**Vertical 10: Crowdsourcing and Citizen Science**

*Content has been crowdsourced and developed by community, with goal of harmonizing content between Innovation Toolkit and existing Federal resources. These resources were drawn upon with an aim toward acknowledging existing content, ensuring accuracy and approval to include. Resources were augmented, updated, and further developed throughout the draft*

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| **Outline:**   1. **An “elevator pitch,” which provides highlights of the content, such as why the approach is important, how it works, and examples of where it has worked.** 2. **A short, digestible summary of underlying premises and rationales, supported by research (i.e., not a report).** 3. **Profiles of major categories of candidate users, including specific examples of when, and under what circumstances, the approach may be employed, supported by research into the target audience and their needs.** 4. **One or more “success stories” or other learning narratives that highlight the impact of and justification for using this approach.** 5. **Documentation of challenges to deployment, and potential limitations of the approach, including barriers or obstacles encountered within agencies employing the approach.** 6. **A “How-To” document, detailing key steps for deploying the approach, including promising practices in adaptation and deployment.** 7. **An online inventory of resources.** 8. **Examples of policy (e.g. legislation, Executive Order, etc.) that have enabled or encouraged the approach.** 9. **Future directions (next practices as opposed to best practices).** |

#### **Deliverable 1: Elevator pitch summary**

**Intro**  
By enabling and scaling the use of open innovation methods such as citizen science and crowdsourcing, the Federal government is increasingly harnessing the ingenuity of the public to accelerate science and technology innovation, and improve the efficiency and effectiveness of government. Crowdsourcing and citizen science are tools that educate, engage, and empower the public to apply their curiosity and contribute their talents to a wide range of real-world problems. Crowdsourcing is an online, distributed problem-solving and production model whereby organizations submit an open call for voluntary assistance from a large group of individuals. Through citizen science, members of the public participate voluntarily in the scientific process, addressing real-world problems in ways that may include formulating research questions, conducting scientific experiments, collecting and analyzing data, interpreting results, making new discoveries, developing technologies and applications, and solving complex problems. Members of the public can contribute to a wide range of scientific and societal problems, including public health, disaster response, biodiversity research, and astronomy. *Sourced directly from:* [Holdren, J., “[Addressing Societal and Scientific Challenges through Citizen Science and Crowdsourcing](https://www.whitehouse.gov/sites/default/files/microsites/ostp/holdren_citizen_science_memo_092915_0.pdf),” Office of Science and Technology Policy, September 30th, 2015.]

**Why**

Citizen science and crowdsourcing are important for a number of reasons. First, citizen science and crowdsourcing help enhance and accelerate scientific research through group discovery and co-creation of knowledge. For instance, volunteers can collect data over large areas and long periods of time—and sometimes increase the frequency of observations—in ways that Federal agencies may not be able to do, given geographic and resource constraints. Second, citizen science and crowdsourcing projects not only augment and enhance the scientific process, but also address other societal needs while drawing on a vast reservoir of untapped resources—the skills, dedication, and ingenuity of the American people. Diverse participation by all parts of society helps bring in new ideas and insights to contribute to solutions. Citizen science and crowdsourcing can address a range of societal needs and Federal agency goals, ranging from enhancing the accuracy of prediction markets to tagging and transcribing National Archive records. Finally, whether as youth or as adults, participants in crowdsourcing and citizen science projects have the opportunity to acquire a lifelong enthusiasm for science, along with valuable skills in science, technology, engineering, and mathematics (STEM). *Sourced directly from:* [“[A Strategy for American Innovation](https://www.whitehouse.gov/sites/default/files/strategy_for_american_innovation_october_2015.pdf),” Economic Council and Office of Science and Technology Policy, October 2015.]

Citizen science and crowdsourcing are powerful tools that can help Federal agencies:

* Advance and accelerate scientific research through group discovery and co-creation of knowledge. For instance, engaging the public in data collection can provide information at resolutions that would be difficult for Federal agencies to obtain due to time, geographic, or resource constraints.
* Increase science literacy and provide students with skills needed to excel in science, technology, engineering, and math (STEM). Volunteers in citizen science or crowdsourcing projects gain hands-on experience doing real science, and take that learning outside of the classroom setting.
* Improve delivery of government services with significantly lower resource investments.
* Connect citizens to the missions of Federal agencies by promoting a spirit of open government and volunteerism. S*ourced directly from:* [Marcoullier, T., “[Crowdsourcing Month: An Overview](https://www.digitalgov.gov/2014/12/08/crowdsourcing-month-an-overview/),” DigitalGov, December 8th, 2014.]

**How**

In December 2016, Congress passed the [American Innovation and Competitiveness Act](https://www.congress.gov/bill/114th-congress/senate-bill/3084/text), which adds explicit new authority for agencies to undertake crowdsourcing and citizen science projects. While citizen science has long been conducted by Federal agencies, this new law explicitly recognizes the value of this approach and gives agencies the capacity to carry out the projects. [Nelson, C., personal communication with Policy Design Lab, January 10, 2017.]

For executing a crowdsourcing or citizen science project, there are five basic process steps for planning, designing, and implementing:

1. scope out your problem

2. design a project

3. build a community

4. manage your data

5. sustain and improve

In order to use citizen science and crowdsourcing appropriately and effectively, agencies should apply the following principles, where relevant, in project design:

* **Data quality**. Information collected and/or used by volunteers should be credible and usable. Recognizing that a “one-size-fits-all” quality-assurance approach will not work for all projects, Federal agencies should apply the principle of “fitness for use,” ensuring that data have the appropriate level of quality for the purposes of a particular project. In addition, citizen science projects should incorporate the same practices generally followed by all science projects, including data-quality assurance, data management, and ongoing project evaluation; relevant Federal and agency policies for scientific integrity and ethics; and other applicable agency principles, policies, and practices.
* **Openness**. Information is a valuable national resource and a strategic asset to the Federal Government, its partners, and the public. Data worth collecting and using also are worth preserving and sharing. Federal agencies should design projects that generate datasets, code, applications, and technologies that are transparent, open, and available to the public, consistent with applicable intellectual property, security, and privacy protections. Agencies should use machine-readable formats to share data, metadata, and results with project volunteers and the general public.
* **Public participation.** Public engagement enhances the government’s effectiveness and improves the quality of its decisions. Americans’ collective expertise and information are valuable assets. Participation in projects should be fully voluntary, and volunteers should be acknowledged for their contributions. Further, volunteers should know how their contributions are meaningful to the project and how they, as volunteers, will benefit from participating. Where appropriate, agencies should consider engaging other countries or regions with relevant experience, programs, or citizenry to provide useful scientific data on issues that span national borders and build international understanding of shared scientific challenges. *Sourced directly from:* [Holdren, J., “[Addressing Societal and Scientific Challenges through Citizen Science and Crowdsourcing](https://www.whitehouse.gov/sites/default/files/microsites/ostp/holdren_citizen_science_memo_092915_0.pdf),” Office of Science and Technology Policy, September 30th, 2015.]

#### **Deliverable 2: Summary of underlying rationales / empirical research**

Citizen science and crowdsourcing projects can enhance scientific research and address societal needs, while drawing on previously underutilized resources. For example, after analyzing 338 citizen science biodiversity projects around the world, researchers at the University of Washington estimated that the in-kind contributions of 1.3–2.3 million citizen science volunteers to biodiversity research have an economic value of up to $2.5 billion per year. Other benefits include providing hands-on learning in science, technology, engineering, and mathematics (STEM), and connecting members of the public directly to Federal agency missions and to each other. *Sourced directly from:* [Holdren, J., “[Addressing Societal and Scientific Challenges through Citizen Science and Crowdsourcing](https://www.whitehouse.gov/sites/default/files/microsites/ostp/holdren_citizen_science_memo_092915_0.pdf),” Office of Science and Technology Policy, September 30th, 2015.]

There are a wide range of additional benefits associated with crowdsourcing, including:

* **Alleviate difficulties in inter-agency collaboration**
* **Capture more ideas than traditional models of analysis**
* **Bring in tailored groups from outside**
* **Increase diversity in participants - a larger idea pool**
* **Stimulate Innovation through Incentives - crowdsourcing through competitions**
* **Redefine government and public interactions**
* **Alleviate difficulties in inter-agency collaboration:** Crowdsourcing alleviates difficulties in inter-agency collaboration and information sharing by bringing entire organizations into crowdsourced ideation and analysis platforms
* **Capture more ideas than traditional models of analysis:** Crowdsourcing captures more ideas, insights and understandings than traditional models of analysis at a lower price by using hundreds of experts who outperform more expensive analysists susceptible to cognitive bias, “tunnel vision” and institutional inflexibility
* **Spur more citizen engagement:** Crowdsourcing facilitates analysis from groups by opening up new opportunities to access expertise and knowledge from the crowd, which is an “essential element to building a citizen-centric 21st century government”.

[Hershkovitz, S., “[Federal crowdsourcing is here to stay – hopefully](http://www.federaltimes.com/articles/federal-crowdsourcing-is-here-to-stay-hopefully),” Federal Times, December 23rd, 2016.]

Increase diversity in participants - a larger idea pool   
One of the biggest advantages of crowdsourcing is the sheer number and diversity of people that come together to tackle an issue, regardless of education, age and other factors. Building a community of problem-solvers is a crucial aspect of any successful challenge competition. Those that have run challenges for the government have used a variety of strategies to reach out to potential participants.

Examples of this include:

* The National Science Foundation’s [Generation Nano Challenge](http://www.nsf.gov/news/special_reports/gennano/), which calls on students to think up superheros and equip them with gear inspired by nanotechnology
* The [Congressional Apps Challenge](http://www.congressionalappchallenge.us/), where students in more than 160 congressional districts are designing original apps for a chance to be recognized by their member of Congress. [Beidel, E., “[Challenges and Crowdsourcing: A Quick Overview and Look Ahead](https://www.digitalgov.gov/2015/12/08/challenges-crowdsourcing-a-quick-overview-and-look-ahead/),” DigitalGov, December 8th, 2015.]

Stimulate Innovation through Incentives - crowdsourcing through competitions  
There’s nothing like a monetary prize to motivate the public. But dollars aren’t the only drivers of public engagement. In the absence of a cash prize, agencies are crafting other creative incentives to motivate citizen problem-solvers to take action.

Incentivized, open competition has become a standard tool for Federal agencies to solve mission-centric problems. Well-designed competitions allow agencies to:

* Establish “big” goals and pay only for success;
* Extend beyond the agency’s known network of vendors to a wider range of problem-solvers;
* Bring out-of-discipline perspectives to bear; and
* Make for more affordable solutions that maximize the return on taxpayer dollars.

[Challenge.gov](https://www.challenge.gov/list/) is a one-stop shop for the public to discover challenges and engage with Federal agencies that are running crowdsourcing competitions. Federal agencies have run more than 630 crowdsourcing challenges since the site launched in 2010, tackling a variety of creative, business, technical and scientific problems, including:

* [Building resiliency](http://www.rebuildbydesign.org/) in communities damaged by natural disasters;
* [Raising literacy levels](http://www.wordgapchallenge.hrsa.gov/) for low-income students;
* [Jumpstarting technology development and startups](http://catalyst.energy.gov/) in the energy sector;
* [Creating environmentally friendly and economically feasible products](https://www.challenge.gov/challenge/nutrient-recycling-challenge/) to recycle nutrients in livestock manure on America’s farms; and
* [Designing new gear](http://www.ebolagrandchallenge.net/) to help healthcare workers stop the spread of Ebola.[Beidel, E., “[Challenges and Crowdsourcing: A Quick Overview and Look Ahead](https://www.digitalgov.gov/2015/12/08/challenges-crowdsourcing-a-quick-overview-and-look-ahead/),” DigitalGov, December 8th, 2015.]

