice, including documentation, data and toolkits.

The workgroup's fourth major finding is that EPA can leverage existing networks to support the work of the Agency and integrate community-driven citizen science efforts. This finding led to Recommendation 4: Use networks and partnerships to support community-driven citizen science. EPA should consider improving connections between communities and local governments, creating standardized approaches for data reporting, and adopting an integrated approach to support citizen science (e.g., integrating citizen science into existing programs).

Discussion topics on community-driven citizen science identified by the workgroup include attitudes toward sharing data and privacy among tribal communities and citizen science practitioners, the trend

toward open-source software and the technology boom, and how EPA can lead the push in acceptance of citizen science data. Mr. Mears noted that traditional ecological knowledge does not have a single definition and stated that each tribe should be free to define what it means to that tribe.

Dr. Gallagher added that the workgroup had interviewed people who work in community-driven citizen science. Many of the recommendations of the Strategic Opportunities and Research and Data Quality and Data Management Workgroups are similar to comments made by the interviewees. For reference, the interviews are summarized on the workgroup's SharePoint site. She added that the Community-Driven Citizen Science Workgroup is in the process of integrating the information gathered from the participants at the Region 5 Tribal Environmental Program Management Conference. Dr. Gallagher suggested streamlining the NACEPT report by combining similar recommendations developed by different workgroups.

Discussion

Ms. Dosemagen proposed that EPA address the needs of individuals interested in using the new technologies being created in the technology boom. Many citizen scientists rely on known tools such as Google Earth. She also advocated for incorporating case studies and examples in the NACEPT report.

Dr. Graciela Ramirez-Toro (InterAmerican University of Puerto Rico) agreed with eliminating repetition in the report. She advocated for NACEPT to define a focused role that EPA could take with regard to citizen science rather than offering many, diffuse suggestions.

Mr. Trahan stated that data management—including gathering, organizing, manipulating and determining the appropriate use for data—will be a key issue because of the large amounts of data that will be generated by citizen science.

Dr. Cooper emphasized the benefits that will accrue to communities from connecting to each other through citizen science projects. Mr. Ross responded with a request for recommendations about how to foster connections among communities. Ms. Dosemagen stated that the primary reason communities engage in community-driven citizen science is the lack of information about an issue of local concern.

Dr. Liban asked whether there is any evidence of community-driven citizen science data being used by commercial or humanitarian entities for their own purposes. Ms. Dosemagen replied that private companies are interested in developing smartphone applications that use citizen science data. Dr. Liban suggested that EPA fund such development efforts by private companies, similar to the approach being taken by the U.S. Food and Drug Administration (FDA).

Data Quality and Data Management Workgroup

Dr. Olufemi Osidele, Workgroup Lead, Southwest Research Institute

Dr. Olufemi Osidele (Southwest Research Institute) reported on the progress of the Data Quality and Data Management Workgroup. NACEPT was charged with developing approaches to better use and integrate citizen science data into EPA's mission and work. The Data Quality and Data Management Workgroup was established to identify pertinent data issues and recommend guidelines for collection, management, sharing and reporting of citizen science data. The workgroup's ultimate goal is to recommend strategic, actionable guidelines to both EPA and citizen science groups for data quality and data management in the context of citizen science projects. The workgroup's charge was to consider the following questions: How can EPA ensure that citizen science data are of high quality and suitable for their intended purpose? How can EPA build capacity for management and maintenance of citizen science data? To address this charge, the workgroup met biweekly via teleconference; attended webinars on "Ethical, Legal, and Social Implications of Citizen Science," "Data Quality and Management," and "Citizen Science, New Technologies and Wetlands Monitoring"; heard from EPA quality assurance staff from the Office of

Environmental Information, Office of Air and Radiation, Office of Water (OW), and Office of Pollution Prevention; and reviewed citizen science case studies.

The workgroup's first major finding is that science data are science data, so one should treat these data as professional science from the start and then adapt processes toward citizen science. In particular, the workgroup found that professional researchers or retired scientists often lead citizen science efforts. This finding led to Recommendation 1 on data utility: To increase the utility of citizen science data, work with stakeholders to define transparent processes for how to evaluate citizen science data and projects, including clear policies, roles, work flows and expectations. EPA should consider issues of data categories, data standardization, criteria for data evaluation, and data verification and validation.

The workgroup made the following recommendation on data management: EPA should not own citizen science data but should be able to access the data. Therefore, EPA should develop a more organized, funded approach for developing a citizen science infrastructure—including tools, platforms and training—with an emphasis on data validation, user-friendly modern technologies, and data quality and accessible processes. EPA should consider technical support and training, data storage, multiple audiences, and the functionality of a data warehouse. Technology is likely to drive the use and storage of data.

The workgroup's third major finding is that various legal, administrative and procedural issues may constrain or promote the use of citizen science data in environmental policy and regulatory decision making. The workgroup has not yet developed a recommendation regarding legal and procedural constraints and opportunities.

Discussion topics on data quality and data management identified by the workgroup include the fact that some citizen science projects are initiated, designed and managed by professional researchers and scientists. The workgroup determined that three options exist for EPA's investment in, or support for, data storage: (1) on EPA servers, (2) in the cloud, or (3) on dedicated servers owned and maintained by external partners. Each of these options has its advantages and disadvantages. Potential obstacles to communication among citizen science project implementers—as well as to communication of vital data and information to federal, state and local agencies to fulfill research, regulatory or legal missions—are additional topics for discussion. The workgroup also suggested discussing what actions EPA must take to change internally in data management and the life cycle of data so that the Agency may use citizen science data, as well as how EPA could help other organizations, including states, change. Finally, the workgroup proposed discussing the legal, administrative and procedural issues that may constrain or promote the effective use of citizen science data for environmental policy and regulatory decision making.

Discussion

Mr. Karl Konecny (Northwest Motion Products) provided the example of the need for data to establish baseline conditions for environmental degradation. In the part of Oregon where he lives, slow degradation of the environment is a concern, but only anecdotal information exists about past conditions.

Dr. Ramesh Chawla (Howard University) highlighted the need for procedures to manage and analyze data so that bias is not introduced into data interpretation, particularly for observational, conflicting or large amounts of data.

Ms. Luther suggested that EPA evaluate its data needs strategically, including the timeframes of data needs. EPA should capitalize on opportunities to form partnerships with the private sector. A precedent for such collaborations is EPA's Developer Central (developer.epa.gov), which is an online resource for developers interested in building applications using EPA data and Web services.

Dr. Osidele suggested Google's Street View photographic data as an example of spatially distributed data that a public-private partnership could provide to EPA. He cited issues for data use that include aggregating spatially distributed data from different sources and determining data collection needs specific to the problem being addressed.

Ms. Horn noted the need for defining terms related to data quality in the NACEPT report's lexicon. She suggested that data quality be defined as "sufficient data for the decision that needs to be made" rather than "high-quality data."

Dr. Coronado made the point that not all communities have equal access to the Internet, and EPA should explore providing equal community access to data and software as part of its citizen science outreach efforts. Another issue of interest to disadvantaged communities is gathering human health data, which can provide answers to health questions of interest to these communities, such as pesticide exposure of farmworkers.

Dr. Liban cited possible conflicts between the thresholds established by EPA's regulatory framework and the ways in which citizen science data are produced. A key issue will be bridging the gap between the types of data generated by citizen science and how these data will be used. Ms. Lauren Boles (New Jersey Environmental Justice Alliance) added that the communication of results from citizen science also needs consideration. An example is air pollution monitoring results that exceed daily but not annual thresholds for regulatory action. Mr. Trahan responded that interpretation of such data will depend on the intended use.

Dr. Osidele asked whether a recommendation about the need to consider timeframes in regulatory standards for all media is within the scope of NACEPT's charge. Mr. Benforado responded that the Agency recognizes that citizen science may challenge the ways in which EPA, as well as state and local governments, regulate to protect the environment. For example, citizen science may provide data on finer spatial and temporal scales than previously possible, which may reveal previously unobserved human health concerns. Ms. Boles suggested projects executed by the Senior Environment Corps as potential case studies of citizen science.

Public Comments

Eugene Green, NACEPT DFO, ODACMO, OARM, EPA

In response to Mr. Green's call for public comments, Ms. Karen Andersen (Friends of the Shenandoah River) explained that she is working with a grassroots organization that maintains a state-certified accredited laboratory governed by a Quality Assurance Project Plan. Volunteers are trained and certified, and standard operating procedures are employed for data entry and analysis. When the group identifies an issue, regulatory action can be taken. The group provides the Virginia DEQ with water quality data and monitors 120 monitoring stations for which water sampling data are analyzed within 24 hours. Two decades worth of data at the sites are available. Previously, important data being generated by volunteers were not being used, which influenced the group's decision to obtain state laboratory accreditation despite the high cost and effort. The stigma of being a volunteer group, however, still exists. She described the group's efforts in the Chesapeake Bay and the Smith Creek Watershed. EPA indirectly uses citizen science data when it receives reports from the U.S. Geological Survey (USGS) and the Virginia DEQ that include the volunteer data collected by the Friends of the Shenandoah River and other volunteer groups. Following the 2009 Executive Order calling on the federal government to restore and protect the Chesapeake Bay and its watershed, funding became available for government agencies; the nine citizen groups that had been working on restoring the bay for 20 years, however, received no funding but were asked by the government agencies to help. These groups ultimately received no recognition or financial support. The Friends of the Shenandoah are required to report data annually to EPA's STORage and RETrieval (commonly known as STORET) electronic data system for water quality monitoring data, but Ms. Andersen is unaware whether EPA looks at or uses these data. She invited the NACEPT members to

visit the citizen-driven laboratory and meet the volunteers. The organization would like to work with NACEPT in developing the response to the citizen science charge.

Mr. Ross commented that this comment highlights the issue of raising a community's expectations and then failing to meet them. He invited Ms. Andersen to provide input regarding NACEPT's recommendations.

In response to questions from Mr. Ross, Ms. Andersen explained that her organization's annual budget is \$120,000, with \$10,000 provided by the Virginia DEQ. The remaining amount is derived from fundraising efforts. The laboratory performs for-fee bacteria analyses for local lakes and community wells. The group's data have been used for delisting and listing impaired and nonimpaired streams under Clean Water Act (CWA) Section 303(d), which confirms that citizen science can be used for regulatory action.

Life, Liberty and the Pursuit of Data: Citizen Science as a Democracy

Dr. Caren Cooper, Assistant Director, Biodiversity Lab, North Carolina Museum of Natural Sciences

Dr. Cooper described citizen science as a knowledge democracy, commenting that it is a system of science of the people, by the people and for the people. She noted that citizen science is present in virtually every scientific discipline and performed in many styles, models and shapes. Dr. Cooper emphasized its role in the larger context of knowledge production and suggested revisiting questions about who makes knowledge and where.

There are many misconceptions about citizen science from people who only are familiar with one part of it, such as community projects or crowd-sourced data collection. One of these misconceptions is that citizen science is free or cheap. In many cases, the data may be inexpensive to collect, but data maintenance and infrastructure can be very expensive. Dr. Cooper used eBird, a real-time online program, as an example; contributions to eBird are free, but the infrastructure makes the immense quantity of data accessible to researchers or other users, and this infrastructure is costly to develop and maintain.

Another common misconception is that citizen science is a new idea. Dr. Cooper described the integral role of citizen science in the history of the discipline and noted that the professionalized, hierarchical view of science is relatively recent. She recounted a study in the 1800s that coordinated tide readers on both sides of the Atlantic Ocean and collected more than 1 million observations.

Dr. Cooper explained that many people also mistakenly believe that citizen science consists only of outreach, education or projects designed for children. She described the Lost Ladybug Project at Cornell University, which included children but collected important observations confirming the presence of the nine-spotted ladybug. She emphasized that citizen science projects can and frequently do make important scientific discoveries. Some information considered new to the mainstream scientific community can come from ways of knowing that do not fit the standard model, such as indigenous knowledge.

In ornithology, Dr. Cooper's field of expertise, a review of available literature on migratory birds and climate change determined that citizen science data contributed between 24 and 77 percent of the data related to each of 10 verified claims, which represents an average of 50 percent of the data having been provided by citizen science. None of the papers, however, used the term "citizen science," so it would be difficult for anyone searching the literature for citizen science results to find the existing data. Dr. Cooper emphasized that the nature of knowledge discovered with citizen science often is very different from the results of professional science. In participatory environmental monitoring, a decision often is made within a year of the first collection of data, whereas decisions made within the professional science model often take several years or decades. Though the largest decisions, such as those made by governments or the United Nations, often require these longer timeframes, significant decisions and changes made at the household, village or district level from citizen science results can be much faster. Dr. Cooper also noted

that there is a sphere of discoveries that only will be made with citizen science because some citizen science studies do not overlap with the kinds of studies performed in professional spheres.

