# Tracking a changing climate: Citizen science contributions to climate change indicator systems

In November 2014, the US Global Change Research Program (USGCRP), the Commons Lab of the Woodrow Wilson International Center for Scholars (The Wilson Center), and the Federal Community of Practice on Crowdsourcing and Citizen Science co-hosted a roundtable titled "Tracking a Changing Climate: Citizen Science Contributions to the National Climate Assessment". The roundtable consisted of a two-and-a-half hour public forum and a day-long invitation-only working session designed to elicit robust conversation among federal, academic, public sector, and private sector experts in indicator development and use, citizen science methods and applications, and crowdsourcing approaches.

The focus of the roundtable was an exploration of ways in which crowd-based approaches, such as citizen science and community-based monitoring, are and can be used to support indicators or indicator systems of climate change, impacts and response. This poster provides a short summary of the oundtable results.

# What are climate change indicators?

Indicators can be thought of as a way to measure or calculate the status, trend, or performance of a given system. As an example, many businesses look at the unemployment index to gauge the health of the economy. Similarly, climate-relevant indicators—whether ecological, physical, or societal—can help communicate key aspects of the changing environment, point out vulnerabilities, and inform decision making at local, state, and national levels. Indicators are an important part of the vision for the sustained National Climate Assessment (NCA).

Mitigation Response

This conceptual framework shows the links between different categories of climate change indicators.

A proposed National Climate Indicators System, currently in pilot phase, will go beyond documenting climate changes to encompass climate-related impacts, as well as adaptation and mitigation responses for natural systems and human sectors (see figure). It will provide scientific data to decision makers that will help them prepare for and respond to climate change.

# Why use citizen science to inform climate change indicators?



Incorporating citizen science projects into scientific studies allows those studies to collect data both across larger spatial scales and in finer letail due to the large number of participants. Since climate is a phenomenon that occurs at all scales, spatially broad and dense data sets collected ystematically over a long period of time are needed to derive trends nation- and worldwide. Volunteer data can help produce more broad and dense data than professional scientists would be able to collect alone, filling this need without expending an overabundance of resources. Linking volunteer data collection with climate trends can also encourage awareness of specific climate dynamics. Instead of relying on professional scientific data, participants can see a trend emerge in real-time as they collect their own data.

Graphic recording of the panel on the proposed National Climate Indicators System

# Setting the stage: Public forum

Keynote addresses discussed the depth of Federal investment, leadership, and vision in citizen science, highlighting work in the US Geological Survey and in NOAA. Panelists highlighted the contributions of climate change to research and monitoring of phenology, weather, birds, and more and discussed ways networks and relationships might be built through citizen science, including opportunities for public co-ownership of climate knowledge, and the potential for citizen science to facilitate climate resilience. Speakers invited the audience to take a deeper look at a diverse public's understandings of climate change, scientists' interests in citizen science, and the roles agencies are playing in mediating complex socialtechnical concerns. Audience questions brought into the conversation ideas around international collaborations, roles for youth and schools, connecting datasets, and looking beyond solely natural sciences.



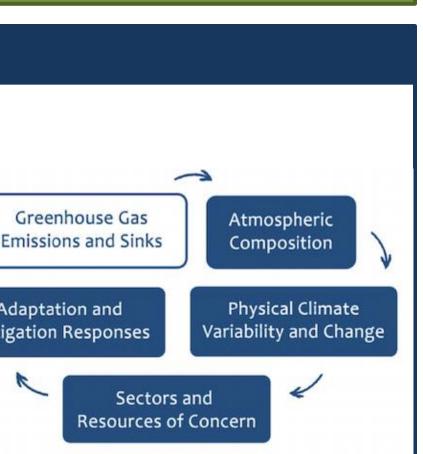
Panelists Tim Watkins (National Park Service), Julia Parrish (University of Washington), Jenn Gustetic (Office of Science and Technology Policy; moderator), Jennifer Shirk (Cornell Lab of Ornithology), and Duncan McKinley (US Forest Service)