## Redefine Government and Public InteractionsDigital initiatives like citizen science and crowdsourcing are revolutionizing how the public interacts with government, according to Jenn Gustetic, former Assistant Director for Open Innovation in the [Office of Science and Technology Policy](http://www.whitehouse.gov/administration/eop/ostp) (OSTP). [Wichman, A., “[Opening Government Through Federal Crowdsourcing](https://www.digitalgov.gov/2014/12/30/opening-government-through-Federal-crowdsourcing/),” DigitalGov, December 30th, 2014.] “The existence, prevalence and growth of the Internet has created an unprecedented opportunity to reach citizens where they are and bring them into problems of national importance,” Gustetic said. [Wichman, A., “[Opening Government Through Federal Crowdsourcing](https://www.digitalgov.gov/2014/12/30/opening-government-through-Federal-crowdsourcing/),” DigitalGov, December 30th, 2014.] “It creates new ways for citizens to interact with their government: a new notion of volunteerism and citizenship. In addition to traditional ways like going to the voting booth and submitting petitions, this whole other way of civic involvement has the opportunity to reinvent the relationship between citizen and government.” [Wichman, A., “[Opening Government Through Federal Crowdsourcing](https://www.digitalgov.gov/2014/12/30/opening-government-through-Federal-crowdsourcing/),” DigitalGov, December 30th, 2014.]

**Deliverable 3: Profiles of major categories of candidate users - examples of when to deploy**

Attributes of research projects ideally suited for citizen science are:

* Data collection is labor intensive
* Data are collected from field situations
* Quantitative measurements/observations are needed
* Protocols are well designed and easy to learn and execute
* Spatial and/or temporal extents are broad Internet-accessible data submission and results acquisition are possible
* Guide materials and/or professional assistance are available
* Large data sets are needed

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| What Contexts Are Most Appropriate for Citizen Scientists?  The list above captures the attributes of scientific projects that are suitable for engaging citizen scientists. An example of such a project might be when data collection is labor intensive and would benefit from a large number of data collectors. This way, the burden is dispersed over many able bodies, using the “many hands make light work” principle. Another example is field-based data collection that involves sampling from multiple geographic or temporal points. For instance, citizen scientists could assist by reporting observations of bird migration in response to climate change across thousands of miles at the same time (Lepage and Francis, 2002).  This list can also be used to vet both largescale and smaller, local research projects for potential success as a citizen scientist project. Will participants find the data collected from field observations relevant and interesting? Does the project entail a well-designed protocol that can be implemented without much assistance? Are training materials and professional assistance available if needed? These characteristics can help ensure the reliability of the data collected. (Cohn, 2008; Haag, 2005). Using internet data entry systems allow citizen scientists to engage from across a large geographic area. By incorporating a transparent reporting system, these systems can help make citizen science projects more relevant by allowing participants to access initial results and see how their data are being used. This has been found to encourage continued involvement with a project and increase reliability of data reported (Gorman, 2001: Silvertown, 2009). *Sourced directly from:* [Gommerman, L. and Monroe, M., “[Lessons Learned from Evaluations of Citizen Science Programs](http://edis.ifas.ufl.edu/pdffiles/FR/FR35900.pdf),” IFAS Extension, University of Florida, 2015.]  Citizen science projects works best when considerations for volunteer management are taken into account:   * The project goals are well-defined and explained at the beginning of the project; * The project team includes members with needed expertise – both scientific (such as data collection and analysis) but also in project management (such as communication and public relations); * The project involves and evaluation component and active feedback loop with the flexibility to adapt as needed; * There are opportunities to experiment, fail, and adjust on a small scale with potential participants before ramping up to engage many volunteers at scale; * Participants are thoughtfully selected and supported throughout the project; * The project plan has taken the motivations and skillsets of all participants into consideration (project team and participants); these motivations are incorporated into engagement plans so that each participant understands his or her value and the benefit of their contribution (both to the project and to themselves); * The data collection process is efficient and enjoyable (as possible) and analysis is accessible to participants; * There are built in mechanisms for measuring and assessing the quality of the scientific data generated.   *Sourced directly from:* [Eveleth, R., “[Citizen Science Projects are Actually Helpful to Science](http://www.smithsonianmag.com/smart-news/citizen-science-projects-are-actually-helpful-to-science-142635880/),” Smithsonian, November 23rd, 2012.] |

**Deliverable 4: One or more “success stories” or learning narratives to underscore impact**

**Case Study 1: The Aggregative Contingent Estimation Program: Predicting Global Events Through Crowdsourcing**

*Sourced directly from:* [“[The Aggregative Contingent Estimation Program: Predicting Global Events Through Crowdsourcing](https://www.citizenscience.gov/2015/08/25/ace-forecasting/),” citizenscience.gov, August 25th, 2015.]

**Summary**

The goal of the *Aggregative Contingent Estimation* Program, sponsored by the Intelligence Advanced Research Projects Activity, is to enhance the accuracy, precision and timeliness of forecasts for a broad range of global events. The program develops advanced techniques to gather, weight, and combine the judgments of people from many backgrounds and fields and in many different locations. *ACE* is powered by human judgment, which makes it flexible enough to provide forecasts on just about any type of intelligence-forecasting question. Launched in 2010, *ACE* is based on the idea that combining forecasts made by an informed and diverse group of people often produces more accurate predictions of future events than those made by a single expert.

**How they did it**

*ACE* started with a “forecasting tournament.” Five teams of leading scholars from industry and academia competed to forecast events. They recruited thousands of research participants; each year, the participants answered about 100 questions related to social, economic and political events. Every day, the teams sent forecasts to an independent evaluator, who scored them based on actual outcomes. Each research team tried to produce the most accurate forecasts, competing against each other and against a benchmark group that used the unweighted average judgment of a group of forecasters.

After two years, one research team — the Good Judgment Project–substantially outperformed the others. In fact, Good Judgment’s improvement in accuracy was greater than the improvement of the other four research teams combined — about 70 percent over the benchmark. Forecast improvement was measured using Brier scoring, a method originally developed to evaluate weather forecasts.

**Key accomplishments:**

The team that won the *ACE* tournament (the Good Judgment Project) made substantial advances in all three areas:

* *Collecting judgments*: Given the advanced algorithms generated in *ACE*, opinion surveys surpassed prediction market platforms as the best way to elicit probabilistic judgments from forecasters.
* *Combining judgments*: Promising new algorithms weighted individual survey responses based on past accuracy, then pushed up some probability judgments (for example, an average prediction of 70 percent might be pushed to 90 percent if the beliefs of previously accurate forecasters warranted it). This dramatically increased the accuracy of the combined judgments.
* *Training forecasters*: The team created a one-hour online class that improved individual forecaster accuracy by about 10 percent.

*ACE* shows that meaningful geopolitical forecasts can be produced quickly and accurately on topics ranging from violent international confrontations to how long international leaders will stay in power. By better measuring exact levels of uncertainty, the project can also increase the rigor of intelligence analysis more generally. For the first time, we have a quantitative system flexible enough for rapid analysis of almost any subject. Where traditional analysis can take days or weeks, *ACE* forecasts can be obtained in a matter of hours. Consumers of *ACE* forecasts can be confident in their accuracy because the technologies have been validated in a real-world forecasting tournament.

**Lessons Learned**

Four of the five teams had difficulty recruiting and retaining the number of people they needed, because continuous forecasting was somewhat time-consuming (taking about one hour per week). Teams also had to decide how best to use project resources —  and whether to focus most of their effort on finding the best ways to efficiently collect probability judgments; on determining how best to combine and weight those judgments; or on developing training methods for forecasters.

* Collecting judgments involved finding the best way to gather the needed range and number of probabilistic beliefs from a crowd of individuals — whether by surveys, by prediction markets, or by some other technique — and then producing the most intuitive and user-friendly interfaces for these platforms.
* Combining judgments involved developing new algorithms to create the most accurate aggregated forecasts.
* Training involved teaching forecasters the skills that would help them become more accurate and less susceptible to judgmental biases or poor decisionmaking.

In addition, the project’s initial concept faced resistance from potential participants and customers. Analysts are not often trained to think in quantitative terms and may be reluctant to provide numerical forecasts that can be scored for accuracy. However, letting forecasters be anonymous made it easier for them to take the risk and to take the time to develop the skills needed.

**Key learning insights:**

The *ACE*case study illustrates the following steps for designing a crowdsourcing project:

* **Know Your Objectives***.*  The objective in this case was to improve forecasting by more than 50 percent over the state-of-the-art forecasts. Choosing a clear, measurable target and having a state-of-the-art control group as a benchmark enabled progress to be clearly gauged. By the program’s end, the Good Judgment Project beat the state-of-the-art forecasts by more than 70 percent. Setting specific quantitative performance benchmarks is a hallmark of all IARPA programs, and *ACE* was no different.
* **Engage Your Community.** The Good Judgment Project recruited and retained an impressive pool of high-quality participants. Participants were highly credentialed (some 60 percent had graduate degrees) and tenacious. Many spent dozens of hours per week forecasting, even though they were paid only a couple hundred dollars per year in Amazon gift cards. The Good Judgment Project understood its pool of participants, providing ongoing feedback on individual accuracy to encourage participation and ongoing effort. The project recognized and rewarded exceptional forecasters as “superforecasters.” The result was a uniquely engaged and loyal group of participants.

**Read more:**

* Website: [*ACE*](http://www.iarpa.gov/index.php/research-programs/ace)
* [Principles of Community Engagement, NIH (2011)](http://www.atsdr.cdc.gov/communityengagement/pdf/PCE_Report_508_FINAL.pdf)
* [Using Crowdsourcing in Government, IBM Center for The Business of Government (2013)](http://www.businessofgovernment.org/sites/default/files/Using%20Crowdsourcing%20In%20Government.pdf)
* [Community Engagement Techniques: Best Practices (2014)](https://www.herefordshire.gov.uk/media/6312587/12_best_practice_community_engagement_techniques.pdf)
* [Crowdsourcing: A Geographic Approach to Public Engagement, SSRN (2014)](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2518233)

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[“[The Aggregative Contingent Estimation Program: Predicting Global Events Through Crowdsourcing](https://www.citizenscience.gov/2015/08/25/ace-forecasting/),” citizenscience.gov, August 25th, 2015.]

**Case Study 2: CoCoRaHS — Community Collaborative Rain, Hail and Snow Network: Citizen Scientists Track Precipitation**

## *Sourced directly from:* [“[CoCoRaHS — Community Collaborative Rain, Hail and Snow Network: Citizen Scientists Track Precipitation](https://crowdsourcing-toolkit.sites.usa.gov/cocorahs-precipitation/),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

## **Summary**

## In 1997, following an evening of intense rainfall in parts of Fort Collins, Colorado, an ankle-deep creek running through Colorado State University became a raging river of mud and debris. The Spring Creek Flood left five people dead and city-wide damages of more than $200 million — all for lack of warning. No one realized how much rain had fallen in the area, and traditional forecasting methods failed to predict such extreme flooding. In response to the disaster, the Colorado Climate Center at Colorado State University launched a project to engage local citizens in collecting data on rainfall and other kinds of precipitation. The main goal of the [*Community Collaborative Rain, Hail and Snow Network*](http://www.cocorahs.org/)*,*or*CoCoRaHS,*is to provide a way for volunteers to collect and submit local precipitation data and educate the public.

## **How it works**

Co-sponsored by the National Oceanic and Atmospheric Administration and the National Science Foundation, *CoCoRaHS* is for citizen scientists of all ages and from all walks of life who can spend a few minutes per day collecting information on precipitation in their area. Volunteers register their location on the project website and can [train themselves online](http://www.cocorahs.org/Content.aspx?page=training_slideshows) or in person with a local coordinator. By following a set of simple procedures and using a standardized rain gauge, volunteers measure and report their daily amount of rain (or melted snow) on the project website, making the data readily available in a centralized database at the touch of a fingertip. Options to report hail and/or other kinds of weather are also available, as well as advanced options such as evapotranspiration and drought impact reports.

