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

September 28 – 29, 2015

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

MEETING SUMMARY

Monday, September 28, 2015

Welcome, Introductions and Overview of the Agenda
Eugene Green, Designated Federal Officer (DFO) for the National Advisory Council for Environmental Policy and Technology (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, Visiting Professor, Nicholas School of the Environment, Duke University; and Denise Benjamin-Sirmons, Director, ODACMO, OARM, EPA

Mr. Eugene Green (NACEPT DFO) welcomed the NACEPT members and participants and asked them to introduce themselves. Following the introductions, Mr. Green provided a brief overview of the meeting agenda.

Mr. William Ross, Jr. (Nicholas School of the Environment, Duke University) welcomed the new and returning Council members and thanked the former NACEPT Chair. The diversity of the Council will help NACEPT to address the latest charge. The Council's recent advice on sustainability has been incorporated into the Agency's latest strategic plan; the importance of citizen science also is mentioned in the strategic plan. After the Council learns about citizen science activities during the day's presentations, it will discuss how to organize its activities during the next year to deliver advice about citizen science to help EPA meet its mission of protecting human health and the environment.

Ms. Denise Benjamin-Sirmons (ODACMO, OARM, EPA) welcomed the members, and thanked Mr. Ross for serving as Chair as well as the guest presenters for sharing their expertise about citizen science, which is a pertinent topic for NACEPT to explore. She expressed her appreciation to her team members for their collaborative effort in finding the right charge for the Council to provide meaningful, needed advice to the Agency. The charge of citizen science aligns well with EPA's priorities and has been vetted by EPA leadership. The partnerships that have been developed in exploring this charge, particularly with Mr. Jay Benforado (Office of Research and Development [ORD], EPA) and his team, have been one of the best examples of the "One EPA" concept at work. She looks forward to the valuable recommendations that NACEPT will provide to the Agency within the next year.

Opening Remarks
Tom Burke, Deputy Assistant Administrator for Research and EPA Science Advisor, ORD, EPA; and Karl Brooks, Acting Assistant Administrator, OARM, EPA

Dr. Tom Burke (ORD, EPA) stated that citizen science is changing environmental science and community decision making. He shared a personal experience about refinery releases of mercaptans in south Philadelphia, which resulted in a community-based effort with EPA Region 3 to understand industrial emissions, with the goal of being able to respond to residents' health concerns and address questions

about exposure to industrial emissions. Community members wondered why EPA did not provide them with the basic information they requested about the exposure. The basic questions about community health and environmental quality were beyond the grasp of the community or Region 3 to address financially, which caused a lack of trust. Ultimately, EPA and the community worked together and shared information, but many questions remained because citizen science technologies were not available.

EPA is excited about the opportunity provided by evolving technology and the growth of citizen science. New technologies that can provide data rapidly or in real time (to understand exposure) and community involvement (to share information) are essential, especially following environmental crises. NACEPT's recommendations will be invaluable for the Agency to determine the most appropriate, strategic approach to citizen science, which Dr. Burke described as a "game changer."

Environmental monitoring provides measures of water and air quality, but emerging technologies can be used to obtain community-level data. Citizen science connects communities and agencies, provides data transparency, increases trust, and empowers communities to be involved in their own decision making. Do-it-yourself laboratory kits are important to allow people to understand their personal environment in real time, and this information also can amplify EPA's data for decision making, provided that the data are verified and accurate. Community data, however, also can introduce scientific challenges (e.g., "bad" data, technology errors) that must be addressed before data can be used and shared.

There are many positive examples of citizen science (e.g., Boston GoViral study, San Juan estuary program), and citizen science can change the perception that there is a divide between university scientists and the community. The scientific community has an obligation to work with decision makers. NACEPT exists on the difficult interface of science and policy and has the power to change U.S. environmental policy. Many EPA program offices are represented at this meeting because there is absolute buy-in about the importance of citizen science across the Agency, which is striving to innovate and support innovators. ORD's role is to provide the correct research infrastructure to perform the necessary data validation, ensure modern technologies are user friendly, and make certain that data are of high quality and accessible. NACEPT's recommendations will be critical to the future of communities.

Dr. Karl Brooks (OARM, EPA) thanked NACEPT for playing a key role in advising the Agency. For nearly 25 years, the Council has been tasked with advising EPA about the Agency's most difficult problems. The topic of citizen science will engage the best talents of NACEPT and has tremendous implications for EPA and the communities it serves. Citizen science is a rich, complex issue, with many different perspectives and considerable scientific, social and legal implications. The Council's recommendations will be of substantial value to the Agency in its partnerships with communities and state, local and tribal governments.

Discussion

Ms. Bridgett Luther (Cradle to Cradle Products Innovation Institute) commented that citizen science is important, noting that a great deal of information can be helpful but not without its challenges. Citizen science tools have power, although substantial investment in developing the correct tools may be needed. Dr. Brooks agreed that gathering information does not make it useable or actionable, and one of the Council's challenges will be to help the Agency to determine which information is useful. Other federal science-based agencies have initiated citizen science efforts, so with NACEPT's guidance, EPA should be able to find the resources to pursue citizen science.

In response to a comment by Mr. Ross, Dr. Burke said that EPA has a responsibility to provide information infrastructure to support communities. New partnerships around citizen science will be built based on the environmental science and public health enterprises because, ultimately, the environment affects the public health of the community.

Ms. Laureen Boles (Philadelphia Water Department) is concerned whether federal agencies and community organizations will be prepared to address the increasing number of problems found through citizen science, as mere problem identification is only part of a solution. Although Dr. Burke agreed with this concern, he believes that the lack of information is a worse scenario. A significant part of this issue is doing what is right for communities and developing the right tools and applications. There has been tremendous progress in this direction, and he is optimistic about the future of these technologies, noting that it will be important for communities to set priorities and make strategic investments.

In response to a question from Mr. Kurt Erichsen (Toledo Metropolitan Area Council of Governments), Dr. Burke explained that water and food quality protection would benefit from a quick microbial test that allows better decision making. Local community practitioners and members also could have access to this information. Testing of private wells also is an important, related issue.

Dr. Olufemi Osidele (Southwest Research Institute) asked Dr. Burke how he has been able to work with his teams so that they realize they are solving a problem for a community. Dr. Burke responded that the success of citizen science depends on understanding the roles of the various community components. Developed tools must be simple for those with no formal training, and there must be good communication. Citizen science will bring communities together because of the mutual benefits, and there will be dependence on local universities and others who can provide assistance. EPA will need to support community-based science in universities so that there is a commitment to provide quality information. Defining roles is critical because everyone will play a role. Part of NACEPT's charge is to ensure that the Agency considers these roles and recognizes that community-based science needs support, which will include university infrastructure in addition to government assistance.

Dr. Giovanna Di Chiro (Nuestras Raices, Inc.) commented that terminology and language for scientific approaches that cross the border between institutionalized science and community-based science have been discussed for quite some time. The term "citizen" can be a multipronged term that may exclude immigrants, whereas "community-based science" is more inclusive. A previous NACEPT charge examined technologies to support vulnerable communities; that conversation could inform this charge, although it was more reactive than preventive. Citizen science efforts could focus on a preventive approach. She also wondered about the connections with data collection on climate change. Dr. Brooks thought that this was a good synopsis of the challenge, and the Council could focus on a number of issues related to citizen science: equity, community, the definition of citizen, bad data and resulting decisions, and so forth. Dr. Burke added that environmental and public health are inextricably linked systems. Health Impact Assessments help to establish a preventive approach by examining environmental impacts and public health to allow better decisions to be made. He challenged the NACEPT members to think about the environmental health system and how citizen science connects the components within the system so that solutions are holistic, more proactive and less reactive while supporting the best decision making. Ms. Benjamin-Sirmons agreed that NACEPT could build on its prior work. She asked members to suggest any past work that could inform the current charge, and she will ensure that it is made available to the members. Vulnerable communities/environmental justice is a critical issue; the Council will have a chance to collaborate with another committee on this issue.

Overview and Discussion of NACEPT Charge on Citizen Science to Advance Environmental Protection at EPA

Jay Benforado, Deputy Chief Innovation Officer, ORD, EPA; and William Ross, Jr., NACEPT Chair, Visiting Professor, Nicholas School of the Environment, Duke University

Mr. Benforado explained that the Council could narrow the charge to provide the best recommendations. He provided several examples of citizen science efforts in Louisville, Kentucky (asthma); California (drought); and Wisconsin (ground water pollution). The framework for citizen science at EPA includes community-level input regarding problems, regional and national environmental monitoring, volunteer research relevant to the Agency's mission, and public education. A key point of the charge explores the breadth of citizen science, which is a form of open collaboration in which members of the public

participate in the scientific process and help to solve complex problems. People have begun to monitor their own health, and now they can monitor their environment as well.