Another misconception about citizen science is that data quality is low; Dr. Cooper emphasized that she has heard this misconception repeated even after demonstrating the amount of citizen science data used in published studies. She described the high knowledge level of amateur birders and mentioned iSpot, a United Kingdom-based website that organizes amateur scientists with expertise in different topics into networks to coordinate their knowledge. Dr. Cooper is concerned that natural history expertise is dwindling and emphasized that it should be cultivated in new generations.

Not all citizen science projects require expertise, however; many projects require an investment of time but do not need specialized knowledge. Dr. Cooper described monarch butterfly breeding, tagging and release activities performed by inmates at Walla Walla Prison, and she added that participating in these projects is a transformative experience for many inmates. Citizen science also can be performed by nonliterate communities. Technology provided to these communities can be used to preserve and understand indigenous knowledge. Disenfranchised indigenous communities can use citizen science tools to map places valuable to their communities, which allows such places to be included in planning and provides these communities a voice in natural resource management.

Observations are not the only way to contribute to citizen science. Distributed computing has been particularly successful in biomedical research; the most powerful computing systems now are created by many computers in networks, and some problems are so significant that they only can be solved using this method. Dr. Cooper emphasized the importance of creativity in finding solutions to these problems. As communities that value creativity and sharing, fandoms have been successful in solving problems using distributed computing. Data can be processed by many individual computers when not in use, and teams can compete in games to discover solutions to problems such as protein-folding arrangements. Dr. Cooper noted that people are better than computers at figuring out three-dimensional problems imaginatively.

Dr. Cooper commented on the misconception that people engage in citizen science to advance political objectives. Participants engaged in a study of koala distribution had stronger views than the general population on protection or management strategies, but this was because they had become highly informed and educated on this topic and not because of a preexisting agenda. Participants formed opinions based on their experiences in the project. Dr. Cooper also described a partnership between HSBC Bank and Earthwatch, a company that arranges for vacationers to participate in climate research. Citizen science participants often are self-selecting, but in this corporate citizen science project, chief executive officers were told to attend Earthwatch vacations. About 20 percent of the participants entered the program as climate change deniers, and 100 percent of these individuals had changed their minds by the end of the vacation. Dr. Cooper noted that this is the “Holy Grail” for environmental justice, and it demonstrates the potential of citizen science to transform people and communities and to produce new knowledge and social capital.

Another misconception is that science is learned only from scientists. The best citizen science involves peer-to-peer learning as well as two-way communication between scientists and the public. Dr. Cooper discussed the Flint Water Study, which was prompted by residents calling EPA to notify the Agency that there was a problem with the water. She emphasized that in most cases, when the public thinks something is wrong, data confirm the existence of a problem. Other examples of studies receiving information from the public include research on farm pollution in North Carolina and work performed by the Silent Spring Institute, which researches environmental causes of cancer and receives a large percentage of its information from public input. Dr. Cooper added that a geographer colleague decides what to study by going into communities and conversing with residents.

Though this presentation has called citizen science a democracy, it is a misconception that this label indicates equal participation by all users. In the case of eBird, 90 percent of the data come from 10 percent of the users. Wikipedia has a similar ratio of users to contributors. Dr. Cooper described the

“onlooker effect,” which shows that even those who only observe the study, such as the group of koala study participants who were not active contributors, can increase their knowledge and transform their opinions.

Dr. Cooper noted that studies of citizen science are emerging as their own discipline, with several organizations and associations now working to understand the best methods of recruitment and retention and to study the benefits of citizen science. SciStarter (www.scistarter.com) is one of these groups, and it is the largest repository of citizen science projects and provides a centralized method to coordinate and understand these studies.

Some believe that citizen science is exploitive, but this also is frequently a misconception. Many participants, including those who participated in the creation of tide tables in the 1800s, already were recording observations on their own. Incorporating these individuals into a network or a citizen science project allows the data to be coordinated and information to be extrapolated to other locations. Each participant contributes a small amount of work or data, and all of the small pieces are combined into a larger beneficial whole. Dr. Cooper described a project in which sailors reported wind and current readings to a central location, and the charts created using these data assisted navigation, making ship travel much safer.

Dr. Cooper emphasized that when societies face big problems, being handed knowledge is not enough. When many people participate, every person’s experience is available to every participant, and this creates a more nuanced understanding of the issue. All people enjoy conducting experiments, all people think and are motivated, and all people enjoy doing things and sharing what they know. Dr. Cooper noted that humanity historically has progressed by reducing restrictions on the spread of knowledge, and the restriction of knowledge persists in the journal system of disseminating professional scientific knowledge. The systems that remain to be opened are not those of knowledge but those of knowledge production. Social capital is needed to find and use knowledge, and infrastructure must be built so that everyone’s observations can be made useful. Dr. Cooper pointed out that the project to collect navigation information from sailors still is running because the creators knew that other people would be making the journey after them. She added that as each person metaphorically “sails the earth” as residents of the planet, they too can follow paths of knowledge begun by those who came before them.

Discussion

Mr. Benforado emphasized that NACEPT’s report should convey the breadth and power of citizen science that Dr. Cooper described, particularly the idea that there are many more ways to use citizen science than most people realize. Dr. Cooper was asked what EPA can do that would be most helpful, and she replied that responsiveness to communities and a proactive strategy are high priorities. The most useful baseline information should be determined before beginning a project, and the design of infrastructure and choice of partners capable of handling large quantities of data are important to arrange in advance as technology continues to increase. Dr. Cooper also mentioned the opportunity to network communities that are isolated in their struggles.

Updates on Citizen Science Activities at EPA and in Other Organizations (Panel)

Moderator: Jay Benforado, Deputy Chief Innovation Officer, ORD, EPA

Mr. Benforado noted that President Barack Obama, his science advisor, and the EPA Administrator have expressed interest in citizen science. He discussed a forum on citizen science and crowd-sourcing—held at the White House on September 30, 2015, the day after the previous NACEPT face-to-face meeting—which included speeches by the director of the National Science Foundation (NSF) and the president of the American Association for the Advancement of Science. Legislation promoting citizen science has been introduced, and agencies are encouraged to align across different groups. The John Holdren memorandum of September 30, 2015, describes context for citizen science in the federal government, noting that every federal agency should have a citizen science coordinator; asking agencies to catalog

projects together and assemble databases; and encouraging agencies to do more to build capacity, issue procedures and provide guidance.

Mr. Benforado discussed technology platforms and research and evaluation of citizen science, and he described an appendix of 15 examples of real science gathered from citizen science projects in areas such as societal need and science, technology, engineering and mathematics (STEM) education. He mentioned the citizenscience.gov website, which was launched on September 30, 2015, and includes a toolkit with step-by-step instructions for starting a citizen science project, 18 case studies with more planned for this year, and a resource library. Mr. Benforado emphasized that people learn best through tangible examples such as those provided on this site.

A catalog of citizen science projects across federal agencies was suggested in the memorandum, but a barrier to this project is that data collection from the general public must undergo a lengthy approval process with the Office of Management and Budget (OMB). Mr. Benforado's office has developed a generic Information Collection Request that will streamline and expedite the process.

Mr. Benforado described the diversity of projects across EPA and explained that Dr. Parker had divided them into the workgroup categories. The challenge is to integrate EPA into ongoing citizen science research. Mr. Benforado discussed seed fund grants and potential areas to apply citizen science. A beekeeper project called "Show Me the Honey" could be a good candidate, as amateur beekeepers are already knowledgeable, networked and engaged on the topic of bee colony health. In this project, honey is sent to EPA and tested to collect information on pesticides and bee health.

Another project discussed, CyanoScope, helps citizen scientists submit images of cyanobacteria collected with a \$100 microscope, and the cyanobacteria are identified by scientists. Ms. Szaro explained that a workgroup of stakeholders was established in 2013, and by the next year the group was monitoring 100 lakes for cyanobacteria. A kit provided to citizen scientists helps guide them through the process of taking the photograph and sending it to EPA's ORD, where researchers determine whether the cyanobacteria are toxic. A new application has been developed called Bloomwatch, which is focused on short-term and quick-moving algal blooms. These blooms can be difficult to identify and treat because they occur so quickly. The eventual hope is for citizens using both of these programs to be able to identify photographs without the assistance of EPA laboratories. Mr. Benforado added that it would be productive to use these identifications of genus and species to develop early warning systems for drinking, bathing and pet health.

Ms. Szaro also described a project in conjunction with the Yawkey Foundation in which data are streamed live from a buoy in the Charles River to an exhibit in the Museum of Science in Boston. Visitors can see models of what would happen to water quality under various conditions. Ms. Szaro emphasized the need to connect advanced monitoring with citizen science. The E-Enterprise for the Environment initiative has resources dedicated to managing third-party certification for sensors and data standards. It was noted that vague recommendations are not enough—who is doing the science, who is the steward of the data, and how to fund the project must be known. The Healthy Communities Grant Program pools small amounts of money and creates results. Each national program within EPA, such as water, air or Superfund, has different knowledge and requires different buy-in to achieve its goals, and Ms. Szaro emphasized that this diversity should be in the recommendation.

Mr. John P. DeVillars (BlueWave Capital LLC) noted that ORD still has regional science liaisons. Ms. Szaro replied that their mission is to link their regions with ORD rather than specifically to assist regional citizen science projects. Mr. Ross asked where Ms. Szaro envisions the long-term home of citizen science residing at EPA. She responded that although she has some ideas, she would prefer to review the suggestions developed by NACEPT. She noted that citizen science development is a collaborative process, and ORD does not have all of the funding necessary, so the initiative requires top-down distribution of resources and eventually a home for the projects.

Growing Citizen Science Networks: Connecting Participants, Projects, Tools and Data

Darlene Cavalier, Professor of Practice, Center for Engagement and Training in Science and Society, Arizona State University

Ms. Darlene Cavalier (Arizona State University) described SciStarter, a website to connect volunteers with citizen science opportunities. Barriers include the difficulty of finding the right project within the database of 1,600 projects and events as well as the inability of users involved in multiple projects to keep track of them all on the site. Ms. Cavalier noted that participants involved in one project are 50 percent more likely to be involved in another. SciStarter received a grant from NSF to build a data infrastructure to help volunteers keep track of what they are doing, and SciStarter is exploring formalizing the citizen science experience, such as by offering college credit.

Another barrier is access to equipment. Ms. Cavalier suggested that the project database could be repurposed as a database for commonly used tools and equipment or as an open-source interface to allow users to add tools. The database should make tools discoverable so that volunteers can find the right tool for the project, and it could allow users to review and rate tools. She noted that tools may have different usabilities when considered for citizen science as compared to their mainstream uses, and it is not helpful to acquire a tool if it does not fulfill the expected purpose. SciStarter also is beta-testing lending libraries for tools at four locations this summer. Users can be trained at the lending library to use the instruments, increasing engagement in the project. Future possibilities might include a build/borrow/buy option for tools on each project page. Ms. Cavalier described a My Turn catalog inventory and noted that the key initiatives are the lending library, school district rate/review projects to reveal any differences in the citizen science experience from the educator point of view, application programming interfaces (commonly known as APIs) to share customized databases, and an ePortfolio to track volunteers' activities.

Discussion

Mr. Ross asked about the best way to connect what SciStarter is doing with the EPA mission. Ms. Cavalier noted that the federal inventory of projects automatically feeds into the SciStarter database. She also pointed out that Dr. Cooper's presentation mentioned the increase in public science programs in universities, and she suggested that these new graduates will be a good resource for building the necessary connections and applying what they know to issues EPA is studying. Mr. Benforado noted that this is consistent with recommendations in the report for translation tools and technologies to use them.

Open-Source Development of Tools for Community Citizen Science

Shannon Dosemagen, President and Executive Director, Public Laboratory for Open Technology and Science

Ms. Dosemagen described global community support for the development of open-source tools for citizen science. She recounted the Public Laboratory for Open Technology and Science's pioneering use of open hardware developed by the European Organization for Nuclear Research (commonly known as CERN). Ms. Dosemagen noted that her early career experiences with the Louisiana Bucket Brigade taught her that low-cost tools could capture data at a community level.

Ms. Dosemagen discussed the use of communities in Louisiana to report on the effects of the Deepwater Horizon oil spill. Local citizens collected a large quantity of information but wondered how best to use this information to help their communities. The Public Laboratory for Open Technology and Science worked to fight the corporate-controlled media blackout around the spill. Citizens launched cameras attached to kites to map the coastline and acquire high-resolution images of oil. The Public Laboratory for Open Technology and Science reviewed the landscape of environmental monitoring and worked to ensure that concerned scientists were directing all science inquiry. In the Public Laboratory for Open Technology and Science process, a range of people from different backgrounds work in many roles on a project. The existing, available information is gathered, and if the appropriate information is not available, the Public

Laboratory for Open Technology and Science determines how to obtain it. Ms. Dosemagen also noted that her organization advocates for communities to be able to control their own information.