From its origins in Colorado, word of *CoCoRaHS* spread, and scientists began requesting support for data collection across the United States. *CoCoRaHS* responded by offering newly participating states access to its technological platform but requiring each state to establish its own network of volunteer leaders responsible for recruiting, training and retaining local monitors. Motivated local leaders have helped expand *CoCoRaHS* to more than 20,000 active volunteers in all 50 states as well as Washington, D.C. (including the White House!), Puerto Rico, the U.S. Virgin Islands and most provinces in Canada.

## **Key accomplishments**

Observations made by volunteers are immediately available for public use on maps and in reports. By providing high-quality, accurate measurements, project participants supplement existing networks and provide useful data to scientists, resource managers, decisionmakers and others — all at a very modest cost.

Many different groups use data from *CoCoRaHS.*The National Weather Service uses *CoCoRaHS* data combined with information from government-managed networks, satellites and radar to create detailed daily precipitation maps. River forecast centers use the raw and mapped data to improve forecasts of both high and low flows on major rivers across the country, helping officials to predict floods, hydropower production and municipal water supplies. Participants in the National Integrated Drought Information System use *CoCoRaHS* in preparing the U.S. Drought Monitor. Agencies such as the U.S. Army Corps of Engineers use the data to refine estimates of “probable maximum precipitation” — information of importance in the design of dams and spillways. Farmers and the U.S. Department of Agriculture use *CoCoRaHS* data to evaluate crop conditions, anticipate market cycles and estimate irrigation requirements. Researchers use *CoCoRaHS* data for myriad peer-reviewed publications.

The project also provides a variety of learning opportunities. Through emails and newsletters, participants discover how their observations are used in meteorology, hydrology and other fields. *CoCoRaHS* has classroom resources for teachers, providing opportunities for students at all grade levels to participate in real science while meeting state and national standards in math, science, geography and more.

By joining a science project with a “local feel,” *CoCoRaHS* volunteers can develop a sense of community with fellow weather observers. They also become more aware of how the weather affects them, their neighbors, their region and the entire country.

## **Lessons Learned**

With volunteers in many different locations, ensuring data quality is a challenge. Volunteer coordinators and *CoCoRaHS* staff members monitor the maps and reports and are able to fix most errors. Also, *CoCoRaHS* volunteers are required to measure precipitation with standardized rain gauges with accuracy to the nearest hundredth of an inch. The cost is around $35 for the rain gauge, discouraging participation by some potential volunteers.

Another challenge is volunteer retention. Because many citizen scientists are motivated by personal contact with scientists or project managers, *CoCoRaHS* encourages regional coordinators to reach out to volunteers on an individual basis; but this is not always realistic. Additionally, *CoCoRaHS* staff members regularly keep in touch with participants by social media, web posts and direct email.

**Key learning insights**

The *CoCoRaHS*case study illustrates the following steps for designing a crowdsourcing project:

* **Know Your Tools**  
  Focus on your core mission. *CoCoRaHS* focuses solely on manual measurements involving aspects of the water cycle.
* **Get Ready to Go**Work with your actual and potential data users to develop protocols and data access methods. This will ensure that the data your volunteers collect can and will be used by others, which motivates participation and benefits the scientific community.
* **Know Your Community Partners**Cultivate a group of local coordinators to help recruit, train and support participants. If the coordinators are also data users and project participants themselves, they can convey the value of the data and the importance of quality control, and they can understand the challenges that a volunteer might face in taking and submitting measurements. *CoCoRaHS*would have never grown to its current size without the continuous support of now over 300 state and regional coordinators.
* **Prepare a Data Management Plan**Take advantage of the work that has been done by other citizen science organizations. In particular, the National Science Foundation’s [Data Management Guide for Public Participation in Scientific Research](https://www.dataone.org/sites/all/documents/DataONE-PPSR-DataManagementGuide.pdf) provides [best practices](https://www.dataone.org/best-practices) for managing data in an iterative way throughout the data cycle.
* **Communicate Effectively**To sustain long-term engagement, give volunteers more than just access to project data. *CoCoRaHS* offers webinars led by professionals in related fields, newsletters and blogs of broad interest to volunteers.

[**Learn More**](https://crowdsourcing-toolkit.sites.usa.gov/cocorahs-precipitation/): [*Community Collaborative Rain, Hail and Snow Network*](http://www.cocorahs.org/)

## For more information, contact John McLaughlin at  [john.mclaughlin@noaa.gov](mailto:john.mclaughlin@noaa.gov)

## [“[CoCoRaHS — Community Collaborative Rain, Hail and Snow Network: Citizen Scientists Track Precipitation](https://crowdsourcing-toolkit.sites.usa.gov/cocorahs-precipitation/),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

**Case Study 3 - MapGive: Crowdsourcing Map Data for Humanitarian Response and Preparedness**

## *Sourced directly from:* [“[MapGive: Crowdsourcing Map Data for Humanitarian Response and Preparedness](https://crowdsourcing-toolkit.sites.usa.gov/mapgive/),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

**Summary**

When a catastrophic earthquake hit Haiti in 2010, map data critical for response efforts were incomplete and hard to access. In a matter of days, hundreds of volunteers created the map for Port au Prince in [OpenStreetMap](http://www.openstreetmap.org/), greatly facilitating recovery efforts. High-quality geographic data helps organizations and communities make important environmental, economic and disaster response decisions. In many places around the world, the information is incomplete or non-existent.

In open (or crowdsourced) mapping, volunteers work together to create a free and open map of the world for purposes that range from mundane to critical. [*MapGive*](http://mapgive.state.gov/) supports a global open mapping initiative with learning tools, satellite imagery, technical services, event support and networks in the global OpenStreetMap and humanitarian communities.

**How it works**

*MapGive* is the U.S. State Department’s program for supporting OpenStreetMap. Contributors map infrastructure data in OpenStreetMap, including the line of roads, building footprints, points of services and amenities, land uses such as fields or industrial areas, and many other things. The Internet has many free maps, but the underlying data in many maps are not available for public use due to legal and technical restrictions. Through open mapping, anyone anywhere can sign up to learn mapping tools and start contributing, and anyone can use the open map data. During humanitarian response, large numbers of volunteers divide up work through the [OSM Tasking Manager](http://tasks.hotosm.org/).

Many entities work in the OpenStreetMap community, including governments, companies, non-profit organizations and schools. The core infrastructure of OpenStreetMap (the servers, intellectual property and domain) is maintained by the OSM Foundation, a non-profit organization based in the United Kingdom. The Humanitarian OpenStreetMap Team connects the OpenStreetMap community with groups working on humanitarian response and economic development.

The *MapGive* initiative began with Imagery to the Crowd, which offers high-resolution commercial satellite imagery services in a format that volunteers can easily map into OpenStreetMap. With a focus on humanitarian and development applications, *MapGive* is run by the State Department’s Humanitarian Information Unit. The unit gives information to decisionmakers and partners in preparation for and response to humanitarian emergencies worldwide. It also supports innovative technologies and best practices for humanitarian information management.

**Key accomplishments**

Map data are key to assisting humanitarian and development missions. First responders to humanitarian emergencies use maps to find their way through unfamiliar and changed landscapes, and decisionmakers use maps to prepare their communities in the event of a disaster. [Successes](https://blogs.state.gov/stories/2015/02/21/open-data-day-how-state-department-linking-diplomacy-collaborative-mapping-during) include support for the Ebola OpenStreetMap response in West Africa; for the [Nepal earthquake](https://blogs.state.gov/stories/2015/05/08/want-help-nepal-volunteer-mappers-can-make-difference); and for Connect Camps, a program in Africa that builds on the Young African Leaders Initiative.

Everyone has an overwhelming urge to help when they see suffering, which is so immediate in today’s wired planet. Through OpenStreetMap, volunteers can make a powerful contribution with no more than an Internet connection and basic computer skills, even if they do not live in the area they are mapping.

*MapGive* has supported many humanitarian responses, notably the Ebola epidemic in Africa and the Nepal earthquake in April 2015. Volunteers have contributed thousands of kilometers of imagery services for digitization into OpenStreetMap; *MapGive* has also offered analysis and visualizations of contributions, extensive networking between OpenStreetMap and humanitarian communities, and support for events. During the Ramallah #map4ebola event, for example, the U.S. consulate in Jerusalem sponsored students mapping for West Africa; and during the Lahore mapathon, students supported by the consulate there contributed data for Nepal. In May, the first-ever White House Mapathon highlighted these and other events.

**Lessons learned**

OpenStreetMap is an extremely dynamic community, with a constantly evolving and growing number of actors, events, new communities and related software projects. It takes an active learning approach to understand this landscape, build relationships and find ways to contribute (and continue to contribute) as an institution. For instance,*MapGive* has worked closely with the Humanitarian OpenStreetMap Team, mappers and other providers of imagery services to develop new processes and coordinate effectively when fulfilling imagery requests.

Another challenge has been keeping aligned with other institutions, both inside and outside of government. Many offices work with OpenStreetMap. Users all map together in the same database, but due to their different organizational structures, they don’t always work together on planning, communication strategies and development of resources and tools. The State Department, along with partners such as the U.S. Agency for International Development, Peace Corps, World Bank and American Red Cross, has been working to bridge the gap.

**Key learning insights**

The *MapGive* case study illustrates the following steps for designing a crowdsourcing project:

* **Know Where Your Project Fits**  
  OpenStreetMap is a large, freewheeling project. It’s important to understand how others are engaging in OpenStreetMap and what unique value your institution can bring — whether it’s introducing OpenStreetMap to new communities and sectors or developing new kinds of applications.
* **Plan Project Management**Over 10 years old, OpenStreetMap has many instructive examples of success and failure. It’s also a passionate community willing to help, so reach out to learn more about how others have approached OpenStreetMap.
* **Know Your Community Partners**There are as many motivations for getting involved in OpenStreetMap as there are contributors. Some are students learning a new skill, such as GIS. Others want to develop software for a rich open dataset; they may be working to make their vulnerable community more visible on the map. Many simply find mapping fun and intriguing, a way to explore the world while creating something useful.