The goals of the NACEPT review 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 highest value efforts; and (4) provide ideas on the Agency's citizen science framework, strategy and partnerships. One key issue is how to interpret new data in terms of what the data mean relative to how EPA, states and local entities currently run their programs. Mr. Benforado provided a list of outcomes and impacts to stimulate NACEPT's thinking on the topic. These included an educated and engaged public to help solve environmental problems, greater use of local data to support communities, filling current gaps in environmental data, contributions to environmental research, and improved environmental governance. NACEPT's charge questions are as follows:

1. How can we sustain and improve current EPA projects and programs?
   - Areas of EPA emphasis:
     - Empower communities
     - Monitor the environment and human health
     - Conduct environmental research
     - Educate the public about environmental issues

2. How can EPA invest in citizen science approaches for the greatest gain?
   - Build capacity through strategic investments.
   - Issues to address:
     - Data quality
     - Data management
     - Instrument evaluation

3. How can EPA help to increase the impact of knowledge and data generated via citizen science?
   - Support using citizen science knowledge and data at the local, state and federal levels.
   - Provide guidance for using citizen science knowledge and data at EPA.
   - Work with the public to interpret citizen science data.

To clarify the charge, Mr. Benforado provided a summary question: How can EPA best leverage citizen science to protect human health and the environment? The ultimate goal is for NACEPT's advice and recommendations to help EPA develop a more cohesive citizen science strategy. Opportunities lie within Agency programs, regions and research laboratories; states; tribes; nongovernmental organizations; and other partner organizations. NACEPT must develop its advice and recommendations and provide them to the EPA Administrator by September 2016. Webinars, workgroups and subteams can be utilized to move forward before the second face-to-face meeting in May 2016. The NACEPT members should leave this meeting with thoughts on how to organize this effort, which will inform the new administration and provide a foundation for long-term citizen science efforts at EPA.

Discussion

Mr. Jeffrey Mears (Oneida Tribe of Indians of Wisconsin) noted that NACEPT's charge should include mention of tribes because there are four forms of government in the United States (local, state, tribal and federal). EPA's relationship with U.S. citizens is different than the government-to-government relationship that it has with tribes. Mr. Benforado agreed, particularly in relation to how to define the term "citizen."

Citizen Science at EPA
Moderator: Jay Benforado, Deputy Chief Innovation Officer, ORD, EPA

Mr. Benforado introduced the speakers for the session, who provided overviews of various aspects of citizen science at EPA.

Community Empowerment
Deb Szaro, Deputy Regional Administrator, Region 1, EPA

Ms. Deb Szaro (Region 1, EPA) considered citizen science to be engaging and empowering the public to make informed decisions and scientific discoveries. Citizen science is not new, but the tools and challenges (e.g., data management and interpretation, health-based risk assessment) are new. Although their goals may vary, stakeholders at all levels can perform citizen science. Because EPA is a regulatory agency, it needs data of known and documented quality; as a result, citizen science does not always fit the Agency's paradigm.

Ms. Szaro showed a video describing a citizen science air monitoring effort in Tonawanda, New York, which highlights what citizen science means to her. Based on this successful citizen science effort that empowered the community, Ms. Szaro developed a citizen science program for Region 2. After learning that stakeholders were concerned about funding, how to establish a citizen science program, and how to ensure that EPA and state regulators accepted and acted on their data, Region 2 developed training videos, webinars, a website and data quality tools and established an equipment loan program for pathogen monitoring. Using the equipment loan program, the community collected high-quality data that the state was willing to use. Ms. Szaro also described citizen science efforts in the Ironbound community in Newark, New Jersey; the Charles River in Massachusetts; and more than 100 water bodies throughout Region 1.

EPA must address the challenges of citizen science, including clarifying the role of and institutionalizing citizen science in the Agency's operations; identifying the best ways to engage the public in citizen science activities related to EPA's mission; engaging state regulatory partners and addressing their concerns with data interpretation, risk communication and community requests for action; ensuring that data quality is appropriate for decision making; providing citizen scientists with appropriate tools; developing tools to manage, interpret, host, visualize and leverage voluminous data sets; communicating risk appropriately; and determining actions for emerging contaminants. Citizen science can help solve environmental problems by filling data gaps, encouraging citizen advocacy, and improving the dialogue between the government and the public.

Discussion

In response to a comment from Dr. Osidele, Ms. Szaro explained that quantitative, definitive data are needed to make defensible decisions.

Mr. John DeVillars (BlueWave Capital, LLC) commented that the media was critical in cleaning up the Charles River. Part of empowerment is publicizing community efforts, so the Council's discussions should address how to include the media in partnerships.

Mr. Ross asked for a description of the museum partnership and the impact of live streaming data from the Charles River buoy. Ms. Szaro responded that the live streaming data has come online only recently, and the museum did not have the interactive display in place yet. The display will show the impact of stormwater on municipal separate storm sewer systems as well as the downstream impact of household activities.

Air Monitoring and Research

Dan Costa, National Program Director, Air, Climate and Energy (ACE) Research Program, ORD, EPA

Dr. Dan Costa (ORD, EPA) explained that air pollution has a compelling history with a very strong citizen component. Public outcry during the 1970s and 1980s drove creation of EPA's Regional Haze and Acid Rain Programs. Citizen science is becoming increasingly quantitative as a result of new technologies, and EPA understands the importance of next-generation air monitoring (e.g., sensors) and how quickly new technologies are advancing regional, community and personal monitoring. The Agency promotes community science, outreach and education through a multipronged approach that includes stimulating technology developments through grants (e.g., Science To Achieve Results [STAR]), funding (e.g., Small Business Innovation Research [commonly known as SBIR]), and Open Source Challenges.

How can EPA make the best use of citizen science as a tool in protecting public health and the environment? The approach cannot be about the Agency, or EPA may lose community trust. Keys to success include embracing community needs and issues, developing outreach and mentorships to build trust, supporting a collaborative mentality, and recognizing that data lead to understanding. EPA must work with communities and not co-opt any community data.

The Village Green project provides real-time air measurements and is used to educate students. A July 2015 community air monitoring training workshop had tremendous feedback and included 30 in-person community and tribal action group attendees and more than 800 webinar participants. Popular EPA-developed community tools include the Air Sensor Toolbox for Citizen Scientists (www2.epa.gov/air-research/air-sensor-toolbox-citizen-scientists) and a training video series available on YouTube. The ACE Research Program also is involved in a number of citizen science collaborations through Regional Applied Research Effort (commonly known as RARE) projects in Regions 1, 2, 4, 5, 7 and 8 as well as Regional Sustainability and Environmental Sciences Research Program projects in Regions 4, 6, 7 and 10. The ACE Research Program also is investing in the future through the education of children, teaching them to make hand-held air sensors and developing air quality lesson plans with game cards.

Moving forward, the Agency would like to build a strong relationship with the public to build trust and foster novel, accessible, low-cost technologies to assist citizen scientists. EPA has three major focus areas to better collaborate with citizen science groups: (1) sensor technology development and evaluation, (2) data management, and (3) interpretation and communication of data. Although citizen science data cannot be used directly for regulatory compliance issues, quality data or analyses have a wide range of potential uses, such as network design, screening, and spatial and temporal analyses. It is critical that EPA work with citizen science groups to ensure that the data collected are of high quality and useful to EPA, communities and other organizations.

Discussion

Ms. Erica Bannerman (Prince George's County [Maryland] Office of Central Services) asked about EPA's actions when citizen scientists identify a problem using sensors. Dr. Costa explained that currently there is no coordinated action, but the ACE Research Program has discussed this issue with the Office of Air and Radiation (OAR). The Agency is developing a Web-based platform to disseminate information to help people understand what a single 1-minute ozone measurement means relative to an 8-hour standard in terms of risk and hazard exposure.

Water Monitoring and Research

Susan Holdsworth, Monitoring Branch Chief, Assessment and Watershed Protection Division, Office of Wetlands, Oceans, and Watersheds (OWOW), Office of Water (OW), EPA

Ms. Susan Holdsworth (OW, EPA) explained that volunteer monitoring can provide community education, establish a baseline to track changes, and identify problems. Volunteer monitoring for water quality has been supported by several organizations for more than 40 years; EPA began supporting

volunteer monitoring in 1988. Since then, the Agency has provided reference materials (e.g., methods manuals, a quality assurance manual), Quality Assurance Project Plan (QAPP) reviews, outreach through newsletters and listservs, and equipment loans. Most EPA regions have active volunteer monitoring and citizen science efforts. The Agency is exploring data sharing through the Water Quality Exchange (WQX) online data submission tool and a pilot project with the North American Lake Management Society and the Global Lake Ecological Observatory Network to develop a mobile application that allows data submission to EPA.

The National Water Quality Monitoring Council (NWQMC), which is co-chaired by EPA and the U.S. Geological Survey (USGS), has embraced volunteer monitoring activities. NWQMC sponsors a biennial national monitoring conference that fully integrates volunteer monitoring and has developed a volunteer monitoring resources website (acwi.gov/monitoring/vm/index.html). A recently formed volunteer monitoring workgroup will expand volunteer monitoring activities for water quality. A map of current volunteer monitoring programs is available on the NWQMC website acwi.gov/monitoring/vm/programs/vm_map.html).

Ms. Holdsworth would like input from NACEPT regarding changing technologies, emerging water quality sensors, social media use, pathogen monitoring, time-sensitive tools and indicators for protecting human health, environmental integrity, data management, and tools to examine biological community conditions and nutrients.

Discussion

In response to a question from Mr. Erichsen regarding real-time data, Ms. Holdsworth explained that site-specific calibration of dissolved and suspended solids and precipitation levels were used to predict pathogen levels. Mr. Erichsen asked for examples of states that have credible data programs as well as examples of credible volunteer data being used for Total Maximum Daily Load (TMDL) gaps. Ms. Holdsworth responded that New Jersey and California have active volunteer monitoring programs; she was unaware of any examples in which volunteer data have been used for TMDLs. Ms. Szaro added that Region 2's program was based on the New Jersey program, which includes training of volunteers to certain data quality standards (tiers). New Jersey also allows the use of data for regulatory decision making if the data are within the highest quality tier.