Ms. Dosemagen described several projects, including one in western Wisconsin using particulate matter sensors to monitor dust from hydraulic fracturing sites, a project with sensors and cameras created to track turbidity in water, open coal pile monitoring in southeast Chicago, and water monitors in Massachusetts using near-infrared cameras to look for invasive pond species.

The biggest question, said Ms. Dosemagen, is how to engage citizen scientists as researchers, not subjects. She noted that it can be easy to forget that the scientific process is a collaborative one. Openness and accountability also are important concerns. She pointed out that obvious participation in projects, such as the spectacle of a person standing in a community holding a string with a camera attached to a kite, allows the community to approach the participants and ask questions, encouraging the social process of data collection. The Public Laboratory for Open Technology and Science is developing a research platform in which people can post information about their projects, encouraging collaborative and cooperative workflows, and the organization holds a large annual gathering to bring together community scientists. She emphasized the importance of keeping track of all of the pieces of information that create a whole.

Discussion

Dr. Osidele asked whether the Public Laboratory for Open Technology and Science has investigated merging its data with satellite imagery from the National Aeronautics and Space Administration (NASA). Ms. Dosemagen replied that the data used are primarily from the USGS, which provides the most available data. She explained that satellite imagery often is not useful because Louisiana has many clouds; therefore, drones are able to obtain better pictures from lower altitudes. Ms. Dosemagen added that her organization has a partnership with NASA and is interested in trying to open up the process. She suggested a thorough review of how NASA has adopted the citizen science process and open technology.

Citizen Science Post Election: More, Less or the Same?

David Rejeski, Director, Science and Technology Innovation Program, Woodrow Wilson Center

Mr. David Rejeski (Woodrow Wilson Center) explained that momentum now exists at many agencies to conduct citizen science projects; this is the biggest agenda-setting opportunity that the field has experienced in recent years. The federal government budget is seven times the budget of the largest corporation (Walmart), so a major funding shift will occur when the new EPA Administrator is appointed. Position papers currently are being generated across many agencies to take advantage of this opportunity.

Mr. Rejeski noted that the first stage of the transition already has started, and many people are thinking about what actions the next president likely will take. Transition teams are in place at agencies, including EPA, and 4,000 political appointees will be put in place. Mr. Rejeski described the ease of the transition between employees appointed by President George W. Bush to those appointed by President Barack Obama, noting that it is considered a good example of a successful transition. Because transitions typically take a long time to plan, the Presidential Transitions Improvements Act of 2015 was passed into law recently. The federal transition committee has a point of contact in the Agency as it moves forward.

Mr. Rejeski emphasized that any information on citizen science that the group wants to convey to the transition team needs to be in the briefing book, which must be created by November 1 to instruct all new appointees. After the inauguration, targets for the citizen science transition strategy are key political appointees, who then can be briefed. The top items at the Agency will be gathered from each group and consolidated into the transition strategy, so the focus should be on two or three “stretch” goals.

Mr. Rejeski suggested communicating with all the stakeholders, not just federal stakeholders, about what the federal government should or should not do; these goals will be delivered to the transition teams. The key will be to keep the recommendations brief and focus on the top items from the NACEPT report.

Mr. Rejeski added that EPA is well-situated for its efforts to support citizen science in that it has requested that NACEPT advise that Agency on the topic, which demonstrates that EPA has a vision for progress.

Discussion

Mr. Ross asked for Mr. Rejeski's opinion on the Data Quality and Data Management Workgroup's recommendation that EPA should not own the citizen science data, and Mr. Rejeski agreed with this recommendation. He noted that it is acceptable for EPA to receive the data, adding that it is sometimes easier to stop the government from going down an inappropriate path, such as data ownership, than to define acceptable goals.

Mr. Benforado asked for Mr. Rejeski's input on the stretch goals. Mr. Rejeski listed common stretch goals, such as requests for more energy, more money, more full-time equivalents (FTEs) or more coordination. He thought that it is important to consider whether the group's stretch goals actually require money—goals could be operational or organizational. He recommended a simple coordination structure to ensure that the work is connected, and he added that more support would be helpful.

Council Plenary Session on Structure of the Final Report

Mr. Joyce explained that because citizen science is emerging as a formal field, many issues must be addressed. NACEPT has been charged with developing two reports on the topic of citizen science; the second report will cover issues not addressed in the first report. The EPA Administrator is the audience for the reports and recommendations, but many additional audiences must be considered: policy makers, academics, researchers, state agencies and nongovernmental organizations (NGOs), among others. A master's thesis level of effort should be put into the report, with rationale and reasoning driving the recommendations. The accompanying executive summary will be aimed at high-level EPA management and senior-level policy makers and must include the key messages, recommendations and highlights of the report. All original source materials should be cited in the report, and a reference list included. General recommendations to increase funding are not helpful; recommendations should be grounded in the Agency's statutory context, regulatory authority, and current budget and resource levels. NACEPT's recommendations should be clear, direct and actionable. They should not be too broad or generic; extraordinarily detailed recommendations are not helpful either.

Ms. Dosemagen asked whether information about the current budget and resources would be made available to the NACEPT members. Mr. Joyce responded that the Agency currently is \$2 billion and 2,000 FTEs below its historic highs. Mr. Benforado agreed that recommendations for spending more resources would not be useful; the recommendations need to focus on how EPA can build citizen science into its existing programs. Mr. Trahan thought that the recommendations could concentrate on the advantages of citizen science and how utilizing citizen science could make the Agency more efficient in its current actions.

In response to a question from Dr. Liban regarding making a business case for citizen science at the Agency, Mr. Joyce explained that this would be an appropriate approach. Past NACEPT reports are available for the Council members to examine. Case studies can be included to highlight the rationale of the recommendations. Dr. Liban thought that it might be difficult to make a national business case considering the uniqueness of each of the 10 regions.

Mr. Ross stated that the Council should not limit its imagination and creativeness in developing the recommendations. It is important to connect with the power of collaborations and partnerships.

Mr. James Joerke (Johnson County [Kansas] Department of Health and Environment) cited his county as an example of the practical value of keeping specific line-items out of a budget. His county spends a great deal of money on sustainability and operates nine LEED-certified buildings, despite the fact that no line-

item in the budget is devoted specifically to sustainability. NACEPT's recommendations must be fiscally feasible, which is at odds with the Agency's request that the recommendations not focus on budget and resources. Mr. Joyce stressed that the role of his office is to provide information and clarity so that NACEPT can ensure that its recommendations are as fully informed as possible.

Mr. Kerr noted that citizen science, similar to sustainability, is a cross-cutting item. He cited the previous report on sustainability, noting that the difference is the engagement of the world outside of EPA, which provides a great deal of information, resources and knowledge to make a difference. NACEPT must realize that it is providing advice about an area that lies outside of EPA's standard programs; the recommendations should focus on how roles within the Agency can be redefined to effect change without the need for new or additional resources. Mr. Joyce agreed that citizen science needs to be diffused and incorporated across the Agency; a specific office devoted to citizen science may not encourage cross-Agency diffusion.

Ms. Horn cited the EPA organization chart and the number of different offices and programs, wondering how important it is to make recommendations tailored to each office. Mr. Joyce responded that programs and offices change and merge, so recommendations should not be too specific to a particular program or office. They should not, however, be so broad as to be ineffective for the Agency. If NACEPT has specific recommendations, it is helpful to include case studies to highlight areas of increased emphasis.

Mr. Clinton Woods (Association of Air Pollution Control Agencies) commented on the need for NACEPT's recommendations to consider the incoming Administrator, EPA's regulatory statutes, the links between Agency regulatory and research offices, and the need to break down "silos."

Ms. Dosemagen wondered whether the recommendations should be linked to specific statutes. Mr. Woods did not think that the recommendations needed to be linked to specific legislation.

Mr. Trahan stressed the need for the recommendations to make a case that supports the Agency's core work. Rather than suggesting that EPA take on more work, the recommendations should suggest how the Agency can incorporate citizen science to make its current work more efficient.

Mr. Howard Learner (Environmental Law and Policy Center) asked whether legal counsel had examined the charge in regard to EPA's statutes. Mr. Benforado responded that the Agency's statutory framework, and what actions that EPA can and cannot take, have been considered. EPA has developed a form that allows a generic citizen science authorization from OMB, and the Agency is required to provide the statutory authority under which each citizen science project is performed.

In terms of dismissing budget considerations from the recommendations, Mr. Trahan stated that, in his experience, "If you do not ask, you will not get it." NACEPT should include a scenario about what the Agency would do if it received the funding. If this is not included in the package, then EPA definitely will not receive it. Dr. Liban added that his sense had been that NACEPT could "push the limits." Following this discussion, he has reservations about that assumption. If NACEPT is challenging the status quo too strongly, change will not be effected. He thought that NACEPT must be bold, consider what its recommendations will mean to the new Administrator, and determine how EPA's statutory limits influence the Council's recommendations. Mr. Benforado explained that the recommendations also should include operational items.

Ms. Cavalier noted that there are few examples of policy changes that have resulted from citizen science. EPA's role should be to take citizen science data seriously and provide feedback. More tools, rather than more products, are needed. Training individuals to "see the big picture" of citizen science is important.

Mr. Joyce presented the timeline for developing, finalizing and publishing the report. The final drafts of the workgroup white papers are due by July 1 so that they can be compiled into one unified document. From July to September, the core drafting team, which includes contract support from The Scientific Consulting Group, Inc. (SCG), will revise the text, incorporating additional material from workgroups

and individual Council members as needed. The core team will identify any redundancies and omissions and ensure that the report is cohesive. The report must be finalized by the end of September, and per the Federal Advisory Committee Act, must be approved via a public teleconference, which is scheduled for October. The report will be formatted, finalized and printed in November. The report will be transmitted to the Agency via a formal process that includes a briefing with the Administrator. NACEPT will meet in person in March 2017 to determine the topics of the second report. Dr. Parker added that it is the Council's responsibility to ensure that all pertinent ideas, case studies and so forth are included in the draft.

Mr. Ross instructed the workgroups to identify their top two or three priorities during the concurrent workgroup breakout sessions.

Citizen Science Workgroups Meet in Separate, Concurrent Breakout Sessions

Strategic Opportunities and Research Workgroup

Operational opportunities to integrate citizen science into EPA's mission through grant mechanisms were discussed. Mr. DeVillars suggested that EPA grants awarded to states to implement the Safe Drinking Water Act (SDWA) and CWA include a requirement for states to establish a citizen science action plan. He noted that California has been a leader in integrating citizen science into state programs. In addition, a portion of EPA state grants for SDWA or CWA implementation has been designated for development of state citizen science action plans in EPA Region 1. Budgetary constraints were cited by Dr. Meissen as barriers that hinder states' use of citizen science data. Ms. Horn recognized that in making this recommendation, the workgroup will need to define what is meant by a citizen science action plan. Several members also suggested that EPA's extramural grants for applied research add incorporation of citizen science as a criterion for evaluating applications. This criterion might have the additional effect of directing more funding to universities with close ties to their communities. It was pointed out that not all citizen science would be categorized as applied research. As an example of applying nonresearch criteria in awarding funding, Dr. Chawla cited NSF's requirement that grant applications include a broad impact statement regarding the effects of the proposed research on society. Dr. Liban, agreeing with Mr. DeVillars' suggestion, noted that the FDA allows its grantees the flexibility to use innovative ways to generate information.

Citizen science might offer the Agency an opportunity to conserve resources in its research program. Ms. Horn commented that citizen science does not need EPA, but EPA does need citizen science. Ms. Andersen stated that volunteer monitoring can provide environmental data inexpensively and with a rapid turnaround. EPA could be proactive about soliciting the types of data needed from citizen scientists. Ms. Horn suggested that EPA identify and support key partners in citizen science. Ms. Cavalier noted a widespread lack of trust of EPA among citizen scientists, however, because they have been told that the quality of their data is not sufficient for the Agency's use. Ms. Andersen added that state agencies also have been resistant to using citizen science data, citing quality concerns. She suggested that grant applicants be required to survey existing data, including volunteer monitoring data. Ms. Cavalier noted, however, that researchers would need to learn to advocate for, provide training for and use results from citizen science. A more efficient approach might be to use training and equipment resources that already are in place, such as those being provided by regional offices, for citizen science projects.

Mr. DeVillars suggested that operational tools for regional- and state-level implementation of the priorities of past EPA administrators, such as environmental justice under Ms. Lisa Jackson, might be transferable to citizen science. He suggested establishing an Administrator's Award for Citizen Science, as well as awards at the regional level. A citizen science "czar" could be appointed by the next Administrator.