Learn more:[*MapGive*](http://mapgive.state.gov/)

For more information, contact Benson Wilder at  [wilderbf@state.gov](mailto:wilderbf@state.gov)

## [“[MapGive: Crowdsourcing Map Data for Humanitarian Response and Preparedness](https://crowdsourcing-toolkit.sites.usa.gov/mapgive/),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

**Additional case studies:**

More demonstrations of how agencies have used crowdsourcing and citizen science projects can be found below:

1. [The OpenPV Project: Crowdsourcing Solar Energy Data](https://crowdsourcing-toolkit.sites.usa.gov/files/2015/.../openpv-solar-energy-data.pdf)
2. [eBird: Crowdsourcing Bird Data](https://crowdsourcing-toolkit.sites.usa.gov/ebird-bird-data/)
3. [EyeWire: A Game to Crowdsource Brain Mapping](https://crowdsourcing-toolkit.sites.usa.gov/files/2015/08/eyewire-brain-mapping.pdf)
4. [Project BudBurst: Citizen Scientists Track Seasonal Plant Changes](https://crowdsourcing-toolkit.sites.usa.gov/project-budburst/)
5. [The Monarch Larva Monitoring Project: Citizen Scientists Monitor Monarch Butterflies](https://crowdsourcing-toolkit.sites.usa.gov/monitor-monarchs/)
6. [Disk Detective: Crowdsourcing New Planets](https://crowdsourcing-toolkit.sites.usa.gov/disk-detective/)
7. [Measuring Broadband America’s FCC Speed Test App for Android and iOS: Crowdsourcing Mobile Broadband Performance](https://crowdsourcing-toolkit.sites.usa.gov/files/2015/09/fcc-speed-test.pdf)
8. [The GLOBE/S’COOL Partnership: Citizen Scientists Validate Satellite Data](https://www.citizenscience.gov/2015/07/14/globe-scool-satellite-data/)
9. [The SMAP/GLOBE Partnership: Citizen Scientists Measure Soil Moisture](https://www.climate.gov/.../smapglobe-partnership-citizen-scientists-measure-soil)
10. [Did You See It?: Crowdsourcing Landslide Information](https://crowdsourcing-toolkit.sites.usa.gov/files/2015/09/did-you-see-it-landslide.pdf)
11. [The North American Bird Phenology Program: Crowdsourcing Migratory Bird Data](https://crowdsourcing-toolkit.sites.usa.gov/north-american-bird-phenology/)
12. [The Smithsonian Transcription Center: Crowdsourcing Document Transcription](https://crowdsourcing-toolkit.sites.usa.gov/files/.../smithsonian-transcription-center.pdf)
13. [Tweet Earthquake Dispatch: Crowdsourcing Earthquake Detection](https://crowdsourcing-toolkit.sites.usa.gov/tweet-earthquake-dispatch/)
14. [The National Map Corps: Crowdsourcing Map Data](https://www.citizenscience.gov/2015/07/13/the-national-map-corps/)
15. [Did You Feel It?: Crowdsourcing Earthquake Maps](https://crowdsourcing-toolkit.sites.usa.gov/files/2015/09/did-you-feel-it.pdf)
16. [Nature’s Notebook: Citizen Scientists Track Seasonal Change](https://www.citizenscience.gov/files/2015/09/natures-notebook.pdf)
17. [mPING: Crowdsourcing Weather Reports](https://crowdsourcing-toolkit.sites.usa.gov/mping-weather-reports/)
18. [Cyclone Center: Crowdsourcing Hurricane Intensity Estimates](https://www.citizenscience.gov/2015/06/25/cyclone-center/)
19. [EteRNA: Crowdsourcing New RNA Designs](https://www.citizenscience.gov/2015/06/25/eterna/)
20. [The Enhanced Passive Surveillance System: Crowdsourcing for Early Detection of Animal Disease Outbreaks](https://www.citizenscience.gov/files/2015/.../enhanced-passive-surveillance-system.pdf)
21. [The Air Sensor Toolbox: Citizen Scientists Measure Air Quality](https://crowdsourcing-toolkit.sites.usa.gov/air-sensor-toolbox/)
22. [Citizen Archivist Dashboard: Improving Access to Historical Records Through Crowdsourcing](https://crowdsourcing-toolkit.sites.usa.gov/citizen-archivist/)

**Deliverable 5: Challenges to deployment / approach limitations (inc. lessons learned from agencies where implemented)**

*Sourced directly from:* [“[Step 5 — Sustain and Improve Your Project](https://crowdsourcing-toolkit.sites.usa.gov/step-5-sustain-and-improve/#flexibility),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

Successful citizen science projects require sustained participation and funding, as well as sound methods of evaluating progress toward goals. It’s important to have a holistic plan at the outset, and continue to evaluate each step as part of your designed plan. At each stage, be mindful of the inputs required for subsequent stages ; this includes documenting and preserving records and data for future use.

Key ingredients for successful crowdsourced project deployment include:

### **Communicate Effectively**

### **Sustain Your Project Funding**

### **Build Flexibility Into Your Project**

### **Ensure your data collection is valid**

### 

### Communicate EffectivelyClear and consistent communication is the most crucial component of a successful project from beginning to end. Tips for this include:

### Use a “pre-nup” agreement to clarify roles and responsibilities and to avoid misunderstandings.

### Give your participants news about your project and chances to respond, and keep data accessible rather than locked away.

* Draft and sign a [collaborative agreement](https://ccrod.cancer.gov/confluence/display/NIHOMBUD/Collaborative+Agreement+Template) outlining tasks, roles and responsibilities, including who has access to what data. Regularly review and update the document, particularly when new people join the team.
* Hold regular meetings so everyone can understand how the project is progressing, talk about new developments and raise any concerns.
* Watch for any conflict (such as over how to interpret data) and [be prepared to handle it](http://ombudsman.nih.gov/tools.html).
* Use a common website, hub, tool or software to keep your project information and data up to date and accessible.
* Store data in shared spaces that are easy to find (such as the cloud).
* Consider developing a [terms-of-service agreement](https://www.digitalgov.gov/resources/negotiated-terms-of-service-agreements/).

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### Sustain Your Project FundingAt different stages of your project, you might need different sources of funding, depending upon your project’s maturity, your partners and other factors. Sustainable funding will depend on your project design, your success in recruiting participants and achieving your goals, and your ability to learn from experience and improve your planning and budgeting.

* Always think ahead about how to fund the next phase of your project. Keep your project aligned with your organization’s mission and with the goals of your citizen science community.
* Review existing case studies of citizen science and crowdsourcing projects for lessons about hidden or expanding costs. Keep careful account of your expenditures. As phases of your project end, review your budget estimates and adjust as needed.
* Use a variety of sources for funding, including your organization’s budget, government grants (local, regional or Federal), university/private/public partnerships, foundation grants, crowdfunding, and fundraising or donations. Consider breaking out parts of your project for funding in different ways.

Build Flexibility Into Your Project  
Keep your eye fixed on your endpoint, but be flexible — your needs might change, or early results might show that you aren’t hitting your goals. As part of your ongoing project assessment, be prepared to adjust your project design, then reassess and readjust it in an iterative process.

Consider using adaptive management

As your project goes forward, conditions could change and you might face unforeseen obstacles. You can then adjust your processes to better meet your goals.  
Look into iterative project management. Each time you make adjustments, look at your project as something new, to be reassessed and readjusted in a process of iterative development. Document project changes, particularly if they affect participation or data interpretation.

[“[Step 5 — Sustain and Improve Your Project](https://crowdsourcing-toolkit.sites.usa.gov/step-5-sustain-and-improve/#flexibility),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

**Are Data Collected by Citizen Scientists Valid?**

*Sourced directly from:* [Gommerman, L. and Monroe, M., “[Lessons Learned from Evaluations of Citizen Science Programs](http://edis.ifas.ufl.edu/pdffiles/FR/FR35900.pdf),” IFAS Extension, University of Florida, 2015.]

One challenges citizen scientist gathered data has faced is the question of its validity. Scientists, reviewers, and decision makers may question whether data collected by volunteers has the same validity and is of the same quality as that gathered by trained scientists. There have been several studies seeking to assess the validity and reliability of volunteer-collected data, comparing it to professionally collected data. These studies show that, when given proper training and materials, volunteers can collect data comparable to data collected by professional scientists (Au et al., 2000; Canfield et al. 2002; Fore et al., 2001; Delaney et al., 2008). Volunteers may not have performed as well in identifying some technical data (e.g., species identification) but they were able to aptly collect general monitoring parameters (e.g., counts of all species or conspicuous species) (Haag, 2005; Newman et al., 2010). These studies suggested designs that can include volunteer data collection but use professional scientist to conduct the analysis. For example, using LAKEWATCH volunteer-collected chemical measurements in lakes (Canfield et al., 2002). These studies also suggest that quantitative measurements appear more reliable than qualitative assessments made by citizen scientists. For example, Galloway et al. (2006) describes a transect study of white oak forests in Oregon. Here, quantitative measurements (e.g., tree abundance, diameter at breast height) made by groups of students in grades 3–5 and 6–10 were statistically similar to those obtained by professionals working for Federal agencies, while students’ assessments of more subjective assays, including tree dead/alive status or tree crown shape, were not aligned with professionals’ assessments.

Another means of assessing of citizen scientist data is to compare two or more programs that monitor similar data points, assuming that if the two produce similar results, they suggest reliability. Lepage and Francis’s (2002) formative evaluation of two Cornell Laboratory of Ornithology projects used this methodology. They assessed observations from Christmas Bird Counts and Project Feeder Watch. The comparison indicated that the two projects obtained statistically similar population trends for approximately 80% of the bird species. The authors concluded that both programs appear to be recording accurate population demographics for a majority of bird species.

Data quality can be positively impacted by having trained staff accompanying citizen scientists. If this is not possible, studies show that projects can increase the likelihood of successfully enhancing data validity by offering training sessions, guidebooks, and clearly written protocols for data collection (Canfield et al. 2002). Ultimately, the scientists responsible for the study should be aware of the challenges and benefits of using citizen scientists and should carefully analyze the data obtained by volunteers, being prepared to remove suspicious data sets if necessary.

[Gommerman, L. and Monroe, M., “[Lessons Learned from Evaluations of Citizen Science Programs](http://edis.ifas.ufl.edu/pdffiles/FR/FR35900.pdf),” IFAS Extension, University of Florida, 2015.]

**Deliverable 6: How-To: Steps for deploying, practices for adapting**

There are five basic process steps for planning, designing and carrying out a crowdsourcing or citizen science project:

**Step 1 - Scope Out Your Problem**

**Step 2 - Design a Project**

**Step 3 - Build a Community**

**Step 4 - Manage Your Data**

**Step 5 - Sustain and Improve**

**Step 1 - Scope Out Your Problem**

*Sourced directly from:* [“[Step 1 — Scope Out Your Problem](https://crowdsourcing-toolkit.sites.usa.gov/step-1-scope-out-your-problem/),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

Start with a detailed [exploration of the problem](http://govlabacademy.org/) you need to solve — [why it matters](https://vimeo.com/105270675), [what your priorities are](http://diytoolkit.org/tools/theory-of-change/), who’s interested and what you hope to accomplish. Explore your available approaches and pick the best one. Understand [what citizen science can accomplish](http://edis.ifas.ufl.edu/pdffiles/FR/FR35900.pdf) and [what crowdsourcing can accomplish](http://www.nature.com/news/crowd-sourcing-strength-in-numbers-1.14757). Finally, identify the key stakeholders who will need to agree to and support solutions to the problem. Take the time to carefully [frame your project](http://www.design.caltech.edu/erik/Misc/Heilmeier_Questions.html) and build a solid foundation so that all later steps address your needs.

Whilst scoping out your project, it may be useful to consider:

* [Know your tools.](https://crowdsourcing-toolkit.sites.usa.gov/step-1-scope-out-your-problem/#know)
* [Engage your stakeholders and participants.](https://crowdsourcing-toolkit.sites.usa.gov/step-1-scope-out-your-problem/#engage)
* [Know where your project fits.](https://crowdsourcing-toolkit.sites.usa.gov/step-1-scope-out-your-problem/#fits)
* [Get approval from your supervisors.](https://crowdsourcing-toolkit.sites.usa.gov/step-1-scope-out-your-problem/#approval)

### **Know Your Tools** Find out [what specific techniques are available](http://www.ceh.ac.uk/products/publications/understanding-citizen-science.html) and which ones will best help you meet your mission goals. How might the resources available to you shape your research questions?

* Define your goals for the project: [What do you want to accomplish?](https://vimeo.com/91934378)
* Know the [strengths of your available approaches](http://ntrs.nasa.gov/search.jsp?R=20140006049) and the risks and requirements associated with using them.
* Find out what others have done with [similar projects](http://www.wilsoncenter.org/publication/new-visions-citizen-science) — to tell whether you’ve got a good match, verify that a new project is needed (as opposed to extending an existing project), and to strengthen your plans before you get going.
* Start thinking early about [how you’ll evaluate](http://www.jstor.org/stable/27786204?seq=1#page_scan_tab_contents) and share results and outcomes.

### **Engage Your Stakeholders and Participants** Find out whether stakeholders and participants are comfortable with the type of project you envision and with your ideas for how they will get involved and what technologies they will use. Talk with them to address their concerns. Don’t have just one conversation — [keep talking with everyone](https://www.cl.cam.ac.uk/techreports/UCAM-CL-TR-760.pdf) as your plans move forward. Learn what participants want to get out of your project, what skills they have and what time and resources they can offer.