Dr. Osidele asked about opportunities to obtain water quality source data. Ms. Holdsworth responded that people and organizations can contact the WQX help desk for assistance. Another resource is the NWQMC Water Quality Portal at waterqualitydata.us. Mr. Benforado added that the data management infrastructure issue is an important one for NACEPT to consider.

Mr. Robert Kerr (Pure Strategies, Inc.) asked whether the Agency could form partnerships with private-sector companies that produce data tools to ensure data accuracy. Mr. Benforado tabled discussion of this question until the upcoming panel discussion.

Environmental Justice
Matthew Tejada, Director, Office of Environmental Justice (OEJ), EPA

Dr. Matthew Tejada (OEJ, EPA) explained that community members want better real-time data to make decisions regarding air quality and ozone exposure. Citizen science and community monitoring have many different impacts. EPA has been looking at citizen science for regulatory purposes, but communities may have different goals. Citizen science is a good way to organize communities, particularly environmental justice communities, which face many other challenges. Many different scales, reasons and needs exist in terms of community monitoring, which highlights the need for communication; the Agency must be transparent regarding its needs and purposes.

Dr. Tejada's office supports a variety of citizen science projects around the country through the Technical Assistance Grant program and other sources of funding. An increasing number of grants include citizen science projects. NACEPT's advice is critical, as citizen science and community monitoring will continue to expand at an ever-increasing rate. Environmental justice is an important aspect of citizen science and has been mentioned specifically in the Council's charge. Several members of the National Environmental Justice Advisory Council (NEJAC) have citizen science experience and are interested in having a voice in the fostering of citizen science by EPA. The Office of Enforcement and Compliance Assurance has provided NEJAC with a similar charge to that of NACEPT, with recommendations expected in approximately 9 months. Dr. Tejada suggested that NACEPT connect with NEJAC.

Discussion

Mr. Kerr agreed that it would be critical for NACEPT to coordinate with NEJAC. Mr. Benforado encouraged NACEPT to establish this connection immediately rather than waiting 9 months for NEJAC's findings.

Panel Discussion: What Are the Current Plans and Issues for EPA's Future Work on Citizen Science?

Mr. Benforado returned to Mr. Kerr's previous question regarding sensor performance, data accuracy and partnerships. Dr. Costa said that his office has been considering partnerships and piloted a testing platform in which entrepreneurs voluntarily submitted sensors for testing against primary standards. The results were published on the Web. This testing pilot took a great deal of work and effort, but individuals were pleased with the interaction with EPA. The office created a proposal to develop a protocol for third-party approaches (Sensor Seal). Ultimately, a testing program will need to pay for itself; the Agency's Environmental Technology Verification Program (commonly known as ETV), which concluded operations in 2014, was never able to achieve self-sufficiency in terms of funding. Mr. Benforado said that sensor performance, data accuracy and partnerships would be flagged as a follow-up issue and could be the topic of a future webinar.

Dr. Dale Medearis (Northern Virginia Regional Commission) asked for the top two citizen science needs for air, water and environmental justice to help frame NACEPT's afternoon discussion. Ms. Holdsworth responded that her top need is obtaining input regarding what citizens need to interpret and visualize data. Ms. Szaro agreed that knowing what to do with data and how to manage them are important issues. Dr. Costa added that data quality is critical. Dr. Tejada said that a top priority for environmental justice is expectation (i.e., the Agency's expectations for how community groups collect data and how these data will be useful for EPA).

Ms. Luther framed the issue in terms of a targeted approach regarding how citizen science could help EPA address its highest priority problems. What are the Agency's priorities? How can citizen science data be used to help address these priorities? How can the Agency ensure that it is getting the data it needs from citizens?

Mr. Benforado responded that EPA must identify where data are needed to help with decision making and environmental protection and then align the appropriate partners. Ms. Szaro agreed that it is critical to determine alignment based on identified issues. Because many issues are geographic in nature, the only national platform for citizen science that she could immediately suggest is climate change. Ms. Luther thought that EPA could identify needs by region. Ms. Szaro indicated that her region is concerned about air quality, pathogen-contaminated water and harmful algal blooms. Ms. Holdsworth added that excess nutrients are of concern as they are the driver for many national environmental problems. Dr. Costa stressed the importance of building a relationship before asking a community to act as an agent for EPA. Dr. Tejada thought that citizen science should be considered in determining the Agency's priorities so that there is no disconnect between the Agency's work and community needs. EPA must establish how it will use the vast amounts of data that will become available as a driver to determine priorities. Ms. Luther thought that environmental justice communities might be too overwhelmed to determine priorities, and

EPA should provide assistance so that these communities can help themselves. Mr. Benforado stated that priority setting and channeling citizen science is a topic that NACEPT could discuss in depth during its deliberations.

Dr. Judith Mazique (Texas Southern University) would like to increase university involvement in citizen science. Universities could provide support through data collection and/or analysis. Dr. Costa explained that a recent STAR Request for Applications focused on university and community partnerships, and five grants were awarded. Mr. Benforado thought that universities should be involved in all levels of citizen science projects. Ms. Szaro cautioned that there are some examples of universities driving the research, resulting in communities believing that their needs were not met. Dr. Tejada stressed the importance of universities meeting the communities "where they are," which involves long-term trust building. Understanding the community is an important first step. Dr. Edith Parker (University of Iowa) commented that academics generally are not used to listening to others, so there should be a push to encourage academics to engage the community. Ms. Szaro agreed that universities must address community needs. Dr. Osidele added that engagement at each point in the value chain will foster the necessary trust. He believes that communities should define the problems.

Mr. Ross asked the NACEPT members to consider what types of partners and partnerships should be explored. Ms. Szaro said that it is important to identify funding opportunities; foundations, companies and corporations often are willing to invest in communities. Dr. Costa added that his office has been trying to partner with small companies and entrepreneurs. Mr. Benforado identified this as another issue that should be explored in depth by the Council during future discussions.

Dr. Medearis wanted to know EPA's general expectations of outcomes, which will help the Council frame the plan and make the process more strategic. He also would like to learn about how the Agency could operationalize and implement citizen science. What actions can EPA take to address a problem once it receives citizen science data? Ms. Holdsworth responded that obtaining more spatial and temporal data may allow the Agency to identify patterns that can contribute to solutions. Mr. Benforado agreed to flag this concept, noting that there are a variety of legal and policy issues (e.g., intellectual property, data ownership, human subjects) related to citizen science.

Mr. DeVillars asked whether there had been an analysis of the funding and tools provided to citizens. It will be helpful to understand the tools and monetary resources available. Ms. Szaro responded that EPA funding for community capacity building has been decreasing. Mr. Benforado thought that the Council might examine whether the available funding is being used to its best advantage. Mr. DeVillars suggested that best practices could be included in this effort. Ms. Bannerman agreed that it would be useful to have a catalog of all monetary and nonmonetary incentives.

Dr. Costa would like NACEPT to consider the education component, including what can be accomplished through education. His office has found this to be a valuable way to inspire children, who then can apply the gained knowledge in real-life situations.

The USGS: A Model Agency for the Strategic Use of Citizen Science
David Applegate, Associate Director, Natural Hazards, USGS

Dr. David Applegate (USGS) explained that the USGS is a science agency and, unlike EPA, it is not a regulatory agency. Across its missions, the USGS has established ground-based networks; to extend these networks with additional nodes, the agency utilizes crowdsourcing and has a rich history of engaging in citizen science. The USGS has established an infrastructure for assessing and monitoring hazards, geospatial data, and ecological systems that span different missions, scales and disciplines and that engage broad populations.

Dr. Applegate described several USGS citizen science and crowdsourcing efforts. The "Did You Feel It?" (DYFI) citizen science effort creates rapid and automatic seismic intensity maps based on "felt reports"

submitted online; this effort grew out of a previous program in which the USGS sent postcards to all citizens in an earthquake zone following an earthquake and asked for their input. The DYFI data are accurate when compared with other data and incorporated into the agency's primary tool to convey the impacts of an earthquake. The USGS also utilizes Tweets to track earthquake activity via its Tweet Earthquake Dispatch, or TED, initiative. The USGS "Did You See It?" landslide reporting initiative enables crowdsourced, online landslide reports, with the qualitative information gained being used in USGS reports. The "Is Ash Falling?" volcano activity reporting initiative helps the USGS and National Weather Service scientists track eruption clouds and ash fallouts, ultimately helping to refine ash fall modeling efforts. The Quake-Catcher Network involves the public in seismic data collection by installing low-cost sensors in homes, businesses and schools. National Map Corps volunteers provide updates to the location and names of man-made structures through a Web-based interface (with virtual badges as rewards), allowing the USGS to use crowdsourcing to update its mapping data. iCoast uses crowdsourcing to ground truth coastal prediction models, whereas iPlover helps to forecast the effects of sea-level rise on piping plovers. The National Phenology Network gathers information on plant and animal phenology across the United States that is used for local, national and global decision making and enables adaptive responses to climate change. The Nonindigenous Aquatic Species Database is a central repository for spatially referenced biogeographic records of introduced aquatic species. Other USGS citizen science efforts include the New York City Cricket and Katydid Crawl; the North American Bird Phenology Program and North American Breeding Bird Survey, which have generated large databases of useful information; CrowdHydrology, a pilot effort in seven states; and the Boise Watershed Watch. The North American Breeding Bird Survey is recognized as a model example of a highly efficient, methodologically rigorous citizen science program.