EPA regional offices and laboratories might take a key role in supporting citizen science using existing resources. Dr. Liban advocated for a decentralized approach to integrating citizen science into EPA's

research program: EPA program offices would provide a framework for regional offices to implement. Mr. DeVillars suggested that support of citizen science be added to the duties of the regional scientist in each EPA regional office. Ms. Horn commented that in the past, each regional office also had a volunteer monitoring coordinator. Ms. Cavalier proposed that regional scientists use such websites as SciStarter to identify citizen science projects by topic in their regions. Ms. Horn observed that if citizen scientists know that EPA's culture has changed and that the Agency will consult a particular website for information about citizen science projects, they will ensure that their projects are listed. Ms. Andersen added that regional scientists could contact local officials for information about volunteer science programs. Dr. Ramirez-Toro observed that the Federal Interagency Working Group on Environmental Justice serves as a model for involving communities based on regional priorities. The working group initiated a demonstration project for providing improved drinking water quality from small systems in rural areas, responding to a local need to bring their systems into compliance with the SDWA. She offered to provide a written description of the project to the workgroup. Dr. Liban provided two examples of local use of data generated by citizen science: the Los Angeles County Metropolitan Transportation Authority's campaign to reduce air pollution from buses and the restoration of the Los Angeles River. He suggested emphasizing the use of citizen science in pilot programs addressing such pressing issues as environmental justice.

Metrics will be needed to measure the Agency's progress toward integrating citizen science into its research programs. Mr. DeVillars proposed that preliminary measures of citizen science implementation at the Agency quantify activities (e.g., number of local groups supported, percent funding supporting citizen science) rather than performance. The development of metrics on the use of citizen science in research will be facilitated, Ms. Cavalier suggested, if researchers are encouraged to include "citizen science" as a publication keyword whenever they use citizen science data.

The growing interconnectedness of people in the United States and worldwide likely will affect the ways in which the environment will be protected in the future. Dr. Meissen offered as an example the participation of 1.5 million U.S. citizens in monitoring streams and rivers, which is the type of activity that leads to an informed population that can advocate effectively for environmental protection. He predicted that the growing amount of information available to citizens will create a paradigm shift away from EPA using laws and regulations to carry out its mission toward greater reliance on grassroots support. Businesses also potentially will be involved.

Suggestions were made of material to include in the Strategic Opportunities and Research Workgroup's writeup. Ms. Luther proposed that the workgroup consider integrating the appendix provided by Ms. Horn into the body of the report. Ms. Luther also suggested that the workgroup capture the points made in Mr. Rejeski's article. Ms. Horn stated that a common language is needed. Terms such as "regulatory" and "advocacy" need to be redefined in the context of citizen science.

The scope of the workgroup's recommendations was discussed. Ms. Horn suggested balancing operational and visionary recommendations. Ms. Luther proposed two bold findings: (1) citizen science can transform EPA's work and (2) citizen science can be the catalyst to make EPA a leader. Based on the presentations by Dr. Cooper and Ms. Cavalier, a recommendation that EPA take the lead in developing a data infrastructure for citizen science was suggested by Mr. DeVillars. Ms. Cavalier responded that a citizen science data infrastructure spanning all federal agencies likely would be difficult to implement.

Summarizing the workgroup's discussions, the following top-line recommendations were proposed by Mr. Ross:

- EPA needs to develop a strategy related to citizen science, including changing the Agency's culture, implementing operational changes (e.g., adding a citizen science component to grant programs to the states, establishing citizen science awards), developing a "home" for citizen science, allocating resources to support citizen science, and appointing a citizen science assistant to the EPA Administrator and providing this appointee with staff.

- EPA should form partnerships to support citizen science, including with other federal agencies, private entities, state agencies, and museums and academic institutions.
- EPA should recognize, validate and promote citizen science across all Agency activities.

Community-Driven Citizen Science Workgroup

Mr. Mears thought that the workgroup had met the instructions provided by EPA during the discussion about the final report structure; the group's recommendations do not ask for more resources but rather focus on how the Agency can better use its current resources to support citizen science. The workgroup, however, must clarify its recommendations following the discussions at this meeting. From his point of view in working with tribes, the rules of grants and inconsistencies in staff interpretations of the rules limit the work that can be performed. If EPA would like to truly support citizen science, Headquarters must incorporate it throughout its programs and simplify the ability for tribes and other groups to implement citizen science at the regional level. Ms. Dosemagen added that the workgroup's recommendations should focus on training and technology assistance.

Mr. Trahan thought that it is important to establish consistency among regions. He did not think that the Agency provides adequate guidance regarding the information that states need to submit, so each state submits what it thinks is reasonable and is frustrated when it is denied by EPA. Mr. Mears thought that the process needs to be streamlined. Different levels of effort exist depending on whether legally defensible data are being gathered versus observational data. Citizen science could be included in the scoring for EPA grants so that those grants that include a citizen science component are scored more favorably by the Agency. EPA has included environmental justice components in its grants in a similar manner. Ms. Dosemagen wondered whether the inclusion of an environmental justice component in EPA grants has resulted in a meaningful connection.

Mr. Joerke commented that cultural changes must occur in EPA. Therefore, the recommendations must help the Agency move toward these necessary changes in a way that gradually fosters the change. If the recommendations conflict too much with the current culture, change will not occur.

The workgroup discussed the strategy for the second report, noting that important details must be included in the first report. Those items that cannot be included in the first report should be recorded so that they can be included in the second report. A citizen science fair is planned during the same month (March 2017) that NACEPT is scheduled to meet next; the location for the citizen science fair is yet to be determined.

Ms. Dosemagen asked whether it was appropriate for this group to recommend that citizen science be included in EPA grants or whether this would be considered a cross-cutting issue. Dr. Parker thought that the group could highlight external community grants. Mr. Konecny noted that groups in his state of Oregon have never considered asking EPA for guidance, training or funding.

Mr. Trahan thought that EPA must interact with the community to identify issues of concern and then determine whether citizen science is the appropriate tool to address these issues. He noted the existence of matching requirements that compel communities to match EPA funds with funding or in-kind services. Dr. Parker responded that part of the focus is about responding to community concerns that are entirely community funded. Mr. Mears thought that focusing on citizen science data to be used for regulatory action would not be a productive recommendation. The focus should be on allowing the community to manage the environment locally; he cited the example of how the Grand Portage Band of Lake Superior Chippewa manages its moose population. In this example, citizen science data help the tribe to develop its management plans; this is not a regulatory action by EPA. In his view, this is EPA's role in supporting citizen science; rather than focusing on regulatory action, the Agency will provide tools to help communities manage their natural resources and engage their members in quality-of-life issues related to the environment.

Dr. Coronado commented that communities do not want additional research to be performed in their communities if they are not seeing local benefits of improved air and water quality. Mr. Trahan thought that the biggest challenge is public distrust of industry and the government agencies that regulate industry. Establishing a program that allows better communication between agencies and communities will increase public trust. Ms. Dosemagen noted that the impetus for citizen science is the desire for communities to generate data that can be trusted. To increase trust in citizen science data, Ms. Eunyoung Kim (Synapse International, LLC) suggested that EPA train and certify volunteers similar to how volunteer firefighters are trained and certified. Mr. Trahan did not think that the EPA had to provide the training, but the Agency should establish a culture in which specific training standards or requirements are known if citizens would like their data to be used by EPA. Dr. Parker added that extensive documentation also is important.

Mr. Joerke stated that citizen science is cost effective; this is a compelling fact. The Agency can enhance the effectiveness of how its resources are applied by taking advantage of citizen science. Ms. Dosemagen agreed that it is cost effective, but citizen science also is resource intensive.

Mr. Konecny stated that encouraging the collection of citizen environmental data promotes environmental and public health. In response to a comment by Mr. Trahan regarding EPA's lack of interest in receiving certain types of environmental data (e.g., tribal moose data), Mr. Konecny said that all environmental data speaks to environmental health. For example, tribal moose data at the very least can be used as environmental indicators. Citizen science should advance the Agency's overall mission of protecting environmental and human health.

Ms. Kim commented that it is necessary to solve environmental issues for this generation, or the next generation will be extinct.

Mr. Trahan noted that citizen science is mutually beneficial because EPA obtains relevant, repeatable data and because public trust increases when the data have been collected by the public. The intended use of the data will determine how much certification and training are needed. Dr. Parker explained that the Data Quality and Data Management Workgroup is examining this particular issue.

Data Quality and Data Management Workgroup

Dr. Osidele asked the group for suggestions of items that may have been left out of the working draft, such as legal and administrative approaches and constraints. He reiterated that EPA would not house citizen science data but would want to access it. Mr. Benforado commented that some recommendations were in the draft but were described technically and operationally; he advised framing these items in more strategic terms to better illustrate their benefits.

Mr. Woods suggested that the role of EPA is to deputize citizen science—to set up structures that will allow EPA to instruct users and receive information back. Mr. Learner countered that EPA cannot deputize citizen science because of its role in enforcement. He suggested that NGOs may protest being given responsibilities by EPA without also receiving resources such as funding.

Mr. Benforado proposed franchising as a more appropriate metaphor. He noted that the Agency has existing infrastructure, and financial support could be found in existing areas and supplemented with funds from other agencies, foundations or industry groups. Dr. Osidele asked whether the strategic planning stage is the appropriate time to integrate citizen science structures; Mr. Benforado responded that at EPA, strategic planning often is a description of current activities rather than a plan for future projects.

The group discussed the appropriate level of standardization. Mr. Rejeski commented that standards can be powerful tools, but Mr. Ethan McMahon (EPA) noted that technological applications do not need to be as standardized as some other methods because formats are compatible with different systems. Mr. Joyce

suggested partnering with other agencies or local governments to help organize citizen science projects. Dr. Osidele added that Ms. Dosemagen's presentation mentioned NASA, the USGS, the National Oceanic and Atmospheric Administration (NOAA), and regulatory agencies other than EPA. He suggested that these examples may be useful models of how to engage in collaborative work. Mr. Joyce theorized that successful collaborations are driven by mutual interest and the desire to collaborate. Mr. Rejeski added that strategies can help to focus projects.

Mr. Benforado suggested modeling some citizen science structures on projects run by the USGS. Ms. Sophia Liu (USGS) described the USGS Committee for Data Integration as a strong group of people setting the standard and operationalizing data. She noted that many citizen science projects are in progress. Ms. Liu described the USGS Director's Priority Issues; many of these are domain-specific, but there are three cross-cutting priorities—engagement, information technology and workforce—and consideration of these is encouraged when planning a project in one of the domain-specific issues. She commented on the potential to use citizen science in ways that are not traditionally considered, such as to increase public scientific literacy, which aligns with the “engagement” category of the USGS Priority Issues. Ms. Liu described a well-known paper estimating the economic value of volunteers but asked how to put a monetary value on engagement.

Mr. Benforado noted that an example of monetizing citizen science data could be seen in the Gold King Mine release. EPA looked for data on water quality collected before the spill so that it could be compared to conditions after the spill, and the Agency found the data it needed in records collected by citizen science groups.

Dr. Osidele asked whether USGS data are collected from funded projects or affiliates and whether they are vetted or subjected to a quality assurance process. Ms. Liu responded that these elements vary by project. The National Map Corps recruits peer reviewers from its most experienced volunteers, and other projects may use crowd-sourced data to validate or support the USGS scientific models.

Mr. McMahon asked whether EPA could create a description of the kind of data the Agency would accept to make it clear to citizen scientists what level of rigor must be met. Mr. Rejeski noted that this could help streamline multiple citizen science projects that study similar factors but collect data in different formats that cannot be exchanged or integrated. Mr. Benforado noted that this idea already exists in the draft paper in more technical language. The group discussed what requirements could be established for EPA to use citizen science data. Mr. Learner noted that *Daubert v. Merrell Dow Pharmaceuticals* set a standard for the quality of data and evidence required for legal uses. Mr. Learner described three levels of data rigor: citizen science data requires less rigor than data used for regulatory action, and regulatory data requires less rigor than data needed for litigation. Mr. Benforado pointed out that a recommendation for outlining the purpose of the data already is included in the draft.

Mr. Learner noted that citizen science data could be valuable in situations that do not require high levels of rigor, such as the identification of hot spots. These data would not be used for enforcement but could be used to inform EPA of the existence of a problem. Mr. Benforado commented that many levels and kinds of data can be valuable in environmental protection, and EPA could help standardize citizen science data and define platforms.

Ms. Boles suggested that citizen science data should be part of a feedback loop; data submitted to EPA could be used to inform policy, and the Agency could record how the data were used and transmit feedback to the citizen science groups. Mr. McMahon added that EPA would need to confirm receipt of the data.