* Decide what skills you need and learn who might want to share them with you and why. If you have specific project participants or community groups in mind, learn what skills they have and what technologies they can use. Learn who else might have a stake in your project and what might get them interested in sharing resources or ideas. Understand your participants’ time commitment level and assess what training technique would be most appropriate.
* Reach out to your potential stakeholders and project participants using the media and [messages](https://www.changemakers.com/storytelling) that they’re comfortable with.
* Decide whether you need to “vet” volunteers to ensure that they can offer what you need. You may also need to create formal agreements before getting started (examples coming soon).
* Decide whether you need specialized vendors to provide software, sensors or other products that will help make your project a success.
* Find out what resources your users are familiar with. Are there [resources you can offer](http://www.teklalabs.org/about/) as part of the project?

### **Know Where Your Project Fits** Once you figure out where your projects fits into the larger picture of citizen science and crowdsourcing projects, that will help you identify [best practices](http://www.ecologyandsociety.org/vol17/iss2/art29/ES-2012-4705.pdf) and answer [broader questions](http://dx.doi.org/10.1007/s10606-014-9204-3) about what you’re trying to accomplish.

* Plenty of [frameworks for citizen science](http://ts-si.org/files/doi101504IJODE2010035191.pdf) and [crowdsourcing projects](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2518233) are already out there. Carefully review the ones that might apply to your project — they’ll give you the big picture and ensure that you identify and answer important questions.
* Learn the basic terminology used in crowdsourcing and citizen science projects (e.g., community-based monitoring, participatory science etc.). It will help you connect with others doing similar work, make sure you don’t miss relevant resources and share your own lessons later on.

### **Get Approval from Your Supervisors** You’ll need to know what questions and concerns your manager and other decision makers might have about your project, and how to address them. Many resources can help you [explain why crowdsourcing](http://www.businessofgovernment.org/sites/default/files/Using%20Crowdsourcing%20In%20Government.pdf) and citizen science projects are important and how they can help your agency meet its goals.

* Look at the resources others have used to get leadership approval and adapt them to the needs of your own project (examples coming soon).
* You’ll need to know what [legal authorities](http://wilsoncenter.org/sites/default/files/STIP_CS_Legal_FINAL.pdf) you have for your project and the legal and policy requirements you may need to meet. Having these on hand can also help you collaborate more smoothly with your agency’s legal team.

[“[Step 1 — Scope Out Your Problem](https://crowdsourcing-toolkit.sites.usa.gov/step-1-scope-out-your-problem/),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

## 

## **Step 2 — Design a Project**

*Sourced directly from:* [“[Step 2 – Design a Project](https://crowdsourcing-toolkit.sites.usa.gov/step-2-design-a-project/),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

After you have explored your problem in [Step 1 — Scope Out Your Problem](https://crowdsourcing-toolkit.sites.usa.gov/step-1-scope-out-your-problem/), and found that it’s a good match for citizen science and/or crowdsourcing approaches, you’re ready to design your project.   
The following tips will help you get started:

* [Know your objectives.](https://crowdsourcing-toolkit.sites.usa.gov/step-2-design-a-project/#know)
* [List your resources.](https://crowdsourcing-toolkit.sites.usa.gov/step-2-design-a-project/#list)
* [Plan project management.](https://crowdsourcing-toolkit.sites.usa.gov/step-2-design-a-project/#plan)
* [Get ready to go.](https://crowdsourcing-toolkit.sites.usa.gov/step-2-design-a-project/#ready)

### **Know Your Objectives** To design your project for success, you’ll want to clearly identify objectives and break them into distinct tasks. Advance planning will help you figure out the best workflows later; it will also help you find points where you can validate the information collected by project participants. You’ll also need to think about how you will share your outcomes to clearly show their connection to your goals.

* Add detail to your goals. You know what you want to study, what information you want to collect, or what you want participants to learn. What specific measures will you use? In what format will you ask people to share information?
* Decide whether these measures and formats will work best in an online or hands-on project. If hands-on, decide whether volunteers will be able to collect data more easily individually or in groups, independently or under supervision, with or without training requirements.
* Consider possible ways of storing your [data](http://www.birds.cornell.edu/citscitoolkit/features/new-data-management-guide). Who needs to be able to see it– volunteers, stakeholders, researchers? How long will you need it available?
* It is often helpful to recruit team members with competencies in public communication, community engagement, visual design, data management, and evaluation. Think about your possible funding sources and why they value these goals, and list ways of reporting your results to show success.

**List Your Resources**You’ve described your goals in detail. Now you’ll need to put your team together and find out what your resources and limitations are in terms of funding, staffing, equipment, needs and scope.

* To establish your team and map its tasks, figure out the responsibilities of your paid staff, volunteer staff, partner organizations, and participants. In addition to the skills and tasks common to more research projects, you’ll want to fill roles for marketing, recruitment, and communication with participants. Also figure out how many of each you will need and for how long.
* List everything you will need to complete your project, including equipment, storage, travel and training. Compare your plans to similar projects listed on citizen science and crowdsourcing directories to determine whether you can adopt or adapt protocols from existing or former projects, that represent substantial resource savings and improve data sharing, collaboration opportunities, and technology. Consider what options are most usable by your volunteers.
* Estimate the costs of travel and materials, including the costs of sharing results with volunteers and in conferences, white papers, published articles and workshops.
* Check with your internal legal guidance, and figure what you need to do to ensure the safety of project participants and the security of your data.
* Use the details of your project design to create a realistic budget, including estimates of salaries, indirect and hidden costs, return on investment, and tools and resources you have on hand.
* Choose [funding strategies](http://foundationcenter.org/) suited to your needs. Consider the [cost and benefit tradeoffs of crowdfunding](https://www.kickstarter.com/) and of public and private [funds](http://communityfunded.com/) or [grants](http://nsf.gov/).

### **Plan Project Management** Let your estimated budget along with the [case studies and resources](http://www.birds.cornell.edu/citscitoolkit/conference/toolkitconference) guide the design of your workflows for your project. Many excellent citizen science and crowdsourcing projects have shared their designs and the challenges they faced.

* Identify what tasks– including recruitment, training, data collection, quality assurance, analysis, and application of results– need to fit into your workflow. How long will each one take? Are there limits (for example, academic calendar or budget year) on when each can take place?
* Decide on the best way to create and manage your community of project participants and stakeholders.
* If your project is online, decide whether you can use an existing site or tool as your primary infrastructure. If not, determine whether to build your website with open-source content management systems and/or whether to leverage existing code. You may need to sign a [terms-of-service agreement](https://www.digitalgov.gov/resources/negotiated-terms-of-service-agreements/).
* Don’t forget that participants can help manage the community as well.
* Create a plan for communicating with your community, including timetables and what tools and media you will use at each stage.
* Projects that do not regularly engage with their communities often face sustainability problems, as high participant turnover can exhaust project management resources more quickly than anticipated.

### **Get Ready to Go** You’ll need to be ready to work with your project team and with your community of partners and stakeholders. Set everything up so that when the time comes, it’s easy to bring in participants and share project results.

* Establish a community of stakeholders to report progress, elicit feedback and build support.
* Make it easy to participate in your project. Figure out how you will train people to understand your goals and what they need to do. Consider training by peers, and training for trainers. Pilot test your training. Consider using spotlights, forums/discussion boards, group leaders, badging, and participation procedures with colleagues or friends who are not experts in the topic to work out the kinks before launching the project.
* Design opportunities for socialization and communication among and with participants. Consider using spotlighting, forums/discussion boards, group leaders, badging and spaces for general discussion and learning. Socialization helps support participant retention.
* Make final decisions about metrics for your goals.
* Pick internal and/or external teams who will evaluate your project and analyze the results. Decide whether the evaluation results might become part of a research publication; if so, human subjects review will be needed.
* Identify when you expect the project to conclude, or under what circumstances you might need to hand it off to another party to continue.
* Make a plan for publicizing your project results, both the data you collected and your overall outcomes. Have a timeline for writing reports and briefing materials; incorporate ongoing feedback and periodic progress reports to participants, and announcements of research publications with plain-language summaries. Discuss your results.
* Well in advance of your project’s end date or pre-determined target date for releasing results, select a well-attended conference or other suitable venue to report and discuss your results.

[“[Step 2 – Design a Project](https://crowdsourcing-toolkit.sites.usa.gov/step-2-design-a-project/),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

## **Step 3 — Build a Community**

*Sourced directly from:* [“[Step 3 – Build a Community](https://crowdsourcing-toolkit.sites.usa.gov/step-3-build-a-community/),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

Citizen science and crowdsourcing projects rely on a community of participants and professionals. You will need to address the challenge of building and sustaining a trusting relationship with your community, which will include people with many different things to contribute and reasons for participating.

Since communities are unique, no single template applies to all. Be sensitive to the particular needs, skills and motivation of the community you’re working with and use appropriate techniques to interact with your partners. Consider organizational limitations of your participants and how they fit in with agency protocols. Here, we provide you tools to aid you in understanding your potential partners and choosing the best ways to make sure everyone gets what they need from the project.

The following tips will help you get started:

* [Know your community partners.](https://crowdsourcing-toolkit.sites.usa.gov/step-3-build-a-community/#know)
* [Engage your community.](https://crowdsourcing-toolkit.sites.usa.gov/step-3-build-a-community/#engage)
* [Nurture your community.](https://crowdsourcing-toolkit.sites.usa.gov/step-3-build-a-community/#nurture)
* [Be sensitive to socio-cultural issues.](https://crowdsourcing-toolkit.sites.usa.gov/step-3-build-a-community/#sensitive)

### **Know Your Community Partners**

Some communities are well-defined and have many things in common, even if their interest in your project focuses on a specific issue, question or concern. Others may be a disconnected group of people who share a common interest, concern or hobby. Find out what motivates your partner community and why people might want to get involved in your project.

* Find out who makes up your prospective partner community. Having a good grasp of what types of people you’ll be working with—including things like age range, education, expertise, and access to resources–will help you better engage. Examples of partner communities include [NASA retirees](http://www.rockethub.com/42228), [school children](http://www.schoolofants.org/) and [healthcare advocates](http://www.patientslikeme.com/).
* If you can, build upon an existing, motivated community group. People are always interested in what is happening in their own backyard.
* Talk with your prospective partners and learn what motivates them. Possibilities include political issues, hobbies, scientific curiosity, health-related concerns and more. Don’t go in with assumptions—you may be surprised to find out why people are getting involved.
* Carefully examine assumptions about partners. For example, tribal communities, students, or self-selected volunteers may have very different worldviews, needs, interests, motivations, and terms of engagement. Working with many groups in a single project would likely require a distinct engagement strategy for each participant community.
* Ask your volunteers what motivates them. A [survey of thousands](http://portico.org/Portico/#!journalAUSimpleView/tab=PDF?cs=ISSN_15391515?ct=E-Journal%20Content?auId=ark:/27927/pgg3ztfcv7h) involved in a [crowdsourcing project](http://www.galaxyzoo.org/) found that more people were motivated by contributing to science than anything else.