Many of the USGS citizen science efforts benefited from their predigital roots. One key to success is incorporating an effective feedback mechanism, and another is utilizing the crowd data in USGS projects, which highlights the mission-essential reason for engaging in citizen science. He noted that agencies utilizing citizen science must be willing to have some uncertainty regarding how the projects will evolve.

Discussion

A participant asked about the primary mechanisms the USGS uses to communicate initiatives to the public. Dr. Applegate explained that this is a key issue, and communication efforts vary. Some efforts are connected to certain groups of experts or communities of interest, which are targeted for communication. Google has recognized the need to send people to authoritative sites for information, so many of these searches directly connect people with the USGS site (versus the search provider's regular search algorithm). An interagency effort exists to develop a "one-stop shopping" site for individuals interested in citizen science. Mr. Benforado noted that engaging the public can be challenging and is a topic worth further discussion.

Mr. Ross asked about the federal partnerships that the USGS is considering for its citizen science efforts, the potential of museum partnerships, and the future of mapping. Dr. Applegate sees opportunities with EPA in the water and biological arenas. Museums are perfect partners for the key informal education aspect of citizen science. In terms of mapping, the future is LIDAR and the ability to expand coverage to obtain high-resolution data, for which there are many uses.

Dr. Medearis asked how the USGS prioritizes its work while including citizen science. Dr. Applegate responded that the program level is where the operational value of citizen science can be seen. For example, iCoast was developed as a way to creatively engage the public to help coastal geologists; this public information extends the ability of USGS scientists to do their jobs. If an effort does not have a net benefit for the agency, it will not succeed. Given the broader promotion of citizen science across the federal government, more opportunities should be recognized in the future.

Mr. Yalmaz Siddiqui (Office Depot) asked what Dr. Applegate would recommend to EPA regarding its role in solving the macro-level challenges of engaging in citizen science. Dr. Applegate stated that his

recommendation is to examine all opportunities and determine their feasibility and whether they lend themselves to advancing EPA's mission. Although education and public awareness are valid goals, any effort must have mission value to be sustainable. Many of his examples evolved in the current digital space, but others were long-standing efforts that were brought into the digital domain.

Panel Discussion: The Breadth and Diversity of Citizen Science
Moderator: Jay Benforado, Deputy Chief Innovation Officer, ORD, EPA

Mr. Benforado asked the NACEPT members to consider how to strategically harness crowdsourcing and citizen science. Citizen science is not new, but new tools and technologies are accelerating the public's ability to perform citizen science. A large number of people are interested in recording observations and being a part of "something bigger." To be successful, EPA must determine at inception the defining research questions and primary issues of interest to the public and then follow through on disseminating results after data collection, processing and analysis. Although the Agency focuses on measurements, citizen observations (e.g., date-stamped, geo-tagged photographs) can be utilized and linked to EPA's mission. The federal government is actively considering the role of citizen science, with White House engagement on the topic.

Mr. Benforado provided several examples of federal citizen science efforts that highlighted creativity in meeting the varied needs of the government agencies: Citizen Archivist Dashboard (National Archives), Nature's Notebook (National Science Foundation [NSF]), mPing (National Oceanic and Atmospheric Administration [NOAA]), MapGive (U.S. Department of State), and Measuring Broadband America (Federal Communications Commission). The Federal Community of Practice for Crowdsourcing and Citizen Science has more than 40 participating agencies engaged in networking, monthly meetings and an active listserv highlighting an impressive array of projects and approaches. The Wilson Center is developing a searchable inventory of federal citizen science projects, and a Web-based toolkit for federal employees on citizen science is scheduled to be released on September 30, 2015. Case studies and a resource guide are available as well. Because NOAA has a particularly robust citizen science program embedded in its mission, Mr. Benforado recommended inviting the NOAA Science Advisor to speak to the Council.

Discussion

In response to a question from Mr. DeVillars, Mr. Benforado explained that the USGS citizen science and crowdsourcing efforts were highly leveraged and used partner organizations, which decreased direct costs to the USGS and amounted to a very small percentage of the agency's budget.

The Key Role of States
Kris Stepenuck, Extension Assistant Professor of Watershed Science, Policy and Education, The University of Vermont

Dr. Kris Stepenuck (The University of Vermont) described actions that the state of Wisconsin has undertaken to engage volunteers to contribute to the process of meeting Clean Water Act (CWA) goals. The Water Action Volunteers program was established as an educational program in 1996. In 2003, the state began to engage with university, federal and other partners in short-term research projects. A project that involves citizen monitoring of phosphorus levels is sponsored by the Wisconsin Department of Natural Resources (DNR) and the University of Wisconsin. The establishment of the Wisconsin Consolidated Assessment and Listing Methodology in 2009 and the state's phosphorus standards in 2010 helped to set the protocol for volunteers to generate data to assist the state and EPA; volunteer collection of phosphorus data began in 2012, based on state agency-defined sampling methodology. EPA Section 106 funding is used to support the program, which has grown from 12 DNR-selected sites to 100 DNR-selected and 91 volunteer-selected sites. Ten groups trained by the state but with their own funding also were able to contribute additional data. Benefits of the program to the state and EPA include data contributions to the state and the WQX database and improved knowledge. Outcomes include an

increased ability to make informed policy and management decisions, organizational improvements, waterbody restoration and protection, and civic engagement. To effectively support citizens to address EPA needs, the Agency must identify data and data quality needs, recognize that citizen science data are cost effective but not cost free, develop water quality standards, develop appropriate methods and quality assurance/quality control protocols, and develop user-friendly data reporting systems with the ability to easily extract the data.

Discussion

Dr. Castille was pleased to see involvement with extension services because that is an ideal partnership that should be explored. She asked about delistings. Dr. Stepenuck responded that citizen science data were used for listing but not delisting. Dr. Castille asked how long citizen science efforts last in a particular watershed. Dr. Stepenuck explained that volunteer water monitoring programs in the United States began in 1965, and in her experience in Wisconsin, the average time of volunteer involvement in a project used to be 2 years, but that has increased to 6 years. Projects with more diverse funding sources last longer, with some projects existing for more than 20 years.

Dr. Edith Parker asked whether the resources saved were used to expand the network or redeployed. Dr. Stepenuck responded that DNR biologists were able to work on other projects. She estimates that 22,000 staff hours are saved annually through volunteer monitoring.

A participant asked about the media attention the projects received. Dr. Stepenuck stated that many presentations have been given at conferences, but she was unsure whether the projects had received media attention. Chlorine projects, however, have received more attention in the media. It is best if volunteers issue press releases. The participant asked whether recruiting was self-driven. Dr. Stepenuck confirmed that this was the case. Volunteers are trained to one of three levels of expertise. In response to a question, Dr. Stepenuck explained that of 450 volunteers, 250 are at the entry level, and the remaining 200 are at the second or third levels.

Mr. DeVillars asked how EPA can support citizen science at the state and local levels. Dr. Stepenuck responded that Section 106 funding must address new projects. Dedicated funding is needed to support a staff member hired specifically to manage citizen science programs.

Perspectives From the Academic Community: Citizen Science—Informing Evidence-Based Practices
Jennifer Shirk, Cornell Lab of Ornithology and Citizen Science Association

Dr. Jennifer Shirk (Cornell Lab of Ornithology and Citizen Science Association) stated that her work aims to understand how citizen science works and also aims to use evidence to inform how to do more and better citizen science. She described a California Academy of Sciences effort to understand and protect the endangered black sea turtle, during which the researcher realized that collecting data was not enough. As a result, the researcher collaborated with fishermen (turtle hunters) whose cultural heritage and identity were linked to the turtle populations. These partnerships resulted in scientific and community activities that changed harvesting and management practices such that the black sea turtle population is recovering. This example can be studied to determine what works in these situations to allow change to happen as scientists are realizing that the traditional flow of information is insufficient to achieve environmental change.

The landscape surrounding conservation has different values, knowledge, scales, agendas and perspectives. Effecting change is a difficult, socially embedded effort. Scientists increasingly are stepping into new, unexpected, unsupported and underappreciated roles, working with the public to effect change. Citizen science can be a powerful tool in these settings, as it engages the social and scientific aspects of issues, but must be performed well. The Cornell Lab of Ornithology received funding to understand best practices and examine more broadly many kinds of public participation in scientific research (PPSR); the term PPSR was used because "citizen science" is a problematic term. Other terms include community-

based participatory research and collaborative inquiry. The project examined the different outcomes in three intersecting categories (science, policy and action, and individuals) and the strategies that enable these outcomes. The projects most able to achieve deep outcomes for policy and action were thoughtful in public participation and engagement; the degree and quality of participation require thoughtful attention. A cross-agency and university partnership has resulted in the recent publication by McKinley et al. regarding how citizen science can contribute to decision making in federal projects. A wealth of evidence proves that citizen science can be accomplished with sophistication and statistical power. In addition to big data, local data of known quality can be used to effect change. The evidence concerning citizen science practice is embedded in multiple communities of practice and disciplines. The Citizen Science Association aims to bring these communities and disciplines together and share best practices through new Web tools, a new journal and a biennial conference. The next conference will occur in February 2017, hosted by the North Carolina Museum of Natural Sciences in Raleigh, North Carolina.