The group discussed whether data should be sent to EPA directly. Mr. Benforado commented that EPA could not be the repository for the data but could create systems for helping citizen scientists understand the results of their efforts. Mr. Learner asked Mr. Benforado to explain why EPA should not house the data, and Mr. Benforado replied that the Agency is not nimble enough and would lack both appropriate

funding and technological capability. He also commented on the trust relationship; in the past, government agencies would be the most trusted organizations, but now the public has stronger trust in shared, open-source systems. Mr. Benforado suggested that multiple entities with interoperable standards could house the data, and Mr. McMahon added that one organization would need to take responsibility for the data from the beginning of the project.

Mr. Learner emphasized the importance of understanding who truly controls the data if funding is provided by outside entities such as universities or donations from corporations.

Plenary Discussion of Agenda and Objectives for Tuesday, June 14

William Ross, Jr., NACEPT Chair, Council Member, Gillings School of Global Public Health Advisory Council, University of North Carolina at Chapel Hill

Mr. Ross asked the workgroups to provide a brief overview of their top recommendations so that each workgroup has an idea of what the others are thinking about recommending. Mr. Mears reported that the Community-Driven Citizen Science Workgroup had engaged in a productive discussion, and it had been helpful to hear the presentations, which had provided context for the group. He noted that some of the group's recommendations may be more appropriate for the other workgroups to include. The workgroup plans to clarify its top three or four recommendations during the breakout session the following day.

Mr. Kerr reported that the Strategic Opportunities and Research Workgroup discussed paradigm shifts and ways that citizen science can transform EPA's work. The Agency must operationalize citizen science. The workgroup recommends that EPA create a broad citizen science strategy; develop partnerships; and determine how the Agency can validate, support and promote citizen science activities.

Dr. Osidele reported that the three words that had guided the Data Quality and Data Management Workgroup discussion were standardization, communication and ownership. EPA must do a better job at setting standards based on data purpose and use that are consistent with its mission. The Agency must communicate these standards to citizen science groups and provide feedback to groups that provide data. EPA should not own citizen science data. A new model in which citizen science data are a shared resource must be envisioned. Under this paradigm, EPA can use the data for multiple purposes, including supporting its mission. Citizen science must be included in EPA's strategic plan.

Mr. Ross thanked the Council members for a productive day and recessed the meeting at 5:36 p.m. EDT.

Tuesday, June 14, 2016

Overview and Update on CWA 404 Assumable Waters Subcommittee

Jacob Strickler, Acting DFO, Office of General Counsel (OGC), EPA, and David Evans, NACEPT Subcommittee Co-Chair, Office of Wetlands, Oceans and Watersheds (OWOW), OW, EPA

Mr. Green explained that Ms. Boles serves as the NACEPT liaison to the CWA 404 Assumable Waters Subcommittee, which met the week of June 6 for 3 days. The subcommittee's recommendations will be presented to the Council, and NACEPT will convene a teleconference to discuss and approve the recommendations.

Mr. Jacob Strickler (OGC, EPA) explained that his office has worked with OWOW on this effort. The subcommittee began its work in October 2015 and has met four times to understand the background and legal history of the topic and develop ideas and recommendations. Mr. David Evans (OWOW, OW, EPA) explained that the subcommittee has been exploring in which situations states and tribes can assume the lead on CWA 404 permitting actions. Legal controversy exists regarding which waters are subject to CWA jurisdiction, with past legal challenges having occurred regarding the scope of waters for which USACE had permitting authority. Congress had intended its reorganization of the CWA to cover the broader network of U.S. waters, including streams and tributaries, whereas USACE was following its

historical authority to protect navigation. Because of the conflict, states requested that they take the lead for CWA 404 permitting for major waters. Congress decided to shift authority to the states and tribes through phases. USACE would retain authority over Phase 1 waters, whereas states and tribes could apply for authority over Phase 2 and 3 waters. Approximately 2 years ago, EPA received a request to provide policy clarification regarding which waters are subject to CWA 404 permitting jurisdiction.

The subcommittee membership comprises 10 state, two tribal, five stakeholder and five federal representatives. The charge to the group is to provide advice and recommendations to the Agency about how to clarify for which waters states and tribes will assume CWA 404 permitting responsibilities and for which waters USACE will retain permitting authority. The subcommittee has established three workgroups to explore legal advice, waters used for commercial activities, and waters adjacent to navigable waters. Subtle differences exist in the terms and definitions regarding U.S. waters as related to permitting authority.

Discussion

Mr. Joerke asked about the capabilities of staff that will allow states to carry out these responsibilities. Mr. Evans responded that there is a tremendous range of capabilities and staff sizes across the states. State and tribal permits will need to be at least as protective as federal government standards for any waters for which they are given permitting authority. EPA will provide oversight to state and tribal permitting programs. Mr. Joerke was concerned about the implementation of a delegated program. Mr. Evans replied that EPA's oversight role will be of critical importance. Mr. Learner agreed that the Agency will need to evaluate its process following delegation of authority to ensure that the process is working well.

Dr. Liban asked about the geographic diversity of the subcommittee members. Mr. Evans responded that representatives are from Massachusetts, Arizona, Virginia, Alabama, Minnesota, New Jersey, Oregon and Maryland. A representative from Wyoming no longer is involved in the effort.

Dr. Liban asked about changing conditions, such as climate, being incorporated into the subcommittee's discussions. Mr. Evans explained that the primary focus is the legality of the issue. Dr. Liban noted that tributaries may dry up under changing conditions. Mr. Evans agreed that the existence of nonperennial streams has added to the controversy.

Dr. Osidele asked whether the Phase 1, 2 and 3 waters compose a subset of U.S. waters. Mr. Evans explained that the CWA applies to "waters of the United States." In 1972, Congress attempted to be inclusive in determining the scope of U.S. waters referred to in the CWA, including tributaries of navigable waters. This inclusiveness has been controversial since that time, and USACE has resisted permitting tributaries. Mr. Strickland added that Michigan assumed permitting responsibilities in 1984, and New Jersey assumed permitting authority in 1994, but no other states have been approved. Mr. Trahan commented that to receive National Pollutant Discharge Elimination System permitting authority, the state of Louisiana was required to prove that it had the appropriate staff to carry out the authority. EPA still retains oversight and periodically reviews the state's program.

Ms. Kim asked whether the Paris climate change discussions and the importance of water reuse have been considered by the subcommittee. Mr. Evans responded that the subcommittee had been given a specific, discrete charge, and these items are not included in the charge. Ms. Kathy Hurlburt (OWOW, OW, EPA) added that the subcommittee has been very disciplined in keeping to the policy question of which entities are responsible for CWA permitting.

Dr. Coronado asked whether any subcommittee members represent civil society. Mr. Evans said that the subcommittee co-chair from the University of Michigan is able to view this issue in the broad context of environmental policy and federalism. Ms. Boles provides a local government perspective. When developing the subcommittee, the goal was to include broad state and tribal representation while limiting other stakeholders so that the process of addressing the charge did not become too unwieldy.

In response to a question from Mr. Joyce, Mr. Evans described *United States Army Corps of Engineers v. Hawkes Co., Inc., et al.*, which was a petition to resolve whether determination of navigable waters is a “final agency action” under the Administrative Procedure Act. The Supreme Court delivered an 8-0 decision on May 31, 2016, that a jurisdictional determination by USACE can be challenged (i.e., it is not a final agency action).

Mr. Joyce explained that NACEPT has a broad charter and often forms subcommittees as needed to address the various issues on which it is asked to provide advice. These subcommittees cannot transmit their recommendations directly to the Administrator. He asked Mr. Evans when NACEPT would be receiving the subcommittee’s recommendations. Mr. Evans responded that the subcommittee’s last meeting will be held in November or December of 2016, so NACEPT can expect the recommendations in early 2017.

Citizen Science Workgroups Meet in Separate, Concurrent Breakout Sessions

Strategic Opportunities and Research Workgroup

Mr. Kerr proposed that the session’s goal be to update the workgroup’s message, recommendations and findings. At Mr. DeVillars’ request, he reiterated the workgroup’s top-line recommendations from Day 1:

1. EPA should create a strategy—including a unifying vision—that encompasses citizen science projects.
2. EPA should focus on partnerships.
3. EPA should recognize, validate and promote citizen science across all Agency activities.

The workgroup discussed revising their recommendations. The following changes to the recommendations were considered.

- **Recommendation 1.** Recommendation 1 will be based on the workgroup’s original Recommendation 1. This recommendation includes visionary and operational strategies. Implementing state citizen science action plans should be a requirement for receiving funding from EPA for implementing the CWA (including Section 106 water pollution control grants) and the SDWA. Mr. DeVillars suggested that state citizen science action plans, discussed on Day 1, include provisions for fostering partnerships and education.
- **Recommendation 2.** Suggested partners included the private sector in general; other federal agencies; state agencies; businesses; primary and secondary schools; colleges and universities; interagency working groups; tribal, territorial and local governments; community groups; environmental and sportsmen’s organizations; professional organizations (e.g., American Water Resources Association, American Society of Civil Engineers); and retired scientists. Ms. Luther proposed that EPA establish a website recognizing citizen science groups. Ms. Horn suggested identifying key partners that EPA should support financially and politically rather than including an exhaustive list. The workgroup agreed to include a comprehensive list of potential partners and to identify key partners.
- **Recommendation 3.** Mr. DeVillars questioned Finding 3, which stated that many citizen science efforts struggle from lack of information about how to design and operate effective projects. He cited outreach on citizen science by Mass Audubon and a Massachusetts sportsmen’s organization. Mr. Benforado proposed that the original Recommendation 3, which generated little discussion by the workgroup, be incorporated into Recommendation 1. Ms. Horn suggested including the previous day’s discussion of connectivity in the recommendations. Ms. Luther commented that millions of Americans now have computers and other electronic devices in their

hands, leading to improvements in data collection methods. Dr. Meissen agreed that interconnectedness is the reason that embracing citizen science is critically important at this time. The workgroup decided to replace the old Recommendation 3 with a new recommendation incorporating the potential benefits of connectivity.

- **Recommendation 4.** Mr. Kerr indicated that in addition to the previous day's recommendations, the workgroup's original Recommendation 4, "Use citizen science to revitalize environmental education (both K–12 education and lifelong education)," needed to be captured. Dr. Chawla observed that STEM education is critical and should be prioritized. Vitalizing STEM education is a priority of other federal agencies as well as EPA. Dr. Meissen observed that STEM education fosters U.S. competitiveness and, as such, is a priority for business. Dr. Liban agreed, citing involvement of volunteers from the Los Angeles Chamber of Commerce in local education. Dr. Liban suggested that EPA employ designated volunteer coordinators and create a regional volunteer network. Based on his own experience as a volunteer for the USGS, volunteers could serve as ambassadors for the Agency. The importance of involving students at the primary school level rather than waiting until high school was emphasized. Dr. Meissen noted that extending STEM literacy to "grades" K through 12—including support, mentorship and job shadowing—is receiving considerable attention. Dr. Meissen suggested volunteer programs in the business sector as a resource to promote STEM education. Dr. Chawla drafted a diagram illustrating education and the environment as two components of citizen science at EPA. He used double arrows to indicate the two-way benefits of citizen science. Dr. Ramirez-Toro characterized STEM education as part of the infrastructure that EPA needs to create. STEM education might fit under Recommendation 1.

The workgroup discussed the introduction. Mr. Ross proposed structuring the introduction around Dr. Cooper's correction of common misconceptions about citizen science that she had included in her presentation. He added that Dr. Cooper had agreed to help write the introduction to the report.

Dr. Medearis advocated for a place-based approach in the report. He suggested including location-specific stories that focus around EPA's core priorities (e.g., water quality, air quality). Mr. Benforado noted that environmental protection is moving toward addressing problems at the local level. Important lessons from these stories might include the answers to the following questions: What was the role of partnerships? What made the project work? What was the role of EPA? How did the project save EPA resources? What were the project's funding source(s)? How does the project relate to EPA's mandate? Place-based stories proposed by workgroup members included the following:

- How citizen science is helping to alleviate the water quality problem in Flint, Michigan, particularly the role that community colleges have taken.
- How citizen science is addressing the mine waste contamination of the Animas River in Colorado.
- Case studies in which citizen science prevented problems and helped the Agency to be proactive. Dr. Ramirez-Toro provided the example of the Caribbean Science Consortium, which was established by EPA Region 2 and included universities and Puerto Rican and U.S. Virgin Island agencies in a memorandum of understanding to collaborate and share resources.
- Friends of the Shenandoah River.

Mr. DeVillars suggested making two points. The first is that embracing citizen science is a public relations asset and important political tool, representing EPA's best available approach to connect with the public. The second is that if citizen science is not made a priority for the next administration, EPA will not realize its full potential. The first point addresses the potential for unfavorable public perceptions of EPA, including public disapproval of the Agency's actions in Flint. The second point addresses the

need for top-down support for citizen science from the next EPA Administrator. The Administrator is a political appointee, and a political case for citizen science might resonate with him or her.