### **Engage Your Community**

* Citizen science and crowdsourcing projects rely on participation by a community of volunteers. You will need to reach out and engage these participants. Look for the methods and strategies best suited to engage your community and your project.
* Find the best platforms for reaching your community. For example, some online groups share information about specific diseases, while in-person groups may deal with local issues such as air pollution or environmental justice. Your participants may be most comfortable [entering responses online](https://www.zooniverse.org/), [playing a game](https://eyewire.org/signup), or participating in person in distributed research. Find illustrative project examples in the Resources section below.
* Empower the community you’re working with by letting members know how they can engage with your agency. Design your training to build scientific understanding and skills throughout your community so that everyone can fully participate in your project.
* Work with facilitators who can act as liaisons to the community. Make sure trainers who aren’t from the community understand the people they’ll be working with, and that trainers and liaisons speak the community’s primary language(s) when possible.
* Consider using:
  + The best venues to share information with your community, which may include advertising, online sites, briefings, education and awareness programs, fact sheets, newsletters, media stories, news conferences, telephone hotlines, displays, newspaper inserts, community fairs or events, community meetings, shop fronts and informal club forums;
  + Consulting techniques such as online or in-person discussion groups and workshops, one-on-one interviews, open days, polls, road shows, and survey research; and
  + Active participation techniques such as action research, advisory committees, citizens’ juries, community reference groups, retreats, drama workshops, learning circles, design workshops, focus groups, participatory editing, precinct committees, partnerships for active participation, policy action teams, citizens’ panels, deliberative polling, summits, collective learning techniques (also known as World Cafes), community visioning and community cultural development.

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### **Nurture Your Community**

Your work is not done when your community is built. Continue to engage your volunteers to keep them actively connected to your project. Use techniques specifically tailored to your community to sustain participation.

* For [effective volunteer engagement](http://www.reimaginingservice.org/sites/default/files/Reimagining%20Service%20Summary%20Report%20Jan%202015.pdf), keep connections two-way and active. Following the [principles of community engagement](http://www.atsdr.cdc.gov/communityengagement/pdf/PCE_Report_508_FINAL.pdf), involve project participants in your planning discussions and reports of results, making sure they know they can speak up and interact. Make sure they know how their contributions to your project make a difference. When appropriate, providing project decision-making and governance opportunities to participants demonstrates respect for their contributions and garners trust.
* If your community uses [emerging technologies](http://www.esajournals.org/doi/pdf/10.1890/110294), use them to interact. As technology changes how people communicate, you might need to reach your project participants using new platforms. Make sure that your digital services meet [Federal requirements](https://www.digitalgov.gov/resources/checklist-of-requirements-for-federal-digital-services/).
* Evaluate how effectively your project connects to your partner communities and change your approach as needed. Consider how many project participants stay or leave, why they do so, and what they are getting out of your project.

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### **Be Sensitive to Socio-cultural Issues**

Try to engage a broad range of partners and participants from different backgrounds—the more diverse your input, the less likely you are to miss something important in your design or your data. Be sensitive to the social and cultural beliefs, concerns, and practices of your partner community.

Areas to think about include:

* **Sanctity of place.** Consider cultural and religious attitudes about particular locations, such as sacred sites. Be aware of restrictions on who can visit some places, requirements for how to behave, and the need to ensure historical, cultural, and environmental preservation.
* **Gender and age.** In certain communities, some people may be restricted from participating in certain activities or in certain places; for example, leadership roles in citizen science projects may be restricted to men or to those of a certain age. Interactions with certain age groups may require special cultural sensitivity; for example, it is considered extremely rude to interrupt an elder from many communities.
* **Ethnicity and race.** If you are working with particular ethnic or racial groups, you may benefit from including individuals from those groups on your team. It can make your project more welcoming, and your team can gain skills and unique insights needed for success.
* **Language.** Provide your project participants with information, tools and instruction in their native language(s). You may need local facilitators or members of the community to translate information.
* **Literacy.** Your community partners might have a range of literacy skills. If needed, provide materials in several formats (such as visual representations and audio instructions) so that those with low literacy can access and discuss the same information you’ve made available in writing.
* **Educational level and scientific knowledge.** Learn how much education your participants have and what they know about your project topic. Those with more scientific training may contribute needed skills and knowledge; they may even serve as full partners with academic researchers. Those with less may need additional training—but may also contribute new understanding of the community or project site, or ask questions that highlight gaps in your research planning.
* **Income and employment levels.** Some participants may have limited time to devote to your project, or require funding to help them cover the cost of transportation, child care, materials or meals.
* **Focus on listening.** Get to know your project participants, the culture of their community, and the best ways to communicate with them. Avoid assumptions, listen carefully, respect different ways of contributing to a project and be open to local needs and preferences.

[“[Step 3 – Build a Community](https://crowdsourcing-toolkit.sites.usa.gov/step-3-build-a-community/),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

## **Step 4 — Manage Your Data**

*Sourced directly from:* [“[Step 4 – Manage Your Data](https://crowdsourcing-toolkit.sites.usa.gov/step-4-manage-your-data/),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

Data collection is a primary goal of most citizen science and crowdsourcing projects; similar considerations apply to projects that focus on data processing, e.g., classifying image contents. Successful projects must ensure data quality, usefulness and preservation.

The following tips will help you get started:

* [Think of your data as an asset.](https://crowdsourcing-toolkit.sites.usa.gov/step-4-manage-your-data/#think)
* [Prepare a data management plan.](https://crowdsourcing-toolkit.sites.usa.gov/step-4-manage-your-data/#prepare)
* [Acquire your data.](https://crowdsourcing-toolkit.sites.usa.gov/step-4-manage-your-data/#acquire)
* [Process your data.](https://crowdsourcing-toolkit.sites.usa.gov/step-4-manage-your-data/#process)
* [Analyze your data.](https://crowdsourcing-toolkit.sites.usa.gov/step-4-manage-your-data/#analyze)
* [Share your data.](https://crowdsourcing-toolkit.sites.usa.gov/step-4-manage-your-data/#share)
* [Preserve your data.](https://crowdsourcing-toolkit.sites.usa.gov/step-4-manage-your-data/#preserve)

### **Think of Your Data as an Asset**

To ensure the usefulness of your data, think of it as an asset with a “[data lifecycle](http://www.usgs.gov/datamanagement/why-dm/lifecycleoverview.php)” of interlinked phases, including planning, acquisition, processing, analyzing, preserving and sharing. You will need to answer questions related to documentation, storage, quality assurance and ownership for each stage of the data lifecycle. At each stage, consider cross-cutting elements, such as description (including metadata and documentation), quality management, backup and security.

* Before starting your project, understand your data needs. Make sure that the data you collect will help you achieve your overall project goals
* Make sure that volunteers have the skills or training needed to collect or analyze data with the quality you need.
* Tailor the scope of your data collection to your project needs. Make sure you are collecting data over the right spatial area for the right amount of time. Sampling can be particularly challenging in citizen science due to natural biases, but thoughtful strategies can help avoid problems from oversampling some areas and undersampling others, for the right amount of time.
* Keep in mind potential legal and ownership issues associated with the data you collect. Figure out what types of data you will share, who owns it and who will have access. Make sure everyone involved in the project understands and agrees.

### **Prepare a Data Management Plan**

Planning for data management is closely related to the second “How To” step in this toolkit ([Design a Project](https://crowdsourcing-toolkit.sites.usa.gov/design-a-project/)). Write a data management plan to will help you evaluate what type of data to collect, how to collect it, and what additional resources you will need — plus it’s required under the Federal [Open Data Policy](https://www.whitehouse.gov/sites/default/files/microsites/ostp/ostp_public_access_memo_2013.pdf). You will need to take several general considerations into account before developing a specific data management plan.

* In your plan you should address:
  + standards, responsibilities and methods for data collection;
  + data description (metadata) and structure (schema);
  + data evaluation, quality assurance and quality control; and
  + methods for data hosting and preservation, sharing, statistical analysis and getting feedback
* Consider such questions as:
  + What data are you collecting? Do the data already exist?
  + Will you need to incorporate data from outside sources to meet your project goals?
  + Who is responsible for managing the data and the data management plan?
  + How will the data be collected?
  + What format will the data and their metadata be in?
  + How will the data be checked and certified?
  + What are all the likely uses for the data, who will use them, and what kinds of outputs will be needed?
  + How will the data be stored and backed up and for how long?
* Obtain any required institutional permissions or approvals– you may need to look at the [Paperwork Reduction Act](http://www.gpo.gov/fdsys/pkg/PLAW-104publ13/html/PLAW-104publ13.htm) and the Privacy Act, and/or consult with your [Human Subjects Board](https://en.wikipedia.org/wiki/Institutional_review_board). These may include requirements for data preservation or privacy protection.
* Obtain any needed permissions and waivers from volunteers, such as for potential future uses of the data they’ll be collecting or analyzing.
* Document your project’s policies, terms and conditions relating to privacy; to participation (such as age restrictions and physical requirements); and to data ownership, access and use. Make these policies available to participants in plain language.

### **Acquire Your Data**

You can acquire new data by collecting them, by adapting old data, by sharing or exchanging data and by purchasing data. In citizen science and crowdsourcing projects that involve data collection, volunteers typically record their empirical observations or use equipment such as cameras to create data. The more accurate your volunteers are in collecting data, the more credibility your project will have and the less work you’ll need to filter and clean up data later on.

* Whenever possible, use standardized protocols for data collection to ensure consistency and to help volunteers know what to do when. Test your protocols and questions in a pilot project to check how easy they are to understand, how easy they are to use and the accuracy of results. Expect to make at least two rounds of revisions prior to launching.
* Train your volunteers and give them the information they need to understand the data they are collecting, including easy-to-understand training materials. Consider creating a video; video training can be as effective as in-person training.
* Asking volunteers to take photos can give you a useful way to evaluate recorded observations or classifications and give feedback. The photos themselves can act as data, providing additional information beyond written or numerical responses.
* Be flexible. Consider a range of tools and approaches for collecting the data you need.
* Mobile devices can decrease errors by automatically and consistently collecting data such as time and location; they can also streamline the handling of photos and other sensor data. However, relying solely on mobile devices can limit collection in isolated areas or exclude people who can’t afford them.
* Consider applying a custom taxonomy or other standard, where appropriate, that allows observational data to be entered at varying levels of certainty. Some participants will choose not to submit data when they are uncertain of their performance, and can either be reassured or offered means of indicating certainty.
* Consider using many ways to collect data, particularly if your project requires participation from isolated communities or a range of socio-economic and age groups. (i.e., paper data sheets) Having options for both non-digital and digital input will allow everyone to participate. For example, participants might record observations with either an app or pen-and-paper questionnaires. If feasible, you can also provide data collection devices to volunteers, either permanently or on loan.
* To keep your database clean and ready to use, follow the standard practices of traditional data collection and data entry—for example, you can frame questions as multiple choice, or only accept responses as numbers within a certain range. This also reduces the likelihood of “spam” submissions and fraudulent data.

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### **Process Your Data**

Synthesize your data and present it in a meaningful format based on appropriate data standards. Federal policies for [open data](https://www.whitehouse.gov/sites/default/files/omb/memoranda/2013/m-13-13.pdf) and [open access](https://www.whitehouse.gov/sites/default/files/microsites/ostp/ostp_public_access_memo_2013.pdf) require that all data acquired for or funded by the Federal government be made accessible in standard formats and, if possible, in non-proprietary and machine-readable formats.

* Decide whether you can strengthen your project by collecting data from both technicians/researchers and the public. Structure databases in a parallel format so that multiple data sources can be easily combined.
* Bring in data from alternate sources, such as remotely sensed data or weather information, that can help you check volunteer-collected data.
* Be sure to look for outliers in your dataset, such as very large or small numbers, that might indicate an error.
* When you notice potential errors, check whether they are systematic in some fashion, e.g., a common data entry error that can be easily corrected with a quick email and an edit to the training materials. Document these issues and make adjustments appropriately.
* If the project requires a substantial shift in procedures that will affect comparability of ongoing data, document these changes and the rationale, and notify participants in plain language. If feasible, provide data with both the original values, and values adjusted to compensate for changed methods.
* Use best practices for data management. For example, rigorously document your processing methods to ensure the integrity of your data. Include details on data transformations such as merging values into ranges, as well as rules applied for correcting data, detecting false or unacceptable records, and omitting data from public view (e.g., altered location resolution for observations of sensitive species). Ensure that participant privacy is being properly protected in any data that are publicly accessible.