Discussion

Ms. Bannerman noted the need to bring together different communities, cultures and languages and asked whether the sea turtle study had been multilingual. Dr. Shirk explained that the researcher was fluent in both English and Spanish in that case, but she agreed that this is an important issue in general. Community-based monitoring will require multiple languages, which becomes more important as citizen science is undertaken on a more global basis. Ms. Bannerman said that this was a good example of an intersection of citizen science and environmental justice and building conversations across different traditions and knowledge systems.

Mr. Ross asked what lessons from the McKinley et al. article could benefit EPA. Dr. Shirk responded that the article, published in the Ecological Society of America's *Issues in Ecology* journal, contains many insights but does not aim to make recommendations. A rich literature exists about the importance of fit-for-mission citizen science and the ability to work with different agendas.

Mr. Benforado noted that citizen science accomplishes multiple things at the same time, with outcomes for individuals, science and policy. If citizen science is examined in one dimension, its true power is not apparent.

How Museums Cultivate Citizen Science

Caren Cooper, Assistant Director, Biodiversity Research Laboratory, North Carolina Museum of Natural Sciences

Dr. Caren Cooper (North Carolina Museum of Natural Sciences) explained that museums are some of the oldest sites of citizen science; as amateur natural historians collected specimens and information, museums provided the infrastructure to organize these collections, which have become valuable in unanticipated ways (e.g., use of historic peregrine falcon egg collections to determine modern effects of DDT). Museums have beneficial systems for the long-term management of data. The exhibits, collections and research of museums provide the public with access to the scientific process and engage the public. Museums, which are one of the most trusted sources of information, provide the experiences that spark curiosity as well as forums to converse with the public about science and technology issues. Museums train volunteers to perform citizen science and teach them appropriate citizen science project protocols. Museums implement citizen science and conduct research, also allowing citizen science practitioners to study citizen science itself. In addition, they serve as an archive and repository to store and manage data; data management is not easy, but it is critical. Dr. Cooper summarized that members of the public want environmental protection, a strong EPA to help them protect their environments, and useful and accessible sensors. Museums can be beneficial partners for EPA to help engage the public, garner support and embed science in society to confront global challenges.

Discussion

A participant asked whether it is better to guide citizen science priorities or take advantage of current research. Dr. Cooper responded that it did not need to be an "either/or" situation. Most of her experiences have been top-down, but there is a great deal of value to be gained by using the opposite approach. Being responsive to communities is key; one bottom-up approach to provide responsiveness is to establish cyber infrastructure to support data collection. A top-down approach can provide a baseline for future comparison. Successful citizen science is a combination of the two.

Panel Discussion: How Can EPA Best Support and Participate in Citizen Science?

Ms. Bannerman asked how operationalizing the citizen science process is different from the peer-review and Federal Advisory Committee Act (FACA) process. Mr. Benforado thought that the quality of the science and participation is important to citizen science. Dr. Cooper added that the regulatory context sets a high bar for data quality. Citizen science has been included in peer-reviewed publications, which may provide insight about how to use it in a regulatory context. Dr. Stepenuck noted that some states effectively have excluded citizen contributions to decision making because of stringent data laws, and others stipulate requirements (e.g., QAPP criteria for using citizen science data). Ms. Bannerman wondered whether these requirements preclude action.

Dr. Fernando Abruña (Abruña & Musgrave, Architects) thought that sustainability naturally links to citizen science; he also wondered about the ethical limits of citizen science. Dr. Shirk responded that data support the fact that sustained seed funding yields higher efficiency and quality work versus small core funding. Sufficient funding is needed to support key staff, who must have institutional knowledge to provide continuity over time. Mr. Benforado pointed out that there are examples that link citizen science to sustainability; more examples in Europe may exist. Regarding ethical limits, citizen science is an evolving field with emerging language and concepts. Two types of citizen science exist: active and passive. Active citizen science involves individuals intentionally engaging in citizen science. Twitter tweets that are collected and analyzed are an example of passive citizen science.

Dr. Medearis mentioned the ethical limits regarding human subjects. Dr. Shirk said that she had attended a recent forum at which someone stated that a citizen science project that results in no action despite proven pollution exposure is equivalent to experimentation on humans without institutional review board review. The action component and the amount of data needed to make a decision are critical aspects of this issue. Dr. Medearis added that this is an important consideration for environmental justice issues as well. Dr. Cooper mentioned that even when humans are not the subject of the project, privacy issues can result when individuals submit georeferenced information. Intellectual property is another concern. A recent study of social media users found that 95 percent of respondents were data altruists (i.e., willing to share their personal data for the greater good) who are more concerned that their information is useful than with privacy. Dr. Stepenuck explained that an exception is farmers, who sometimes do not want an issue found on their farms to be publicized. Mr. Benforado said that ORD's human subjects expert could present to NACEPT about this issue.

Mr. Ross asked what opportunities the February 2017 meeting might bring to EPA. Dr. Shirk replied that 2,000 citizen science practitioners and members of the public are expected to attend that meeting. The past meeting provided opportunities for knowledge sharing to advance innovation by transferring approaches among disciplines. If EPA takes the opportunity to think strategically about building a program that incorporates citizen science into its mission, the Agency could be held as an example at the upcoming meeting. Dr. Cooper added that a range of disciplines are represented at the meeting, which includes a public event to showcase citizen science projects. Mr. Ross said that EPA could showcase its citizen science projects at the meeting. Mr. Benforado liked the idea but noted potential uncertainties (e.g., administration changes). Mr. DeVillars asked whether EPA is providing funding for the meeting. Mr. Benforado was unable to answer definitively but thought that in-kind support might be possible. Because sustained financing is critical, Mr. DeVillars asked whether other federal agencies (e.g., Fish and

Wildlife Service [FWS], U.S. Department of Agriculture) have provided funding for the meeting. Dr. Cooper noted that NOAA, USGS and FWS have funding that supports specific national programs, whereas EPA has a history of funding volunteer water monitoring. Mr. Benforado said that the Council could explore what models of sustained funding exist, such as embedded long-term funding. Dr. Stepenuck stated that many projects across the United States receive EPA funds.

Mr. DeVillars asked whether any programs in other countries provide good models for sustainable citizen science efforts. Dr. Shirk replied that Environment Canada had supported remarkable citizen science work, but the program was cut. Programs must be fit to the mission to be sustainable.

Ms. Luther noted that there was some hesitancy about the language and terminology of citizen science. Dr. Shirk responded that her organization is aware that some connotations can be problematic, but there is no perfect term. Dr. Di Chiro indicated that the negative connotation concerns what constitutes a "citizen." Mr. Benforado stated that the term "citizen" has multiple definitions. Dr. Cooper stated that a citizen in the context of governance is defined as someone who has rights and responsibilities within that government, whereas in citizen science, the term refers to the right and responsibility of anyone to be engaged in science. Those engaged in citizen science should be referred to as participants, volunteers, citizen scientists or other similar terms rather than as citizens, which can be misconstrued. Ms. Boles commented that when the term "citizen science" was initiated, it was meant to include the citizens of Earth; as time has passed, the conversation has focused on what the term "citizen" means.

Mr. Siddiqui noted that EPA could play many roles; if the Agency could announce one action it was taking to solve a macro-level problem related to citizen science, what would the panel members like the action to be? Dr. Stepenuck stated that her priority would be development of a data platform that standardizes the manner in which data are shared. Dr. Cooper said that her priority would be affordable sensors that meet acceptable criteria. Dr. Shirk added that these align with the McKinley et al. paper she described, and her priority would be investment in the capacity of citizen scientists to take on unconventional projects.

Mr. Erichsen asked about the differences between states that facilitate citizen science versus those that obstruct it. Dr. Stepenuck stated that the various state laws (e.g., Ohio's Credible Data Law) make the difference. Dr. Osidele said that a perspective on legal issues is needed. EPA should not advise citizen scientists to act outside of the legal authority. He wondered whether there were any legal issues that the Council needs to consider as it develops recommendations. Mr. Benforado responded that a recent paper had been issued on the topic of law, policy and citizen science; this topic can be added to the agenda.

Update on NACEPT Subcommittee on Clarifying State and Tribal Assumed Waters Under Section 404(g)(1) of the CWA
Laura Bachle, DFO NACEPT Subcommittee, OWOW, OW, EPA

Ms. Laura Bachle (OW, EPA) thanked NACEPT for agreeing to charter the subcommittee, which fits well with the Council's expertise. The subcommittee was authorized by the EPA Administrator on September 8, 2015, after a thorough outreach process. The subcommittee includes representatives from 10 states and 2 tribes; business, agriculture, national environmental groups and state associations are represented, with one representative each. The subcommittee also includes an academic expert on federalism, four federal employees and one NACEPT liaison (Ms. Boles). CWA Section 404(g) allows states and tribes to assume the CWA 404 permitting program from the U.S. Army Corps of Engineers (USACE). The subcommittee will provide advice about how states and tribes might take on this program. The crux of the question is how parties will decide which entities will issue the permit (USACE vs. states or tribes) when a permit is required. The first subcommittee meeting will be held in early October, and a total of approximately five meetings is planned to develop recommendations to present to NACEPT by the fall of 2016.