Developing a business case for the Agency becoming involved in citizen science was discussed. The business case could include both potential savings from embracing and potential losses from failing to embrace citizen science in terms of resources, environmental protection and public health. The number of hours that citizen science volunteers spend could be converted to FTEs at EPA. It was suggested that the calculation of FTEs saved could be used to justify direct support for such projects as monitoring by the Friends of the Shenandoah River or analyzing silicone wristbands. Ms. Horn pointed out a data gap that could be addressed by volunteer monitoring: only 30 percent of U.S. waters have been assessed for water quality. She noted that before regulatory legal action is initiated, extensive monitoring typically is conducted. Ms. Horn observed that other federal agencies might have developed materials that could serve as models for an EPA business case.

Dr. Liban suggested as a thesis that EPA needs to remain cost effective and sustainably relevant through engagement to address such disruptors as emerging technologies and changing environmental conditions. EPA will do so by acknowledging the significant role of citizen science in community-building efforts.

Mr. Kerr indicated that he would distribute a copy of the flip chart that Mr. Benforado had used to record notes from the workgroup's session, including writing assignments. The following writing assignments were made:

- Introduction: Dr. Cooper (with input from members of the Strategic Opportunities and Research Workgroup).
- Box on partnerships: Mr. Ross and Ms. Horn.
- World we live in now: Ms. Luther and Dr. Meissen.
- Place-based, local decision making: Dr. Medearis.
- Seventy percent nonassessed water bodies: Dr. Medearis.
- Gains/losses to EPA from embracing/not embracing citizen science: Ms. Horn.
- FTEs of citizen scientist volunteer hours: Ms. Cavalier, Ms. Dosemagen and Ms. Andersen.
- Case studies/stories: Animus River (Ms. Horn), Friends of the Shenandoah River (Dr. Medearis), Flint (Dr. Liban), and positive examples of citizen science (Dr. Ramirez-Toro).
- Business case: Ms. Horn, Dr. Liban and Mr. Kerr.
- Tidal mapping by citizen scientists: Mr. DeVillars and Dr. Cooper (for the introduction).
- Operational strategies: Mr. DeVillars and Ms. Luther (social marketing).
- Chart of the environmental and educational aspects of citizen science: Dr. Chawla (with input from workgroup members).
- Public engagement and STEM literacy: Drs. Chawla and Liban (including material from Ms. Horn's appendix).
- Redrafted recommendations and findings: Mr. Kerr.
- Glossary: Ms. Horn (using Dr. Cooper's book as a possible source).
- Outline: Mr. Kerr (will revise and distribute to the workgroup members for their review).

A timeline was developed for writing. Writing assignment materials will be completed and distributed to the workgroup members for review by close of business on June 20. The workgroup will schedule a teleconference to revise the writing assignment materials on June 22, 23 or 24. Revised, semifinal writing assignment materials will be finished by June 27 to 29. The finished draft will be completed by July 1.

Community-Driven Citizen Science Workgroup

Ms. Dosemagen noted that the workgroup's recommendations are grounded in many interviews conducted by several workgroup members. Mr. Mears added that the transcripts, interview questions and findings are available on the workgroup's SharePoint site.

The workgroup members provided general comments about the report before discussing the specific recommendations. Mr. Konecny thought that the report's focus should emphasize how citizen science can help EPA fulfill its mission, which is to protect human health and the environment. He also suggested that each workgroup member develop a case study, and the group can choose the best ones to include in the report. EPA should support the gathering of both types of citizen science data (i.e., baseline data and data collected in areas experiencing water, air or other environmental quality issues). The Agency must commit to following up on data. He cautioned that the workgroup's recommendations should not create barriers to citizen science.

Dr. Coronado suggested that EPA engage in listening sessions (at least one in each region) that serve as a problem-solving mechanism and allow environmental justice communities to have a voice. Dr. Parker commented that citizen science is an opportunity for communities to provide input on community research priorities. Dr. Coronado noted that the research must be a joint effort between the community and scientists. It also is important for EPA to set a positive example for the international community. She thought that Agency staff must travel to environmental justice communities to understand community conditions.

Mr. Trahan commented that the case studies show the overall benefit of citizen science, but the next Administrator may need information on how the case studies highlight direct benefits to EPA. Administrators have different viewpoints; some may focus on environmental or societal benefits, and some may focus on what directly benefits the Agency. Therefore, both types of viewpoints must be taken into consideration when writing the report, as the next Administrator's outlook is unknown at this point. He thought that the report should emphasize that the earlier EPA engages communities and helps them plan their research, the more useful the results will be to the Agency. Mr. Trahan stated that some citizen science projects will require little to no training, whereas others will require intensive training. Dr. Parker thought that it would be helpful for EPA to be able to provide any necessary training.

Ms. Kim stated that the environmental paradigm should shift to a preventive focus similar to how the medical paradigm has shifted in this manner. Citizen science data help to establish baseline environmental health.

Mr. Joerke thought that the report should begin with a compelling statement that presents the value proposition of citizen science to EPA; citizen science has multiple benefits in the areas of data collection, community engagement and public relations that the Agency can harness.

Mr. Mears thought that if it becomes necessary for the workgroup to select only two recommendations, Recommendations 3 and 4 are the strongest. Mr. Joerke agreed.

Mr. Konecny suggested that the workgroup's recommendations address the concern that citizen science is not being used for decision making. Mr. Joerke responded that a natural consequence of the collaborative process will encourage the use of citizen science results for decision making.

Mr. Mears commented that citizen science is about nonregulatory indicators, baseline data and citizen involvement. The report could suggest that EPA provide a strategy, tools, funding and resources to empower communities to engage in citizen science, but the Agency should not provide direct management because EPA does not know the local conditions as well as the local community does. He also stated that citizen scientists should not be considered "citizen inspectors" or "citizen regulators."

Dr. Parker noted that the Agency is concerned about crisis situations and regulatory issues; the workgroup's report should attempt to alleviate these concerns.

The workgroup discussed its following four recommendations and subrecommendations specifically:

- **Recommendation 1:** *Expand the availability of EPA resources to support community citizen science.* Ms. Dosemagen thought that this is an example of a bold future issue that must be addressed. Accessibility and technology are important considerations that should be introduced in this report but expanded on in the second report. Mr. Joerke thought that Recommendations 1 and 3 are similar. Ms. Dosemagen suggested that Recommendation 1 be refocused around capacity building/resource allocation; Recommendation 3 focuses on distribution of technical resources. Mr. Mears commented that increasing knowledge and using existing resources are important. The group agreed that Subrecommendation 1.3 will be moved to Recommendation 3.
- **Recommendation 2:** *Remove barriers to the use of community citizen science data in decision making.* Ms. Dosemagen commented that Subrecommendation 2.2 regarding data quality does not reflect the discussion surrounding the main recommendation. Mr. Trahan thought that Subrecommendation 2.1 should focus on Agency/community collaboration. Ms. Dosemagen commented that EPA must be a leader in determining how to use community data, but the Agency also requires a feedback loop. Mr. Trahan stated that a regulatory bias against community data exists, while at the same time, EPA and other agencies are working with communities to collect appropriate data. Mr. Mears proposed that EPA provide tools to collect, analyze and manage data, but communities should manage and use their own data how they see fit. Because of time limitations, the workgroup agreed to table the discussion regarding data acceptance and the usefulness of data, which were recognized as two separate issues. These issues will be discussed via email or on a future conference call.
- **Recommendation 3:** *Build capacity in communities to use citizen science on issues they care about.* Ms. Dosemagen thought that this recommendation needs an increased focus on technology. The recommendation can be rewritten so that it incorporates two different viewpoints: the desire for listening sessions and collaboration, and the desire for tools and resources without additional EPA involvement in projects. Mr. Mears thought that this recommendation is the most important recommendation of the four. Dr. Gallagher suggested that the recommendations should be reordered, with this as the first one. The workgroup will discuss this on a future conference call. The workgroup agreed that more language regarding baseline data, indicators, being proactive versus reactive, the different tiers of citizen science data, and use of citizen science data for regulatory purposes should be added to this recommendation.
- **Recommendation 4:** *EPA can leverage existing networks to support the work of EPA and integrated community citizen science efforts.* Mr. Mears noted that the tribes interviewed did not like this recommendation; they prefer to receive funding and resources directly from EPA rather than having to share them with other groups. Because the 567 federally recognized tribes all are different, however, local organizations can be helpful. This information will need to be synthesized before the report is finalized. Ms. Dosemagen thought that this recommendation should focus on citizen science as a technique applied across EPA. Subrecommendation 4.2 regarding data reporting may be more appropriate for the Data Quality and Data Management Workgroup to include. Dr. Gallagher thought that it could be included within Subrecommendation 2.2. Ms. Dosemagen reported that Mr. Ross had mentioned that a discussion of EPA support of community-to-community partnerships is missing from the workgroup's report. Mr. Mears emphasized that tribes are sovereign nations and should not be forced to work with other tribes; states would not be forced to partner with each other to receive funding. Ms. Dosemagen added that the group needed to discuss data sharing and privacy. Based on the interviews, it does not appear that tribes are interested in sharing their data with EPA. Mr. Mears explained that tribes are sovereign nations that own their data. Some tribes, however, have established methods to share environmental data.

The workgroup decided that each member will write up one or two case studies, and the workgroup will select the best ones to be included in the report. The following case studies were suggested and will be developed for consideration:

- Student/scientist moth identification in Great Smoky Mountains National Park (Dr. Gallagher).
- Community-driven project to collect baseline creeper data (Mr. Konecny).
- Tonawanda Coke Corporation example (Ms. Dosemagen).
- A citizen science case study from the Louisiana DEQ Single Point of Contact hotline (Mr. Trahan).
- Examples of a priest noticing a cancer cluster in a community and a school nurse understanding student health complaints based on weather (Dr. Coronado).
- Air quality citizen science projects conducted by neighborhoods near Kansas City, Kansas (Mr. Joerke).
- Southeast Alaska Tribal Toxins partnership with communities to monitor harmful algal blooms that affect subsistence clam resources (Mr. Mears).

The workgroup discussed action items and their associated deadlines. Ms. Dosemagen will send the case study template to the workgroup members. The workgroup members will develop their case studies and share them with the group no later than June 17. Ms. Dosemagen will review her notes from the NACEPT meeting and incorporate comments into the workgroup's report in Google Docs no later than June 17. The workgroup members will provide their comments on the revised report no later than June 22.

Ms. Dosemagen will collate all of the comments and provide workgroup members with their writing assignments no later than June 24. Workgroup members will complete their writing assignments and send them to Ms. Dosemagen no later than June 29. The final report is due to EPA on July 1.

Data Quality and Data Management Workgroup

Dr. Osidele proposed beginning with a discussion of funding and potential areas to expand in the draft report. He suggested development of a data plan to ensure useful data. Mr. McMahon noted that this only has been done when EPA responds to requests from citizens to define data requirements; he offered to find examples.

Mr. McMahon suggested choosing a word other than "standards" to describe the desired data; he thought "standards" has several possible definitions, some of which may be perceived more negatively than the term "requirements." Mr. Learner countered that message testing has shown that "standards" are perceived as fair and "regulations" are more controversial or more political. Mr. Learner did not have data at hand related to the perception of the word "requirements."

Mr. Rejeski noted that a mechanism exists within EPA to allow communities to contact the Agency when problems related to clean water develop, and he suggested that this mechanism could be explored for use in data management. Dr. Osidele suggested that EPA could describe the kind of data expected without prescribing specific technology to be used.

Mr. Learner referred to the three levels of data rigor outlined in the previous workgroup session and asked what is necessary to transition data between levels. Ms. Liu noted that existing citizen science projects often work closely with government agencies, and frequently, training is offered in schools to help conduct these projects. Ms. Boles added that individuals who perform the training include EPA representatives and university and retired scientists. In projects with a connection to EPA, the Agency provides formal training once or twice a year.

Ms. Liu commented that the key in designing a citizen science project is to define the problem that the project is trying to solve because there are many different ways to engage citizens.

Mr. Learner suggested that the rigor needed for data to be usable by scientists cannot be collected at a citizen science level.

Dr. Osidele noted that the draft paper includes a data categories section. He asked about the requirements for the data to be transferred from local-level projects to a larger impact area.

Mr. Rejeski had created a chart entitled “Regulatory Limits on Use of Citizen Science,” which was distributed to the group. In increasing order of limits required, the chart lists public outreach, condition indicators (hot spots), resource management, regulatory decisions, regulatory standard setting and enforcement.