### **Analyze Your Data**

As in any scientific undertaking, analysis helps you document and describe facts, detect patterns, develop explanations, test hypotheses and check for error. Analysis of citizen science or crowdsourcing data isn’t necessarily different from analysis of data collected by other methods, and can vary widely depending on the nature of the study and type of data. Knowing how you’ll analyze data before you create your final collection plan is key–if you are not familiar with how to analyze data for your project, find expert partners who can help you ensure a good match between collection plans, analytic methods, and project goals.

* Measure or account for error. Consider having multiple people make observations so you can estimate the variance between observers. If recognized experts can provide some observations, you can also evaluate differences between traditional and volunteer data collection. When appropriate, samples or vouchers can provide additional means for verification, but requiring a priori evidence may be an unnecessary barrier in some cases.
* Many statistical frameworks require accounting for effort. Identify ways to account for the effort your volunteers put into making their observations, making sure that your ways of accounting for effort are appropriate for your analytical method.
* Some analytics specific to citizen science can quantify the cost savings from using volunteers. Document such data to help evaluate the quality and success of your project. Volunteer hours is one of the most comparable metrics across projects, and can be tied to effort reporting.
* Have a non-scientist review materials intended for the public before distributing them.

### **Share Your Data**

One goal of citizen science and crowdsourcing is to generate data that meets your organization’s needs for basic research, problem solving, policy making, decision support or education. You should maintain and share your data in a medium that people can find, understand and easily use in a variety of technical and non-technical contexts.

Both raw and processed data will require accurate metadata (descriptions of data); metadata provide essential information about datasets including their ownership, origins, purpose, content, scope and structure; methods of handling and processing the datasets; and legal constraints on their use. This information is critical to ensure that you fully understand your data, can readily evaluate them for quality and suitability, can successfully integrate them with other datasets, and can reuse or defend them if necessary.

* To the extent you can, figure out who will need your data or want to see them, whether it’s researchers, journalists, policymakers or a particular community.
* Decide on the most efficient, audience-appropriate and cost-effective ways of giving users the data access they need. Start by providing easy-to-use search and discovery tools.
* Consider how you can present and interpret your results to make them clear and understandable to your volunteers and other audiences. Translate results into plain language, use simple graphs and offer map-based visualizations where appropriate.
* Provide the simplest possible tools or methods for data visualization, evaluation and comparison, summary or abstraction (such as maps or GIS, statistical summaries and charts and graphs), and data download (such as CSV files for custom query results, as well as compressed packages of pre-selected, documented data).
* In sharing your data, know your organization’s standard review, approval and release policies. In particular, make sure to include controls to protect privacy, proprietary or other restricted information, and the integrity of the data itself.
* Make sure data recipients can access complete metadata and other documentation so that they can evaluate, replicate and make the best possible use of your results. Identify the sources, license, methods, and contents of the data.
* Make your data available for public use beyond your own immediate needs, in accordance with Federal requirements for [open data](https://www.whitehouse.gov/sites/default/files/omb/memoranda/2013/m-13-13.pdf) and [open access](https://www.whitehouse.gov/sites/default/files/microsites/ostp/ostp_public_access_memo_2013.pdf). Request (or require) that participants share original images under an unrestrictive license such as CC-BY that permit redistribution. Organize your data to be searchable. If necessary, restrict access to certain parts (for example, to protect physically or culturally sensitive collection sites or threatened and endangered species).

### **Preserve Your Data**

Plan to preserve your data for the long term, meeting the data retention policies and practices of your agency as well as of the National Archives and Records Administration. You can preserve your data by archiving it or submitting it to an authorized data repository. You should organize and document your datasets well enough for others to understand and reuse them long term. You should also promptly label and replace outdated information.

* Find an authorized data repository for the long-term storage of your data. One example is the U.S. Geological Survey’s [ScienceBase](https://www.sciencebase.gov/catalog/), which allows for storage of many different types of data and associated project information. There are also many repositories focused on specific topics and types of data.
* Arrange for the long-term storage of “archival” data — that is, data that remain important for future use but are no longer needed for immediate access.
* Prepare archival data by reviewing its metadata and documentation for accuracy, and making certain that potentially personally identifiable information about participants is properly managed.
* Consider how potential future users will discover that your archived data exist, along with the basics of what they contain. Make sure that your data are listed in catalogs or directories of data of similar types (such as [MoveBank](https://www.movebank.org/) for animal movement data) and in the appropriate Federal and agency open data catalogs (such as [Data.gov](http://www.data.gov/) and [Data.doi.gov](https://data.doi.gov/dataset)).

[“[Step 4 – Manage Your Data](https://crowdsourcing-toolkit.sites.usa.gov/step-4-manage-your-data/),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

## **Step 5 — Sustain and Improve Your Project**

*Sourced directly from:* [“[Step 5 — Sustain and Improve Your Project](https://crowdsourcing-toolkit.sites.usa.gov/step-5-sustain-and-improve/#flexibility),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

Successful citizen science projects require sustained participation and funding, as well as sound methods of evaluating progress toward goals. At each stage of your project you’ll need to plan for all the later stages, including documenting and preserving records and data for future use.

To sustain and improve the project, five elements are recommended:

* [**Adapt to cycles of participation.**](https://crowdsourcing-toolkit.sites.usa.gov/step-5-sustain-and-improve/#adapt)
* [**Solicit feedback from your participants.**](https://crowdsourcing-toolkit.sites.usa.gov/step-5-sustain-and-improve/#feedback)
* [**Evaluate the quality of your data.**](https://crowdsourcing-toolkit.sites.usa.gov/step-5-sustain-and-improve/#quality)
* [**Evaluate your participants’ engagement.**](https://crowdsourcing-toolkit.sites.usa.gov/step-5-sustain-and-improve/#engagement)
* [**Know how to end your project.**](https://crowdsourcing-toolkit.sites.usa.gov/step-5-sustain-and-improve/#end)

### **Adapt to Cycles of Participation**

Project participation levels can change over time or vary from person to person. Some people participate just once; others volunteer sporadically; still others are long-term participants. Then there are the “SuperUsers” — the small number who do a lot of the work. Do what you can to motivate volunteers to keep coming back, but recognize that “life happens” and sometimes people discontinue participation for unavoidable reasons.

* Remember that people’s [motivations change](http://hcil2.cs.umd.edu/trs/2011-28/2011-28.pdf), as do their life situations. To keep participants motivated, pay attention to their needs, tap into their personal interests and stay on top of any shifts in what they want from your project.
* Analyze user data to improve project participation. Don’t be discouraged if [most contributors participate only once](http://arstechnica.com/science/2015/01/most-participants-in-citizen-science-projects-give-up-almost-immediately/); instead, try to understand why so you can adapt management strategies, participation procedures, and analytical tactics.
* Reward your volunteers by giving certificates, prizes and other recognition to encourage them to keep coming back. Make sure to acknowledge their work; if possible and appropriate, attribute the work to them personally. Be aware that some participants may also prefer to contribute without recognition.
* If it’s suited to your goals, turn your project into something [fun and engaging](http://citizencyberlab.eu/research/gamification/) by [making it a game](http://crowston.syr.edu/sites/crowston.syr.edu/files/gamingforcitizenscience_ver6.pdf)! Examples include [EyeWire](https://eyewire.org/signup), [Fold-It](https://fold.it/portal/) and [Old-Weather](http://www.oldweather.org/). Recognize users who do well in the game by awarding badges, using visible leaderboards and giving other creative rewards — but also remember that good games must make the task fun even when success is a struggle. Be careful to avoid incentivizing “gaming the system” in an unproductive fashion, and be aware that some participants may be turned off by competition and game elements. The key lies in identifying what works best for your particular community, and being willing to adapt to meet their needs.
* Let your volunteers know how their work is making a difference. For example, [Galaxy Zoo](http://blog.galaxyzoo.org/2015/03/02/first-radio-galaxy-zoo-paper-has-been-submitted/) collectively acknowledged its volunteers in a scientific paper. By validating the work of your volunteers, you encourage them to keep coming back.
* Evaluate whether they may be able to contribute in a special role, such as reviewing others’ data submissions or moderating online discussions. Consider special recognition for SuperUsers, and find out what motivates them so you can recruit more.

### **Solicit Feedback from participants**

Participant feedback can help you evaluate your project and make needed changes. Your funding source might also require you to collect participant feedback.

* Collect feedback using tools that allow free text comments, such as collaboration-based websites or forums. If your project uses an app, make sure it lets you collect feedback from your participants, both for resolving technical issues and providing other input.
* Use [surveys](http://help.surveymonkey.com/articles/en_US/kb/5-Tips-for-Writing-a-Great-Survey) to encourage your participants to provide feedback. Find tools that make the results more quantifiable, and that that yield consistent results over time. Make sure to evaluate whether to secure human subjects approval based on your intended use of survey results.
* Incorporate useful feedback into your project and let your participants know why you are making those changes.
* Keep participant feedback throughout the life of your project and use it in overall project evaluation.

**Evaluate the Quality of Your Data**

How do you know if your project is accomplishing its goals? You can use project evaluation and metrics to continually monitor the quality of your data and outcomes.

* [Evaluate your project early](https://www.teamsciencetoolkit.cancer.gov/Public/Home.aspx) to make sure you’re on track to achieve your goals. Make project evaluation a routine part of your project.
* Measure your project’s outputs or activities, such as the amount of data or number of samples collected and the number of training sessions held or Web visits recorded. Keep records of changes to your methods of monitoring project health and productivity.
* Use metrics to detect problems with the quality of your data. Your metrics should be specific, measurable, attainable, relevant and time-bound.
* Quantify and account for systematic bias in your data.

### **Evaluate Your Participants’ Engagement**

Citizen science and crowdsourcing projects often have multiple goals and stakeholders. Some projects are designed to teach participants new knowledge and skills, or change how they act. In designing your evaluation strategy, take both data quality and participant engagement into account.

* Carefully [choose the right instrument](http://www.citizenscience.org/evaluation/instruments) for evaluation, taking into account your project goals and all the people and organizations with have a stake in your project.
* Evaluate the motivation levels of your volunteers and take steps to keep them well-motivated.
* [Measure how your participants change](http://www.citizenscience.org/evaluation/) over time — in their motivation, their level of interest in science and the environment, their self-confidence in participating in citizen science, their knowledge of the nature of science, their skills in scientific inquiry and their stewardship of natural resources. Choose the right instrument. Keep in mind that self-selected volunteers are less likely to show attitudinal changes than other groups, and learning may take many forms. for these measurements.

### **Know How to End Your Project**

When should your project end, in whole or in part? What do you do with the data you have gathered? The answers may lie in who funded you, who the participants are or what you are studying. After your project ends, a smooth transition will preserve what you’ve learned and protect the good reputation of your project’s brand.

* Make sure your volunteers understand why and when your project is ending. From the very beginning, give them a sense of the project timeline, with updates at regular intervals or milestones to remind them of project status. Good communication is key!
* Help your volunteers find other projects that might interest them.
* Keep your data safe and secure. If you do not share all data throughout the project, you can share data without contacting each person individually by uploading to a hub that all participants have access to, and sending a bulk notification.
* If necessary, get permission to continue using your data in the future. If the data includes personally identifiable information, find a way for those who contributed the data to share it with analysts.
* At the completion of the project, create a persistent public-facing presentation of the results rather than leaving a no-longer active project website to look abandoned.

*Sourced directly from:* [“[Step 5 — Sustain and Improve Your Project](https://crowdsourcing-toolkit.sites.usa.gov/step-5-sustain-and-improve/#flexibility),” Federal Crowdsourcing and Citizen Science Toolkit, citizenscience.gov, February 23rd, 2016.]