Discussion

Ms. Boles asked which NACEPT members were interested in this topic. Mr. Erichsen indicated his interest and had contacted an expert in this area for input.

Mr. Mark Joyce (ODACMO, OARM, EPA) explained that a member of the Council participates in subcommittees to keep abreast of subcommittee activities, although the NACEPT liaison has no formal standing. The liaison will keep the Council informed about the subcommittee's discussions to ensure that there are no major issues as the subcommittee develops its recommendations.

In response to a request from Mr. Green, Ms. Bachle described the selection process for the subcommittee, which began in early spring. During the 60-day solicitation period, she performed exhaustive outreach to other EPA FACA committees, standing OW workgroups and state associations, which resulted in a number of qualified applicants who were vetted before the final selection was determined.

Public Comments
Eugene Green, NACEPT DFO, ODACMO, OARM, EPA

Mr. Green called for public comments. Mr. Christian Hoogerheyde (Socrata) explained that his company works with federal agencies to help them deliver their data more effectively. Although considerable effort, time and money is invested in collecting data, not as much effort is put into delivering the data for various uses. Sharing data is equally as important as collecting data. Data can be delivered more effectively by being released in a way that can be captured by existing data platforms. He encouraged EPA to consider how to deliver citizen science data to a platform that allows the data to be syndicated by existing applications. Finally, there are many different stakeholders and data customers. Different experiences are needed for these different users, which could mean data visualization to communicate the results of citizen science, exhibition and deliverance of raw data for use in applications, or summarization of published reports. He asked the Agency to consider the various stakeholders and data customers so that the importance of citizen science work is not lost.

Mr. Gregg Treinish (Adventurers and Scientists for Conservation) explained that his company builds citizen science efforts from the ground up, recruiting, training and managing highly skilled outdoors people to collect high-quality data. He urged EPA to consider more remote environments in addition to urban areas when developing a citizen science strategy. This provides partnership opportunities with the National Park Service, FWS and similar agencies. Many people are willing and able to enter these environments and have the necessary skills and attention to detail to be successful data collectors. His company's website is www.adventurescience.org.

Discussion of NACEPT Charge on Citizen Science to Advance Environmental Protection at EPA and Council's Response
William Ross, Jr., NACEPT Chair, Visiting Professor, Nicholas School of the Environment, Duke University; and NACEPT Members

Mr. Benforado explained the 1-year process to develop recommendations, with 2 to 3 months allotted for the learning phase utilizing webinars to gather information. A number of issues already have been identified, and the Council may want to establish subgroups to address the diverse topic. Mr. Joyce added that the charge describes the issues on which EPA would like advice. The final recommendations are due in September 2016, and because of term limits, there will be new members present at NACEPT's next face-to-face meeting in May 2016. The Council needs to determine where and how it can provide the most salient advice to the Agency, either through a series of shorter advice letters or one long report. The plan and timetable for the effort must be determined prior to the end of this meeting. Mr. Green added that a past successful NACEPT effort utilized multiple, chaired workgroups with individual deliverables that were collated into one set of advice to EPA.

Dr. Osidele thought that the charge was well developed with three key question areas. In terms of the second question, Dr. Castille thought that it could be divided into and addressed by two subcommittees: (1) program and data development; and (2) data integration, use, interpretation and dissemination. Dr. Medearis agreed, adding that it might be useful to identify specific outcomes for EPA programs to provide a clearer focus. A focused target is helpful because the Council will not be able to address all of the broad issues.

Ms. Luther thought that the first charge question was too broad and needed to be refined. She thought that Mr. Benforado framed it better during his presentation: How can EPA best leverage citizen science to achieve the Agency's mission? Mr. Benforado said that this observation made sense, noting the difficult process in framing a feasible, accessible charge. In terms of the first question, he wanted to ensure that the Council learns enough before making its recommendations. The question was designed to encourage NACEPT to interact with current EPA citizen science efforts.

Mr. DeVillars said that he had not heard the term "citizen science" prior to receiving the charge, remarking that it is a new term for a historic phenomenon. Citizen science is different today as a result of the technologies and the number of people who are interested in participating as more individuals realize and understand the threats facing the planet. There are two parts to citizen science. The citizen portion focuses on education, and the science part includes data quality, integration and access.

Dr. Osidele wondered whether there was a need for feedback within citizen science that captures what is done with gathered data (e.g., decision making). Mr. Benforado explained that five types of citizen science are outlined in a paper Dr. Shirk published approximately 5 years ago. Some issues are community-driven, which is a type of citizen science; another type occurs when scientists want help from citizens to collect data and make observations. Policy questions also exist. As the Council deliberates, it must consider these different categories, which operate differently and have different incentives. Dr. Shirk said that the definition that encompasses all of the models is whether there is a use for the data and whether the data contribute to an end product.

Dr. Di Chiro thought that capacity building to allow people to generate useful data to inform environmental policy and sustainability initiatives is important. The question of what constitutes environmental expertise needs to be considered. *Citizen Science: A Study of People, Expertise and Sustainable Development* by Alan Irwin speaks to many important questions. EPA's Community Action for a Renewed Environment (CARE) grants, which support capacity building, could serve as a resource for learning about successes.

Dr. Mazique suggested that each of the Council members research prior citizen science efforts. She thought that three subgroups should be formed based on the three charge questions.

Mr. Matthew Howard (City of Milwaukee) stressed the importance of the NACEPT members being in agreement about addressing the charge questions. Is the charge about engaging in citizen science to help EPA formulate public policy? Is it about answering key issues that affect communities? He thought the charge needed to be clarified before the Council could effectively address it. He was in favor of using a phased approach for discovery of the topic and delivering outcomes.

Mr. Mears spoke of the importance of making connections and how to apply knowledge to benefit tribes. He is a member of the National EPA-Tribal Science Council (TSC), which is meeting in Washington, D.C., during the first week of December. He invited Mr. Benforado to present at the TSC meeting, as this topic provides a good connection with that group. He likes the idea of getting citizen scientists and tribal members involved and engaged in science. Citizen science could help to improve the efficiency of tribes that need to gather data across large geographic areas.

Dr. Shirk commented that the division of education and science is a false dichotomy. If collected data are not used, it is a disservice to volunteers.

Ms. Amanda Kaufman (ORISE Research Fellow, EPA) explained that she recently became involved with community air monitoring training, and her supervisor receives multiple calls each day regarding citizen science and the use of monitors. The current environment does not allow EPA staff members to incorporate citizen science into their individual jobs. Citizen science should be added to current job descriptions, and/or new jobs focused on citizen science should be created.

A participant commented that people of all different backgrounds should be included.

Mr. Kerr agreed with clarifying and rephrasing the first charge question and also liked a phased approach to addressing the charge. He wondered how to involve EPA staff members if citizen science is not included in their job descriptions. Rephrasing the first part of the charge will help address the issues at hand, such as what the mission is, what the priorities are, who the potential users are, and how to increase involvement so that citizen science has more value in the Agency. Mr. DeVillars agreed with the phased approach as well. He thought that it would be beneficial to look at best practices of other organizations or countries to increase understanding and knowledge of the topic.

Dr. Medearis suggested that an inventory of citizen science efforts supported by EPA and other federal agencies would be helpful to provide assistance in determining the legal framework. Mr. Ross recommended assigning the topic of legal issues to Mr. Howard Learner (Environmental Law and Policy Center), who was not able to attend the meeting. Mr. Benforado noted the difficulties in developing an inventory; NSF attempted to create an inventory, but most projects do not use the term "citizen science." Therefore, it is difficult for EPA to capture its citizen science work. The Agency can provide examples, but it will not be a precise inventory that includes budgets. Mr. DeVillars commented that it appears that citizen science is woven throughout many different programs.

In terms of reframing the first charge question, Mr. Benforado stated that EPA programs would like NACEPT feedback on citizen science work currently underway. The ancillary benefit is that it provides the Council with the opportunity to learn about current Agency citizen science efforts. Ms. Luther recanted her objection to the phrasing of the first charge question after hearing Mr. Benforado's explanation of the question's intent.

Dr. Stepenuck agreed that NACEPT should focus its efforts on something small and move forward from there. She recommended that the Council use the volunteer water monitoring tools developed in the 1980s and 1990s as a resource to explore new ways people are accessing information. She cautioned against minimizing volunteers, who deserve respect for building knowledge. She also supported adding citizen science to EPA job descriptions and reaching out to a diverse audience.

Dr. Edith Parker wanted to know about federal citizen science efforts in addition to those of EPA and how the Agency could leverage these opportunities. Mr. Benforado replied that he could invite three or four agencies to present information. Of particular interest are NOAA, USGS, FWS, and the National Aeronautics and Space Administration.

Discussion of Agenda and Objectives for Tuesday, September 29
William Ross, Jr., NACEPT Chair, Visiting Professor, Nicholas School of the Environment, Duke University

Mr. Ross stated that the following morning the Council would discuss a phased approach, internal organization to address the charge, and the strategic direction of the response to the charge. The NACEPT members met in small groups to discuss these items in preparation for the morning session.

Mr. Ross recessed the meeting at 5:15 p.m. EDT.