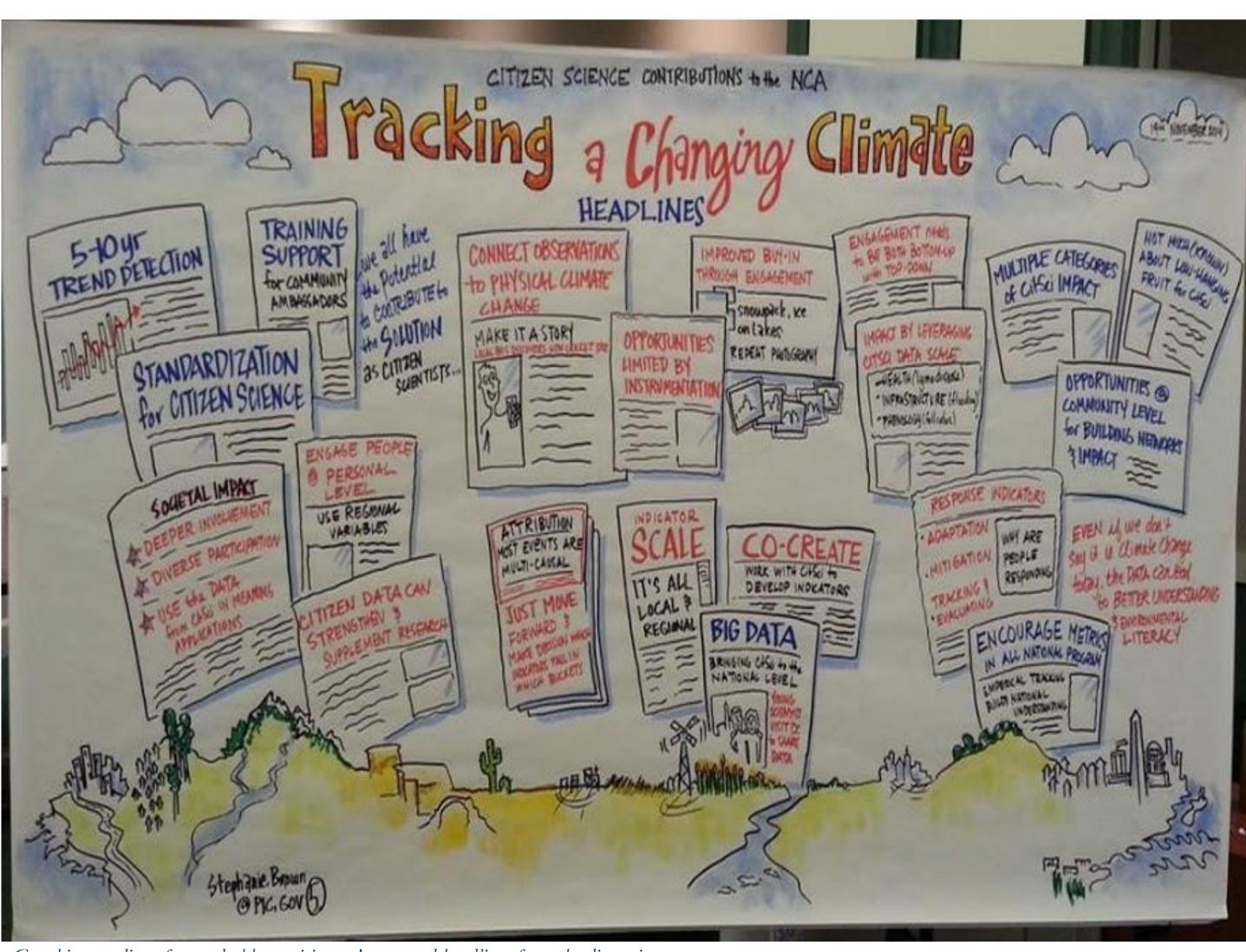


Keynote speakers Virginia Burkett (US Geological Survey) and Richard Spinrad (NOAA)



Graphic recording helped participants see themes emerging during discussions





Graphic recording of roundtable participants' suggested headlines from the discussion

## Indicators that could leverage citizen science

A number of indicators could incorporate information from existing citizen science projects and other available data sets in the near term, with only modest investments of time and money:

### Physical climate changes

- Precipitation (CoCoRaHS, GLOBE, WeatherBug, Cooperative Observer Program, mPING)
- Drought (UNISDR)
- Flooding (census data, insurance)
- Snow cover (CoCoRaHS, GLOBE, Cooperative Observer Program)
- Air & surface temperature, Humidity (GLOBE, WeatherBug,
- Cooperative Observer Program)
- Soil Moisture (CoCoRaHS, GLOBE)
- Wind (WeatherBug)
- Water temperature, pH, and Salinity (Multiple regional and local programs)
- Albedo (In development GLOBE)