Dr. Osidele asked about language and documentation requirements for the data to meet each level and the required level of scrutiny to ensure data rigor. Mr. Learner noted that if EPA relies on outside parties for both providing data and housing data, these data would not be an appropriate basis for regulatory or enforcement decisions. Mr. McMahon countered that projects that fit the categories on the handout requiring fewer limits could be performed without the intent to affect regulatory decisions. Ms. Liu added that data can inform decision making of any kind at any level. Mr. Learner suggested that EPA could decide to promote an agenda or to distribute money based on less rigorous data, but any regulatory decisions likely would require more rigorous justification. Ms. Liu commented that citizen science data often are used in conjunction with data gathered by more formal projects. Ms. Boles added that data from a citizen science group can trigger action from the city, which then can trigger action from the state followed by action from EPA.

Dr. Osidele emphasized that EPA must be ready to defend any challenge to requirements set by the Agency, noting that a judge could reject data developed without a scientific process. Mr. McMahon responded that not all data are designed for use in litigation, suggesting that he could use a local, casual measurement of air quality data to decide whether to go for a walk now or later. Mr. Learner noted that Mr. McMahon’s idea used even less rigor than the least rigorous category on Mr. Rejeski’s chart. He described air quality alerts compiled from community organizations, with volunteers testing ozone levels and sending alert messages when the air is unsafe for high-risk populations. He noted that citizen science provokes the most engagement at the community level, where data rigor is less important, but eventually EPA or an environmental lawyer will be asked to act on or litigate any persistent situation indicated by such data, and those entities will require legally defensible data.

Mr. McMahon noted that projects conducted with low rigor already are prevalent, but they are seldom noticed by EPA. Though citizen scientists must have high-quality data if they want them to be used by EPA, communities already are trying to effect change at local levels. Mr. McMahon suggested that personal exposure monitors could measure air quality; if many people receive readings that indicate a hotspot, EPA could be contacted to conduct a more formal evaluation of the situation.

Ms. Boles noted that data often are discarded as a result of a chain-of-custody breakdown, which could occur in the process of collection or transportation and could be as simple as an individual forgetting to sign a form. Closing these gaps could increase the rigor of citizen science data. One option could be delivering samples to a research institution to provide a more rigorous, formal chain of custody. Mr. Joyce noted that Ms. Dosemagen’s data collected via Public Lab were accepted by governmental organizations; Dr. Osidele replied that Ms. Dosemagen had sought certification at the state level, and obtaining certification is an aspect of transitioning data collection abilities to categories requiring more rigor.

Mr. Rejeski noted that EPA is starting to validate the low-cost test equipment and sensors used by citizens. Ms. Liu emphasized that citizen science data can be used in ways less traditional than sample collection, such as using passive data gathered via social media or crowd-sourcing data analysis. She noted that many types of data could help communities reach the point of requesting EPA assistance, and these types of citizen science could further engagement. Mr. Rejeski added that a system similar to “Did

"You Feel It?" could be developed for public health concerns. Ms. Liu cautioned that "Did You Feel It?" uses metrics that are very easy for the public to identify, such as noting whether frames on the wall have shifted, but a public health system may require more technical expertise to collect the data.

Mr. Learner wondered about the rigor of public health data from community sources. Ms. Liu commented that there are elements of this kind of data collection in precision medicine initiatives as well as data collected by other groups, such as insurance companies and electronic health records groups. Mr. Learner pointed out that Epic Health Services is one of only a few big health data compilers, but these groups are not making the data available for research, public or open-source use.

Mr. Woods pointed out there is an opportunity at every level of data rigor to identify potential roles for EPA, such as gatekeeper, cheerleader or other contextual roles. Mr. Rejeski noted that a federal equivalent monitor could assist in defining the appropriate level of rigor for each of these roles.

Ms. Boles wondered about the best way to ensure that the public believes or trusts data. Dr. Osidele suggested developing a procedure that could transition data from less rigorous collection to greater level of rigor. Mr. Rejeski pointed out that projects connected to the CWA are looking for less regulated data, adding that there are many strategies that would be interstitial if plotted on the levels of rigor defined on his chart.

Dr. Osidele emphasized the importance of communication. EPA should ask for the data it wants, and when those data are submitted, EPA should provide feedback to the collectors. He asked what mechanisms are needed and which parts of the Agency should be responsible for providing continuous feedback.

Mr. Rejeski asked whether EPA ever releases calls for data, and Mr. Learner asked whether there was an interface between EPA and NSF. Dr. Parker responded in the negative to both questions but commented that this is a promising path for EPA to pursue. Mr. Learner pointed out that NSF frequently releases requests for information (RFIs) and "Dear Colleague" letters, and the workgroup discussed the potential of EPA representatives meeting with NSF representatives to learn how this strategy might be incorporated into EPA's data goals. Dr. Osidele recounted an example from the aftermath of the Fukushima incident in which an RFI was sent out to review U.S. nuclear power plants, and information was returned to the Nuclear Regulatory Commission (NRC) for review.

Mr. Rejeski wondered whether regional offices would be the best places to manage such emerging issues. Mr. McMahon commented that EPA needs to create a role somewhere between a cheerleader and a gatekeeper. He wondered how EPA can prepare for an influx of data and the associated analyses. Mr. McMahon added that his office is developing strategies to make data interoperable and methods to find signals within a large quantity of low-quality data.

Dr. Osidele suggested that the recommendation emphasize a stronger RFI mechanism. He commented that if information is requested, some information will return, whether useful or not; he compared the RFI process to conducting a Google search. Mr. Rejeski added that EPA could have a powerful signal function, and it often is surprising what comes back from "Dear Colleague" letters. Dr. Parker compared the RFI process to EPA's current public comment system and suggested that more formal requests could be built on that system. The group discussed whether any other agencies use RFIs frequently, citing NOAA and several universities developing open-source strategies for NOAA data.

The group discussed whether data are owned by those who collect or generate the data. Mr. Learner wondered whether ownership of citizen science data was contrary to the concept of open-source data. He commented that there are not many organizations both equipped to handle the expected quantity of data and trusted by the public. Dr. Parker suggested that the data repository could be determined on a project-to-project basis. Mr. McMahon suggested that EPA could provide best practices to make data public and readable; Mr. Woods added that the best practices should incorporate Scientific Integrity Policy language.

The group discussed possible locations to house data. Citsci.org was considered too small; opensource.io and data.org were suggested, and it was noted that some of these contract their data storage and management to Amazon. Mr. Learner asked why EPA cannot house the data; Dr. Parker explained some of the bureaucratic limits that restrict EPA's abilities to handle data. Mr. McMahon added that EPA is moving toward cloud-based storage, which involves many layers of security and complex access requirements. He noted that it is very expensive to protect large quantities of high-level data with high security, and he emphasized the potential liability issues if EPA houses data of unknown quality. He added that this also may not be entirely in line with EPA's function as a government organization.

Group members identified individual tasks to contribute to the development of the draft. Dr. Osidele planned to investigate the RFI process and practices from other agencies to recommend how EPA can make the first pitch for this project. He also planned to discuss standardization and ownership in more detail with Mr. McMahon. Mr. Rejeski planned to update and expand the chart of data limits, defining more levels of rigor and refining the distinctions between the areas of environmental concern on the vertical axis. He also planned to discuss these levels with members of the Strategic Opportunities and Research Workgroup. Ms. Boles planned to research data requirements information and relevant examples discussed on a recent conference call, and Mr. Learner planned to discuss with Mr. Ross the best way to pull the draft together. Mr. Woods planned to identify organizations and practices that govern the use of data, identify case studies for regulatory purposes, and further refine the "standardization" goal discussed in Mr. Osidele's report out. He also offered his assistance in any undefined area requiring further development.

Workgroups Report Out and Full Council Discussion

Community-Driven Citizen Science Workgroup

Mr. Mears reported that the Community-Driven Citizen Science Workgroup had engaged in a productive discussion and developed some good ideas for case studies. The workgroup had established a tight timeline for finishing the draft of its portion of the NACEPT report. Ms. Dosemagen presented the workgroup's work plan. The workgroup had retained its four top-level findings and recommendations, but in the course of the breakout session, the workgroup members had discussed how to clarify and expand on those recommendations so that they apply both to EPA and citizen scientists. The workgroup will expand its summary to include long-term citizen science efforts and describe the direct benefits of citizen science to EPA. Further consideration is needed regarding EPA's role in establishing partnerships. Also important is ensuring that the tribal perspective is represented, including in case studies. The workgroup plans to consolidate its discussion of new technologies into a single section, which it will consider sending to the Data Quality and Data Management Workgroup. Case studies will range from problem identification (e.g., a recognition of an increase in funerals led to the identification of a cancer cluster) to classic examples of environmental citizen science leading to regulatory action (e.g., the citizen air monitoring in Tonawanda, New York, that led to legal action against Tonawanda Coke Corporation). The workgroup recognized that the effects of citizen science are not always related to regulatory action and policy change but can include bringing people together, empowering them to ask questions, and giving them a greater voice in their communities.

Mr. Mears described the workgroup's timeline for completing its section of the report. Mr. Mears and Ms. Dosemagen will incorporate any new material into the workgroup's section. In response to discussion about possible overlaps with the Data Quality and Data Management Workgroup's section of the report, Dr. Parker suggested that these be addressed after all workgroup sections have been compiled.

Data Quality and Data Management Workgroup

Dr. Osidele stated that the discussions of the Data Quality and Data Management Workgroup had centered on three terms: standardization, communication and ownership. The workgroup discussed standardization extensively, focusing on ways to determine how data from citizen science projects will

have value to the Agency. The workgroup agreed to use the term “data standards” rather than “data mandates” or “data requirements.” Various levels of stringency will be associated with different types of projects. It is important to recognize the value that different types of data will have to EPA.

A new item developed during the breakout session is a chart that identifies which program areas (e.g., air, water, land) address particular types of environmental problems. To address a range of problems (i.e., from identification of issues to regulatory enforcement), different qualities of data will be needed (i.e., from casual observations to legally defensible data). The Agency will need a strategic approach—one that likely will involve testing equipment, training and certification—to transition along the data continuum. The workgroup recommended a data plan as a mechanism to capture data standardization requirements.

Regarding communication, the workgroup discussed whether mechanisms exist for EPA to ask for information or express a data need to the citizen science community. The Agency should take the lead in communicating data needs. Responders can self-select based on their abilities to meet the data standards. The issue arose regarding how EPA will handle the large influx of data of variable quality that will be generated by its data requests. The Agency will need to develop methods to detect patterns and trends so that it can obtain information from citizen science data, despite variations in data quality. The experience of other agencies, such as NSF, NRC and NOAA, may be helpful in this regard.

With regard to ownership, the workgroup discussed why EPA should not own citizen science data and who should own these data if not EPA.

The workgroup plans to maintain the original structure of its portion of the NACEPT report while integrating the three terms: standardization, communication and ownership. Although the workgroup had not finalized a timeline for writing, writing assignments were made during the breakout session. Dr. Osidele acknowledged the insights that had been provided to the workgroup by Mr. McMahon, who will continue to provide technical assistance to the workgroup. Ms. Boles, Mr. Rejeski and Mr. Woods will lead the standardization section; Dr. Osidele and Mr. Learner will lead the communication section; and Mr. Learner and Mr. Matthew Howard (City of Milwaukee; not present) will lead the ownership section. Informal communication among the writers is planned. A key question for the workgroup to address is “If not EPA, then who will own the data?” Drs. Osidele and Parker will compile the workgroup’s section.

Strategic Opportunities and Research Workgroup

Mr. Kerr reported that the Strategic Opportunities and Research Workgroup had discussed the message to convey to EPA in the NACEPT report, findings and strategies, and case studies. Workgroup members were assigned to write different parts of the workgroup’s section. The message the workgroup will convey is that the world is changing dramatically, and citizen science is an opportunity for EPA to revolutionize how it interacts with the world. The workgroup will create a business case, including that citizen science creates “free” FTEs for EPA, to provide support for the Agency integrating citizen science into its research programs through top-down internal change. The workgroup recognized that EPA has performed extensive work in citizen science in the past, but efforts have been fragmented. The Agency needs a unified strategy to guide how it engages with citizen science groups. The workgroup’s recommendation regarding an Agency-wide strategy will bridge visionary and operational approaches. One operational approach would be for EPA to integrate citizen science into its grants programs with the states.

Another workgroup recommendation is for EPA to form partnerships. The workgroup will enumerate the kinds of potential partnerships that the Agency might form and will recount stories about some partnerships. Partnerships have the potential to be transformative relationships, creating change in the Agency through bottom-up mechanisms. Citizen science will be linked to education, offering a way for EPA to engage the American public and play a role in K–14 (kindergarten to 2-year degree) education,

including STEM education. Connecting with partners should be part of the Agency's overall citizen science strategy. The workgroup recognized that citizen science has the potential to create internal and external changes at EPA from the current regulatory framework.

The deadline for workgroup members to finish their writing assignments is June 20.