Tuesday, September 29, 2015

Discussion of Council's Response to NACEPT Charge on Citizen Science to Advance Environmental Protection at EPA
William Ross, Jr., NACEPT Chair, Visiting Professor, Nicholas School of the Environment, Duke University; and NACEPT Members

After Mr. Ross provided an overview of the day's agenda, Dr. Osidele commented that he hoped that NACEPT will gain experience and discover unexpected things while addressing the charge on citizen science.

Mr. Green explained that NACEPT's homepage (www2.epa.gov/faca/nacept) contains a link to summaries of NACEPT meetings that have occurred during the previous 5 years as well as prior advice letters, which he briefly described. Each letter was different in terms of timing, the Council's approach and the sensitivity of the issue. Most advice letters are organized around a series of meetings and information sessions that occur within a specific timeframe; a teleconference between face-to-face meetings can be scheduled to approve an advice letter. Mr. Joyce added that the Council advises the Agency regarding what actions EPA should be taking in concert with local, state, tribal and nongovernmental organizations and private partners to advance its mission of protecting human health and the environment. Budget recommendations are not useful; NACEPT should assume a level budget. Most helpful are recommendations about actions the Agency can take with its existing resources. When characterizing its advice, the Council must recognize that EPA cannot lobby Congress.

Mr. Siddiqui asked how the Council had decided in the past whether to produce an advice letter or a report. Mr. Joyce explained that advice letters are produced more quickly, but ultimately it depends on the issue, timing and how to best meet the Agency's request. Mr. Siddiqui noted that citizen science is about engaging a wider set of stakeholders and the public; it might be a viable topic for a glossy report, which could be used to engage the public further. Mr. Joyce agreed that there is a broad audience for NACEPT reports and advice letters. He cautioned that a report takes about 1 year to produce and must be heavily documented and footnoted. Advice letters typically are prepared in a more timely manner. Ultimately, it is important to remember the recipient and its needs, which is ORD in this case. Mr. Benforado added that sometimes advice can be too detailed; recommendations on strategies, partnerships and how EPA can frame the topic are the most useful. He likes both formats because advice letters can provide faster feedback as the work progresses during the course of a year, whereas a report ties everything together at the end of the year. The phased approach is useful, but it is important not to enter into the recommendation phase too early.

In response to a question from Mr. Howard, Mr. Joyce explained that changes of administration have not affected the Council because NACEPT is a nonpartisan organization. Mr. Benforado noted that the timing is optimal to provide any advice letters or reports to the new administration and discuss new opportunities for the Agency.

Mr. Howard thought that it was important to provide a deliverable that meets the needs of ORD but also is useful and relevant to a broader audience. Mr. Benforado agreed, remarking that one of NACEPT's strengths is bringing together ideas that permeate throughout EPA.

Dr. Osidele remarked that, in the past, NACEPT has provided timely comments on the draft EPA Strategic Plan. Mr. Ross and Mr. Kerr added that NACEPT's comments influenced the *FY 2014–2018 EPA Strategic Plan* and Agency staff.

Ms. Luther mentioned that there would be a gathering at the White House regarding citizen science the following day, and she did not want the Council to be behind the news. Mr. Benforado assured her that NACEPT was "ahead of the curve." The following day, the White House Science Advisor (formally titled the Assistant to the President for Science and Technology) would dedicate Citizen Science Day, with

people attending from all over the country, including two tribal representatives invited by EPA. This is the beginning of an awakening in the federal government about the power of the new approaches enabled by technologies. He believes that EPA is the first federal agency to task a federal advisory committee with considering its citizen science strategy.

The small groups that had met the day prior provided their report outs as follows:

- Group 1 suggested a three-phase plan that included 3 months to research the current state of citizen science at EPA and other federal agencies as well as the desirable future state, the synthesis of the present and future state with a comprehensive future plan (using teleconferences to carry out this phase), and a face-to-face meeting to approve the advice letter.

- Group 2 stressed the need for a sequential process, noting that Mr. Mears had invited NACEPT to introduce the concept of citizen science to the TSC.

- Group 3 also liked the phasing concept, with the first phase dedicated to exploring the current state of citizen science at EPA and other federal agencies, and the second phase identifying and describing how citizen science could help EPA fulfill its mission. The learning phase is critical, as is the environmental justice and enforcement aspects and understanding where funding is provided. The advice should be kept within the regulatory framework.

- Group 4 discussed the need to "do a little well rather than a lot poorly" and move sequentially into the learning process with a focus on outcomes for EPA. A solid amount of work already is being performed, and it is important to have mechanisms to understand which partnerships work well. Innovation that has worked well abroad also can be explored.

- Group 5 concurred with the phased approach, first learning about what EPA has done. A case study addendum to the advice letter could be part of the deliverable. The Council as a whole can learn about what EPA is doing and then divide into subgroups to discuss specific tasks. The challenge will be examining citizen science topically rather than geographically.

Dr. Costa stated that, from an air perspective, he was reluctant to link citizen science to the regulatory process, as the Clean Air Act is rigid in how it deals with air pollution and compliance. There are a range of community science activities that can take place outside of the regulatory process that can benefit communities and the Agency. The greatest success is when citizen scientists do what is best for them, as it often turns out that it is beneficial to EPA as well. In time, it may be possible to use citizen science in a regulatory framework. Dr. Edith Parker asked whether, to be visionary, NACEPT should explore this area for the future. Dr. Costa agreed that this is the vision, and right now citizen science needs to be promoted rather than restricted.

Mr. Kerr asked about the timeframe for technology development. Dr. Costa responded that technology innovation is occurring more rapidly than initially expected, but incorporating these technologies into the regulatory process will take time and a willingness to embrace a new paradigm. Mr. Kerr asked what the Council could recommend to facilitate this. Dr. Costa replied that giving people the freedom to make mistakes would be beneficial. Ms. Holly Wilson (OAR, EPA) said that, although she did not want to dampen the enthusiasm or the creativity of the Council, regulatory input regarding the use of new sensors will not occur in the near future. They can be used locally, which will lead to eventual peer review. The standards-setting process uses a large body of information, including peer-reviewed information, so this may contribute to the use of sensors in a regulatory context in the future. She emphasized that many opportunities exist outside of the regulatory arena to use citizen science. Mr. Larry Weinstock (OAR, EPA) added that citizen science can be used for climate and other issues. His involvement in the CARE program introduced him to the importance of local involvement in ensuring control of larger facilities; there are many nonregulatory uses for citizen science. Dr. Costa agreed with these comments. Dr. Osidele

said that citizen science provides a unique challenge for air quality. The more that is known about the regulatory process, the better sensors and citizen science projects can be designed.

Mr. DeVillars understood the challenge of introducing innovation and change at EPA, but headquarters needs to empower the regional offices to empower the communities. There is a role for citizen science to play in strengthening the Agency's science, but he sees the greatest opportunity in empowering people to use the science. EPA still is inwardly focused in a number of ways and must learn to think externally. Mr. Benforado responded that a key point is decentralizing the process to allow communities "into the action" more frequently.

Ms. Luther thought that examining the role of citizen science in and out of the regulatory framework is two different charges. She thought that this should be clarified in the charge. Mr. Ross said that in addition to its primary regulatory authority, EPA has broader authorities and responsibilities, and tools and partnerships can be used in a variety of ways.

Mr. Benforado explained that the air program was somewhat different than other EPA regulatory programs, such as water, Brownfields and Superfund. EPA's status as a regulatory agency is important in choosing the citizen science strategies it will use. He reiterated a key question that Dr. Medearis had identified: What are the problems that provide the best opportunities for EPA to deploy citizen science? In his experience, it is problems in which there is no other way to obtain the needed data. He provided the example of sudden oak death; garden clubs and homeowners were a source of information, and a citizen science data set was used to develop a peer-reviewed publication about sudden oak death. EPA also needs recommendations regarding how to navigate data quality and management issues. Establishing appropriate, strategic partnerships is another area of interest to allow others to perform science that is not easily performed within EPA. There is a variety of needs (e.g., EPA, national, policy, community), and the Council should consider different modes and how EPA can support community-driven citizen science. Citizen science can help the Agency to reconnect with and re-engage the public. EPA needs recommendations regarding how the Agency can reconnect with the public about the science surrounding the environment. He and his staff are ready to support the Council in bringing in the materials and experts that they need to address this charge.

Dr. Di Chiro remarked that a primary concern of environmental justice communities is air quality, and if NACEPT would like to respond to the most vulnerable communities, air will be a considerable focus. People in environmental justice communities are willing to engage in citizen science projects because they believe that the information that they collect can influence change and quality of life; an unequivocal link exists between direct scientific knowledge and hope.

Ms. Boles said that citizen science and innovation are needed to do a better job of protecting the environment and communities.

Dr. Thomas Lovejoy (George Mason University) stated that citizen science is an important initiative because environmental change is occurring at an unprecedented rate, scale and complexity, and EPA does not have the ability to measure everything that needs to be measured. Engaging citizen scientists will be helpful for increasing awareness. Biological diversity integrates all environmental problems, and biodiversity is the best way to measure the impacts on and quality of an environment. If citizen science can be broader than the questions about air or water quality, it is likely to be an early warning system of new developments on the horizon.

Mr. Ross asked NACEPT members and EPA staff to identify their most important themes based on this discussion.