### Impacts of climate change

- Phenology (National Phenology Network, Project BudBurst, GLOBE)
- Bird Species Range and Migration (Audubon Christmas Bird Count, USGS Breeding Birds Survey, eBird, Hummingbirds at Home)
- Endangered species and cherished species (Thriving Earth Exchange, Forest Watch)
- Invasive species (What's Invasive, SEEDN, EDDMapS)
- Fish catch (dock landing reports)
- Pollinators (Great Sunflower Project)
- Growing season and agricultural yields (Maple Watch)

## Responses to climate change

- Recognition of climate change as an issue (media reports, voting)
- Incorporating climate change into individual and collective decision making (insurance)
- Planning and implementing adaptation and mitigation (local and state publications)
- Energy use (electric bills, renewable energy adoption)
- Transportation choices (public transit ridership)

Many other indicators could benefit from citizen science inputs over a longer time horizon. In some cases, projects are still in early stages of development, while others only operate at local scales and would require additional development and funding to expand enough that information could be incorporated into the nationallevel indicator system envisioned by USGCRP. Even in cases where such development is far off or unlikely to occur, these projects provide a valuable mechanism for participants to learn about climate change and may be able to complement the national system.

For more information about the proposed climate indicators system, visit the poster "Citizen science can apport development of physical, natural, and societal indicators for the U.S. National Climate Indicator System" or point your browser to www.globalchange.gov/what-we-do/assessment/indicators

Roundtable participants brainstormed about indicators that could incorporate information from citizen science

# Inventory of projects

A first step in identifying ways in which citizen science can contribute to climate change indicator systems is an inventory of existing projects. This inventory can identify projects that are already operating and summarize the data and results that are useful for tracking climate change and climate change impacts. The inventory can also help identify where new, expanded, or augmented projects can fill a gap, and where there is opportunity to align existing projects with proposed indicators.

## Criteria for selecting data sets

Citizen science project organizers will need to continue to demonstrate robust data quality by maintaining transparent and well-documented protocols, information management processes, and data. Potential criteria for selecting projects as candidate data providers include their economic sustainability, infrastructure reliability, and capacity for production-level performance.

Scale introduces a number of challenges: achieving adequate geographic coverage at fine scales; bridging geographical scales in data integration, data analysis, and protocol alignment; and helping volunteers understand how their contribution fits into the bigger picture. Scale also brings exciting opportunities. For example, as the cost of sensors inevitably decreases, developing volunteer sensor networks will become more feasible, and can be deployed using the models of successful staged-growth initiatives such as CoCoRaHS. Citizen science to groundreference remote sensing data is already seeing active development, and existing volunteers can be mobilized to "piggyback" additional data collection onto ongoing activities and provide just-in-time support.

# **Participation and engagement**

Incorporating citizen science into indicators will bring a unique set of stakeholders to the table, and with them, opportunities for social progress in addition to scientific developments. Project organizers should seek innovative ways to communicate more effectively with volunteers, increase the range of participation opportunities, experiment with project designs that



may appeal to new demographics, and engage volunteers in inquiry

development. When project leaders embrace this complexity, volunteers can assist in volunteer management and training, leverage their existing social networks for project recruitment, and help take the message to their communities more effectively.

In order to achieve most of these goals, however, the technologies supporting participation need substantial improvement to encourage participation from non-technophiles. An indicator system is a long-term eco-socialphysical monitoring goal, unfortunately citizen science already faces challenges in keeping participant engagement beyond single events. Opportunities to encourage sustainability would be to model low-effort and low-cost monitoring like that used for the Christmas Bird Count.

## Low-hanging fruit

Low-hanging fruit for the development of indicators include capitalizing on existing health and economic indicators, and partnering with industry associations that maintain relevant monitoring systems. Many such indicators could be enhanced with self-reporting projects and coupled volunteer sensor networks.







# **Opportunities and challenges**

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Graphic recording of the panel on opportunities and challenges for citizen science and indicators

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- Steering Committee: Jake Weltzin (USGS), Andrea Wiggins (University of Maryland), Jennifer Shirk (Cornell University), Brian Wee (NEON, Inc.)
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U.S. Global Change Research Program

Federal Community of Practice on **Crowdsourcing & Citizen Science**