Ms. Horn added that she had volunteered to compile a glossary of the terms used in the NACEPT report. Mr. Kerr noted that Dr. Chawla developed a graphical figure for the report. Ms. Luther pointed out potential overlap between the Strategic Opportunities and Research Workgroup's description of the changing world and Ms. Dosemagen's piece. Ms. Dosemagen has agreed to provide her section to the Strategic Opportunities and Research Workgroup for reference. Dr. Parker noted that overlaps will be addressed in the compiled draft.

Public Comments

Eugene Green, NACEPT DFO, ODACMO, OARM, EPA

Mr. Green called for public comments; there were none.

Discussion of Action Items and Next Steps

William Ross, Jr., NACEPT Chair, Council Member, Gillings School of Global Public Health Advisory Council, University of North Carolina at Chapel Hill, and NACEPT Members

Mr. Benforado asked the NACEPT members and participants which messages received from the meeting would be most important to include in the Council's report. Ms. Luther thought that it is important that EPA "gets in the game." Dr. Liban said that the Agency must stay relevant. Mr. Konecny stated that EPA must not impede the progress of citizen science. Ms. Kim thought that interrelationships are important. Mr. Kerr commented that it is necessary to engage the public in science. Mr. Rejeski noted the importance of supporting innovation. Mr. Mears commented that it is important to create citizen scientists rather than citizen inspectors. Ms. Dosemagen stated that science belongs to the public. Mr. Joerke stated that EPA must not miss an opportunity to benefit from the value of citizen science. Dr. Gallagher thought it important to "capture the magic" of citizen science. Mr. Trahan cited the need for EPA to cooperate with the public from the very beginning of a citizen science effort. Mr. DeVillars said that citizen science can have significant political impact. Ms. Boles thought that citizens should be allowed to help inform policy. Dr. Chawla commented that STEM education should be enhanced so that the United States is globally competitive. Mr. Woods noted that "if you build it, they will come." Dr. Coronado cited the need to validate and respect community data. Mr. Ross commented on the importance of tapping into the power of partnerships. Mr. Learner thought that citizen science is a great, but complicated, opportunity for the Agency. Dr. Ramirez-Toro commented that education should be integrated into EPA jobs. Dr. Osidele cited the need to adopt existing best practices. Dr. Meissen wanted to accelerate the positive transformation. Ms. Horn commented that citizen science provides priceless public relations. Mr. McMahon stated that citizen science already is happening. Mr. Joyce described the necessity of empowering the public. Mr. Green thought that it is important to broaden the vision for future generations. Dr. Parker added to Dr. Gallagher's statement, noting the need to communicate the magic of citizen science in addition to capturing it.

Mr. Ross and Mr. Learner thanked the NACEPT members for a productive meeting and EPA staff for their efforts in planning the face-to-face meeting. Mr. Ross and Mr. Joyce adjourned the meeting at 12:42 p.m. EDT.

Action Items

Data Quality and Data Management Workgroup

- Mr. McMahon will provide links to examples of EPA responses to requests from citizens to define data requirements.
- The draft will include a recommendation for EPA to prepare to receive large quantities of data.
- Group members identified individual tasks to contribute to the development of the draft as follows:
 - Dr. Osidele will investigate the RFI process and practices from other agencies to recommend how EPA can make the first pitch for this project. He also will discuss standardization and ownership in more detail with Mr. McMahon.
 - Mr. Rejeski will elaborate on his chart, defining more levels of rigor and refining the distinctions between the areas of environmental concern on the vertical axis. He also will discuss these levels with members of the Strategic Opportunities and Research Workgroup.
 - Ms. Boles will identify data requirements information and relevant examples discussed on a recent conference call.
 - Mr. Learner will discuss with Mr. Ross the best way to pull the draft together.
 - Mr. Woods will identify places and practices that govern the use of data, identify case studies for regulatory purposes, and further refine the “standardization” goal. He also offered his assistance in any undefined area requiring further development.

Community-Driven Citizen Science Workgroup

- Ms. Dosemagen will send the case study template to the workgroup members.
- The workgroup members will develop their case studies and share them with the group no later than June 17.
- Ms. Dosemagen will review her notes from the NACEPT meeting and incorporate comments into the workgroup’s report in Google Docs no later than June 17.
- The workgroup members will provide their comments on the revised report no later than June 22.
- Ms. Dosemagen will collate all of the comments and provide workgroup members with their writing assignments no later than June 24.
- Workgroup members will complete their writing assignments and send them to Ms. Dosemagen no later than June 29.

Strategic Opportunities and Research Workgroup

- Mr. Kerr will distribute a revised outline to the workgroup for their review.
- The workgroup members will complete their writing assignments by June 20.
- The workgroup members will meet by teleconference on June 22, 23 or 24.

- The workgroup members will complete the revisions to their writing assignments between June 27 and 29.
- The workgroup members will complete a draft of their portion of the report by July 1.

**National Advisory Council for Environmental Policy and Technology (NACEPT)
Meeting Participants**

NACEPT Members

Ms. Laureen M. Boles

State Director
New Jersey Environmental Justice Alliance
Trenton, NJ

Ms. Darlene Cavalier

Professor of Practice
Center for Engagement and Training in Science
and Society
School for the Future of Innovation in Society
Arizona State University
Tempe, AZ

Dr. Ramesh C. Chawla

Professor/Chair of Chemical Engineering
Department of Chemical Engineering
College of Engineering, Architecture
and Computer Sciences
Howard University
Washington, D.C.

Dr. Irasema Coronado

Professor
Department of Political Science
University of Texas at El Paso
El Paso, TX

Mr. John P. DeVillars

Managing Partner
BlueWave Capital, LLC
Boston, MA

Ms. Shannon Dosemagen

President/Executive Director
Public Laboratory for Open Technology and
Sciences
New Orleans, LA

Dr. Patricia M. Gallagher

Associate Professor
Provost's Fellow in Sustainability
Department of Civil, Architectural and
Environmental Engineering
Drexel University
Philadelphia, PA

Ms. Barbara Jean Horn

Water Quality Resource Specialist
Water Unit
Department of Natural Resources
Colorado Parks and Wildlife
Durango, CO

Mr. James Joerke

Deputy Director
Johnson County Department of
Health and Environment
Olathe, KS

Mr. Robert Kerr

Co-Founder and Principal
Pure Strategies, Inc.
Reston, VA

Ms. Eunyong Kim

Chief Executive Officer
Synapse International, LLC
Washington, D.C.

Mr. Karl Konecny

Partner
Northwest Motion Products
Glide, OR

Mr. Howard Learner (*NACEPT Vice Chair*)

Executive Director
Environmental Law and Policy Center
Chicago, IL

Dr. Emmanuel Crisanto Battad Liban

Executive Officer
Environmental Compliance/Sustainability
Los Angeles County Metropolitan
Transportation Authority
Los Angeles, CA

Ms. Bridgett Luther

Senior Vice President of Sustainability
Code Blue Innovations
San Francisco, CA

Mr. Jeffrey M. Mears

Environmental Area Manager
Environmental Health and Safety Division
Oneida Nation
Oneida, WI

Dr. Dale G. Medearis
Senior Environmental Planner
Environmental and Planning Services
Northern Virginia Regional Commission
Fairfax, VA

Dr. Ronald Meissen
Senior Director of Sustainability
Baxter International, Inc.
Deerfield, IL

Dr. Olufemi Osidele
Senior Research Engineer
Geosciences and Engineering Division
Southwest Research Institute
San Antonio, TX

Dr. Graciela I. Ramirez-Toro
Institutional Director
Center for Environmental Education,
Conservation and Research
InterAmerican University of Puerto Rico
San German, PR

Mr. David Rejeski
Director
Science/Technology Innovation Program
Woodrow Wilson Center
Washington, D.C.

Mr. William G. Ross (NACEPT Chair)
Council Member
Gillings School of Global Public Health
Advisory Council
University of North Carolina at Chapel Hill
Chapel Hill, NC

Mr. Donald Trahan
Attorney
Senior Environmental Specialist
Office of the Secretary
Louisiana Department of Environmental Quality
Baton Rouge, LA

Mr. Clinton J. Woods
Executive Director
Association of Air Pollution Control Agencies
Lexington, KY

NACEPT Designated Federal Officer

Mr. Eugene Green
U.S. Environmental Protection Agency
Office of Diversity, Advisory Committee
Management and Outreach
William Jefferson Clinton Building (1601M)
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 564-2432
Email: green.eugene@epa.gov

EPA Participants

Mr. Jay Benforado
U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 564-3262
Email: benforado.jay@epa.gov

Ms. Geraldine Brown
U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 564-4235
Email: brown.geraldine@epa.gov

Ms. Marian Cooper
U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 564-0620
Email: cooper.marian@epa.gov

Dr. Joel Creswell
AAAS Science and Technology Policy Fellow
U.S. Environmental Protection Agency
4225 8th Street, NW
Washington, D.C. 20011
Phone: (202) 564-0333
Email: creswell.joel@epa.gov

Mr. David Evans
U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 566-0535
Email: evans.david@epa.gov

Ms. Arielle Gerstein

U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 566-1868
Email: gerstein.arielle@epa.gov

Ms. Kathy Hurd

U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 566-1269
Email: hurld.kathy@epa.gov

Dr. James Johnson

U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (703) 347-8200
Email: johnson.jim@epa.gov

Ms. Shirley Jones

U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

Mr. Mark Joyce

U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 564-2130
Email: joyce.mark@epa.gov

Mr. Jacques Kapuscinski

U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 564-6683
Email: kapuscinski.jacques@epa.gov

Ms. Stephanie McCoy

U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 564-7297
Email: mccoy.stephanie@epa.gov

Mr. Michael McDavit

U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 566-2465
Email: mcdavit.michaelw@epa.gov

Mr. Ethan McMahon

U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 566-0359
Email: mcmahon.ethan@epa.gov

Ms. Bridget O'Brien

U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 566-1950
Email: obrien.bridget@epa.gov

Dr. Alison Parker

ORISE Research Fellow
U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Email: parker.alison@epa.gov

Dr. Chris Rea

ORISE Research Fellow
U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Email: rea.chris@epa.gov

Mr. Jacob Strickler

U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 564-4692
Email: strickler.jacob@epa.gov

Ms. Deb Szaro

U.S. Environmental Protection Agency
Region 1 Headquarters
Five Post Office Square
Boston, MA 02109
Phone: (617) 918-1011
Email: szaro.deb@epa.gov

Ms. Emily Trentacoste

U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: (202) 566-0703
Email: trentacoste.emily@epa.gov

Other Participants**Mr. Vibce Alvarese**

Fuel Tech, Inc.
Warrenville, IL

Ms. Karen Andersen

Friends of the Shenandoah River
Winchester, VA

Dr. Caren Cooper

North Carolina Museum of Natural Sciences
Raleigh, NC

Dr. Sophia Liu

U.S. Geological Survey
Reston, VA

Mr. Melvin Keener

Coalition for Responsible Waste Incineration
Ashburn, VA

Ms. Amena Saiyid

Bloomberg BNA
Arlington, VA

Ms. Elizabeth Tyson

Woodrow Wilson International Center for
Scholars
Washington, D.C.

Contractor Support**Ms. Kristen LeBaron**

The Scientific Consulting Group, Inc.
656 Quince Orchard Road, Suite 210
Gaithersburg, MD 20878
Phone: (301) 670-4990
Email: klebaron@scgcorp.com

Dr. Jennifer Lee

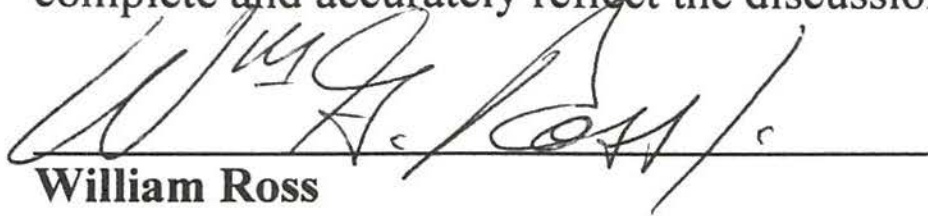
The Scientific Consulting Group, Inc.
656 Quince Orchard Road, Suite 210
Gaithersburg, MD 20878
Phone: (301) 670-4990
Email: jlee@scgcorp.com

Ms. Sally Paustian

The Scientific Consulting Group, Inc.
656 Quince Orchard Road, Suite 210
Gaithersburg, MD 20878
Phone: (301) 670-4990
Email: spaustian@scgcorp.com

Chair Certification

I, William Ross, Chair for the National Advisory Council for Environmental Policy and Technology (NACEPT) certify the meeting minutes for June 13-14, 2016 (face-to-face) are complete and accurately reflect the discussions and decisions of said meeting.

A handwritten signature in black ink, appearing to read 'William Ross', is written over a horizontal line.

William Ross
NACEPT Chair

A handwritten date '9-9-16' is written over a horizontal line.

Date