- Dr. Abruña and Dr. Edith Parker: The need to explore existing programs at EPA and other federal agencies.
- Mr. Mears: Distinct citizen science for regulatory and nonregulatory needs.

- Dr. Mazique: Obtaining background information about current citizen science projects.
- Mr. Kerr: Engaging and educating citizen scientists; using citizen science as an early warning system; exploring ways to include citizen science in the regulatory process.
- Mr. DeVillars: Citizen science as an empowerment tool to engage more people and spawn citizen activism.
- Dr. Castille: Community engagement and education; how citizen science can apply to each of EPA's tiers.
- Mr. Siddiqui: Regulatory and nonregulatory uses of citizen science; using citizen science to advance EPA's broader goals and address problems not easily addressed directly by EPA.
- Ms. Bannerman: Citizen science as a tool to learn about potential issues in communities.
- Dr. Medearis: Citizen science to advance the Agency's mission.
- Ms. Luther: Strategic use of citizen science data to raise awareness of problems.
- Mr. Howard: Determining the specific issue EPA is trying to solve.
- Dr. Di Chiro: Proactive, preventive citizen science in environmental justice communities.
- Mr. Erichsen: Understanding the learning potential of citizen science data to extend its reach; focusing on the Agency's strategic goals.
- Ms. Boles: Citizen-led citizen science as an early warning system; upgrading the quality of citizen science; involving university scientists in citizen science.
- Dr. Osidele: Citizen science as a web of feedbacks; data flow and use of data streams; the adaptive learning process that EPA will need to undergo.
- Mr. Benforado: Strategies to use citizen science; future leveraging of technologies.
- Dr. Costa: Education at the community level to increase public excitement about science.

In response to Mr. Howard's most important theme, Mr. Benforado explained that the goal is to determine the strategic use of citizen science to advance EPA's mission; the Agency is at the beginning stages of this and needs to determine the best way to deploy citizen science to help it meet its mission. EPA does not need to do it all itself and can form partnerships as part of its citizen science strategy. There are many ways to frame the response to the charge, such as focusing on the community-driven aspect of the issue, data storage and management, or which problems are amenable to citizen science. These topics could serve as the basis for forming subgroups after the learning phase. He reiterated the three charge questions that he had presented on the prior day. Dr. Costa agreed that these would be useful organizing principles. Mr. Benforado and Dr. Costa stressed that EPA cannot be the reservoir for citizen science data; the Agency needs partnerships.

Dr. Alison Parker (ORD, EPA) agreed with the phased approach that the Council had discussed and will assist with providing additional materials and education. It will be helpful for the Council to divide into subgroups before the learning phase so that members can focus on information specific to their groups. Two natural areas on which to focus are community-led citizen science (bottom-up) and EPA-led (top-down) citizen science. The focus should not be solely on community air monitoring. She mentioned that the September 30 White House event will be broadcast online.

Mr. Howard described three broad phases for NACEPT to address its charge. The first phase is discovery of current and future issues related to citizen science. The phase tentatively will conclude in December 2015. The second phase is characterized by three subgroups as they relate to the strategic question of citizen science: community-driven citizen science, EPA problems amenable to citizen science, and data issues related to citizen science. There is no timetable set for this phase yet. Dr. Abruña described the third phase, which will be to determine how to help EPA manage the information and develop

partnerships. Ms. Boles reiterated the need to advise the Agency how to be more strategic in its use of citizen science.

Mr. DeVillars suggested including environmental justice in the learning phase. Ms. Bannerman added that each subgroup should be assigned a charge question so that each group has a specifically defined task to address. Dr. Osidele saw each charge question fitting within each subgroup.

In response to a question from Ms. Boles, Mr. Ross explained that the deadline for NACEPT to produce its recommendations is September 2016. Hopefully, some of the Council's advice will be able to be adopted and presented by EPA at the February 2017 Citizen Science Association meeting. The Council decided to immediately establish subgroups, so that NACEPT members can approach the learning phase through the lens of their group. Subgroups will finish their research and provide their report outs at the May 2016 face-to-face meeting.

The NACEPT members discussed the format of the deliverables. One possibility is a report early in 2016 describing the current state of citizen science and associated issues for EPA. Mr. Ethan McMahon (Office of Environmental Information, EPA) thought that it would be helpful to NACEPT and EPA for the Council to submit an initial report of findings about current (not future) issues and obtain feedback on using citizen science techniques to provide input about the next steps. Mr. Green said that the Council could develop a white paper about the current state of citizen science activities. Additionally, once the learning phase has been completed, the topics/subgroups may be adjusted.

In response to a comment by Ms. Boles, Mr. Kerr stated that some issues were identified that are outside of these three subgroups (e.g., human subjects, legal authority) and will need to be considered. Mr. Ross agreed, indicating that the meeting summary will be used to identify important issues outside of these subgroups that NACEPT will need to address in some manner.

Mr. DeVillars suggested implementing a survey or webinars about what citizen science efforts exist outside of the Agency. Ms. Bannerman wondered whether there is a method to drive the public comment period more robustly; citizen science is a grassroots effort, and this type of input would be beneficial in addition to that of practitioners. Mr. Joyce explained that EPA cannot use federal funds to conduct surveys, but Mr. Green indicated that a public comment period could be implemented. An EPA staff member added that webinars can be a robust source of information.

The following subgroups were formed based on the interests of the NACEPT members:

- Data Issues: Dr. Abruña, Ms. Boles and Dr. Osidele.
- Community-Driven Citizen Science: Mr. DeVillars, Dr. Di Chiro, Dr. Mazique, Mr. Mears and Dr. Edith Parker.
- Opportunities/Problems: Ms. Bannerman, Mr. Erichsen, Mr. Kerr, Dr. Lovejoy, Ms. Luther, Dr. Medearis, Mr. Ross and Mr. Siddiqui.

The following members currently are not assigned to a group: Ms. Ondrea Barber (Gila River Indian Community), Dr. Castille, Ms. Deeohn Ferris (Sustainable Community Development Group), Dr. Patricia Gallagher (Drexel University), Mr. Howard, Mr. Learner and Dr. Ronald Meissen (Baxter International, Inc.).

Public Comments
Eugene Green, NACEPT DFO, ODACMO, OARM, EPA

Mr. Green called for public comments, and there were none.

Discussion of Action Items and Next Steps
William Ross, Jr., NACEPT Chair, Visiting Professor, Nicholas School of the Environment, Duke University; and NACEPT Members

Dr. Alison Parker would like to have a brainstorming session with interested Council members about the topics and issues NACEPT would like to learn more about. She also asked Council members to volunteer to help organize the resulting learning sessions. She provided her email address: parker.alison@epa.gov.

In response to a question by Dr. E. Parker, Mr. Joyce indicated that he and Mr. Green would consult with NEJAC about collaborating with NACEPT.

Ms. Wilson remarked that the Clean Air Act Advisory Committee has a subcommittee working on air toxics that has developed draft recommendations that include community air issues; this is a potential resource for NACEPT.

In response to a comment by Mr. DeVillars about learning what recommendations external organizations and groups would make to EPA, Mr. Ross said that the Citizen Science Association would be a good approximation of this "universe."

Dr. Di Chiro suggested the topics of sustainability initiatives, renewable energy, and jobs and infrastructure.

In response to a question from Ms. Luther, Dr. Alison Parker said that case studies in addition to those presented the day before could be provided to the NACEPT members. Mr. Siddiqui added that an inventory of the current EPA access and use of citizen science would be helpful. Dr. Alison Parker added that this inventory is underway but not yet complete.

Dr. Edith Parker commented that the "Investing in Citizen Science Can Improve Natural Resource Management and Environmental Protection" article that had been provided to the Council made numerous claims but had very few references. Dr. Shirk indicated that the authors thought that the nature of the publication was such that they did not want citations. More detailed documents will be released that include references.

Mr. Joyce stated that the first group teleconference would be scheduled once Dr. A. Parker has a more definitive list of the learning topics. Mr. Green added that NACEPT members will have an opportunity to review the draft meeting summary, and Mr. Ross will certify the final summary. NACEPT is approaching a new membership cycle, and he may be soliciting Council members to provide nominations for new members who have broad expertise. A public solicitation for recruitment also will be released.

Mr. Ross adjourned the meeting at 12:24 p.m. EDT.

Action Items

- ✧ Ms. Benjamin-Sirmons will ensure that the Council's past work regarding vulnerable communities is available to all of the NACEPT members.
- ✧ Council members with ideas about past NACEPT work that can inform the citizen science charge will notify Ms. Benjamin-Sirmons, who will ensure that the work is available to all of the Council members.
- ✧ Interested Council members will contact Dr. Alison Parker (parker.alison@epa.gov) as soon as possible to volunteer for the brainstorming session to determine the topics and issues NACEPT would like to learn more about.
- ✧ Interested Council members will contact Dr. Alison Parker as soon as possible to volunteer to help organize the learning sessions.
- ✧ Mr. Joyce and Mr. Green will consult with NEJAC about collaborating with NACEPT on citizen science efforts.

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Chair Certification

I, William Ross, Chair for the National Advisory Council for Environmental Policy and Technology (NACEPT) certify the meeting minutes for September 28-29, 2015 (video/teleconference) are complete and accurately reflect the discussions and decisions of said meeting.

William Ross
NACEPT Chair

12-21-2015
Date