**Deliverable 7: Online inventory of resources**

**Federal Resources for Crowdsourcing and Citizen Science:**

* [The Federal Crowdsourcing and Citizen Science Toolkit](https://crowdsourcing-toolkit.sites.usa.gov/) provides essential information for those embarking on a crowdsourcing project.
* [Citizenscience.gov](https://www.citizenscience.gov/community/) is the home of the two primary groups within the federal government currently working to advance crowdsourcing and citizen science use and practice: (1) The Federal Community of Practice for Crowdsourcing and Citizen Science and (2 )the Agency Citizen Science and Crowdsourcing Coordinators.
* Resources from [DigitalGov](http://digitalgov.gov/), including:
  + [Opening Government Through Federal Crowdsourcing summarizes “the evolution and future direction of federal crowdsourcing initiatives as a whole,” including challenges and prizes.](https://www.digitalgov.gov/2014/12/30/opening-government-through-federal-crowdsourcing/)
  + [Crowdsourcing Month: An Overview](https://www.digitalgov.gov/2014/12/08/crowdsourcing-month-an-overview/): a series of articles highlighting programs that use a variety of online mechanisms for crowdsourcing, including hackathons, data jams, code-a-thons, prize competitions, workplace surveys, open ideation, micro-tasks or microwork, citizen science, crowdfunding, and more.
  + [Challenges & Crowdsourcing: A Quick Overview and Look Ahead gives an overview of strategies on how to engage potential crowdsourcing participants and citizen scientists.](https://www.digitalgov.gov/2015/12/08/challenges-crowdsourcing-a-quick-overview-and-look-ahead/)
  + [Challenges, Crowdsourcing, Citizen Science: What’s the Dif?](https://www.digitalgov.gov/2015/12/16/challenges-crowdsourcing-citizen-science-whats-the-dif/) defines citizen science vs. crowdsourcing, as well as internal ideation, open innovation competitions and crowdfunding, as they’re used by government agencies
* [Open Science and Innovation: Of the People, By the People, For the People](https://www.youtube.com/watch?v=J17uBahTdDE&feature=youtu.be): a video of a 2015 forum bringing together citizen science professionals, researchers, and stakeholders from local, state, Federal, and Tribal governments.
* [A 2015 workshop](https://www.genome.gov/27559982/) organized by the National Institutes of Health explored the ethical, legal and social implications of citizen science. The website includes videos and slides from the presentations, and a summary of tweets from the event.
* “[Fact Sheet: Empowering Students and Others through Citizen Science and Crowdsourcing](https://www.whitehouse.gov/sites/default/files/microsites/ostp/citizen_science_backgrounder_03-23-15.pdf),” The White House Office of Science and Technology Policy, March 23, 2015. Outline of steps taken by the Obama administration to increase student and general public participation the in science.

**Databases and Organizations:**

* [Citizenscience.org](https://citizenscience.org), the American Citizen Science Association, shares insights from citizen science across disciplines.
* [SciStarter](http://scistarter.com/about.html) is a useful database of citizen science projects.

**Multimedia content:**

[Gov Innovator Podcast](http://govinnovator.com/): Conversations on useful practices and insights from public sector innovators and experts, hosted by Andy Feldman, a Visiting Fellow at the Brookings Institution and former Special Advisor for Evidence-Based Policy at OMB.

* “Using online tools to engage citizens” with Matt Leighninger, executive director of the Deliberative Democracy Consortium

**Further Reading / References:**

* Bell, D., [*The Crowdsourcing Handbook*](http://dl.acm.org/citation.cfm?id=1803758), Emereo Pty Ltd., 2009. A How To on Crowdsourcing including hints and tips.
* “[The Future of Federal Citizen Science & Crowdsourcing: Strategic Recommendations for Advancing U.S. Federal Policies, Programs and Partnerships](https://www.wilsoncenter.org/sites/default/files/stategic_recommendations_full_file.pdf),” Wilson Center, 2016. Whitepaper on how federal gov’t uses crowdsourcing, funding sources, and ten strategic recommendations.
* Boudreau, K. and Lakhani, K., “[Using the Crowd as an Innovation Partner](https://hbr.org/2013/04/using-the-crowd-as-an-innovation-partner),” Harvard Business Review, April 2013.
* Surowiecki, J., *The wisdom of crowds : why the many are smarter than the few and how collective wisdom shapes business, economies, societies, and nations*, Anchor, 2005. This book explores the idea that large groups of people are superior to an elite few at ‘solving problems, fostering innovation, coming to wise decisions, and predicting the future.’
* Howe, J., [*Crowdsourcing : why the power of the crowd is driving the future of business*](http://www.worldcat.org/title/crowdsourcing-why-the-power-of-the-crowd-is-driving-the-future-of-business/oclc/176951599), Crown Business, 2008. An analysis of how the growing phenomenon of crowdsourcing reflects on the dramatic economic, cultural, business, and political implications.
* Gorman, J., “Counting birds at the grassroots: Making a census into “Citizen Science,” naturalists share their findings online,” New York Times, Dec 13 2001.
* Noveck, B. S., “[Could crowdsourcing expertise be the future of government?](https://www.theguardian.com/science/political-science/2016/nov/30/could-crowdsourcing-expertise-be-the-future-of-government),” The Guardian, November 30th, 2016.

**Selected Academic Resources:**

* Wiggins, A. and Crowston, K. “[From Conservation to Crowdsourcing: A Typology of Citizen Science](http://ieeexplore.ieee.org/document/5718708/),” System Science (HICSS), 2011. A paper identifying five types-Action, Conservation, Investigation, Virtual, and Education- that differ in primary project goals and the importance of physical environment to participation.
* Catlin-Groves, C. “[The Citizen Science Landscape: From Volunteers to Citizen Sensors and Beyond,”](https://www.hindawi.com/journals/ijz/2012/349630/abs/) International Journal of Zoology, 2012. Explores methods of data mining available datasets, and the blurring of the line between citizen science and citizen sensors.
* Schweitzer, F. et. al., “[Crowdsourcing: Leveraging Innovation through Online Idea Competitions,”](http://www.tandfonline.com/doi/abs/10.5437/08956308X5503055) Resource Technology Management (55), 2012. A. paper comparing the expense and results of online idea competitions with focus groups for idea generation in the market for senior citizen mobile phones and services.
* Galloway, A. et al., “The reliability of Citizen Science: A case study of Oregon White Oak stand surveys,” Wildlife Society Bulletin 34 (5), 2006.

**Deliverable 8: Examples of policy that has enabled or encouraged approach (legislation, exec order)**

* [S.3084 - American Innovation and Competitiveness Act](https://www.congress.gov/bill/114th-congress/senate-bill/3084), 114th Congress, December 2016. Stipulates that ‘Federal agencies may use crowdsourcing and voluntary, collaborative citizen science to advance their missions.’
* “[A Strategy for American Innovation](https://www.whitehouse.gov/sites/default/files/strategy_for_american_innovation_october_2015.pdf)”, National Economic Council and Office of Science and Technology Policy, October 2015. Outlines strategic plan for increasing American innovation.
* Holdren, J., “[Addressing Societal and Scientific Challenges through Citizen Science and Crowdsourcing](https://www.whitehouse.gov/sites/default/files/microsites/ostp/holdren_citizen_science_memo_092915_0.pdf),” Office of Science and Technology Policy, September 30th, 2015. Memorandum that outlines principles that agencies should apply in order to ensure the greatest value and impact of citizen science and crowdsourcing.
* “[Multi-Agency Science and Technology Priorities for the FY 2017 Budget](https://www.whitehouse.gov/sites/default/files/omb/memoranda/2015/m-15-16.pdf),” Office of Management and Budget, M-15-16, July 9th, 2015. Memorandum that encourages Federal agencies to consider incorporating citizen science and crowdsourcing into their programs, as appropriate.

**Non-Federal discussion of legal issues and policy:**

* Gelman, R., **“**[Legal Issues in Using Citizen Science](https://www.wilsoncenter.org/publication/crowdsourcing-citizen-science-and-the-law-legal-issues-affecting-federal-agencies),” Woodrow Wilson Center Commons Lab, April 20, 2015. A report by The Woodrow Wilson International Center for Scholars addressing some of the administrative, legal and ethical frameworks for using citizen science and crowdsourcing.
* [The citizen science Legal Policy page](http://www.birds.cornell.edu/citscitoolkit/toolkit/policy/legal-policy) offers a short summary of local laws, state laws, national laws, and other guidelines that govern the interactions between citizen science projects and their volunteers. developed by the Cornell Lab of Ornithology. [The Data Policy Guide](http://www.birds.cornell.edu/citscitoolkit/toolkit/policy/Bowser%20et%20al%202013%20Data%20Policy%20Guide.pdf/view) from Cornell Lab of Ornithology as offers useful information.
* Shanely, L. et. al., “[Tweeting Up a Storm: The Promise and Perils of Crisis Mapping](https://pacscenter.stanford.edu/sites/all/files/TweetingUpAStorm.pdf),” Programmetric Engineering & Remote Sensing, October 2013. Provides an overview of the ethical, legal, policy, and security issues of crowdsourcing in the context of disaster response and humanitarian assistance.
* Rak, A.,“[Legal Issues and Validation of Volunteered Geographic Information](http://www2.unb.ca/gge/Pubs/TR283.pdf),” University of New Brunswick Department of Geodesy and Geomatics Engineering, April 2013. A technical report that discusses the legal and data quality issues that arise when integrating volunteer-collected data with government datasets.
* Lieberstein, M. and Tucker, A., “[Crowdsourcing and Intellectual Property Issues](http://www.acc.com/legalresources/quickcounsel/caipi.cfm), ” Association of Corporate Counsel, August 29, 2012. This study addresses privacy/publicity rights and implied contract claims and how crowdsourcing projects can avoid pitfalls and minimize risk.
* Hoffman, S., “[Citizen Science: The Law and Ethics of Public Access to Medical Big Data](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2491054),” Berkeley Technology Law Journal, September 2014. This article analyzes the benefits and risks of health data sharing and proposes balanced legislative, regulatory, and policy modifications to guide data disclosure and use.

#### **Deliverable 9: Future directions (“next practices as opposed to best practices”)**

Based on interviews with experts in citizen science, in December 2016, the [Science and Technology Innovation Program at the Wilson Center](https://www.wilsoncenter.org/program/science-and-technology-innovation-program) issued a set of recommendations to further support the adoption of crowdsourcing and citizen science methods throughout Federal agencies, including:

* Creating a government-wide assessment of citizen science and crowdsourcing funding
* Creating a legal framework for conducting citizen science and crowdsourcing initiatives to eliminate administrative and legal grey areas, analogous to the role played by [The America COMPETES Act](https://www.gpo.gov/fdsys/pkg/PLAW-110publ69/content-detail.html) for spurring the use of incentive prizes and challenges: “For example, this framework could create a government-wide generic Information Collection Request (ICR) to facilitate the collection and use of data from large numbers of citizens (OMB and EPA have already negotiated a generic ICR; DOI and USGS are currently under negotiation with OMB). The framework could also define keywords like consent, data, and human subjects; and explicitly permit the use of funds appropriated by Congress for citizen science and crowdsourcing projects. “
* Noting and encourage the use of crowdsourcing methods in Dear Colleague letters as a precursor to grant making. (To date, U.S. agencies including the [National Science Foundation](https://www.nsf.gov/), [National Aeronautics and Space Administration](https://www.nasa.gov/), [National Oceanic and Atmospheric Administration](http://www.noaa.gov/), [U.S. Environmental Protection Agency](https://www.epa.gov/), [U.S. Geological Survey](https://www.usgs.gov/) and the [National Institutes of Health](https://www.nih.gov/) have included language in their [funding](https://www.usgs.gov/) calls.)
* Leveraging existing Federal Advisory Committees as an additional touchpoint to engage with stakeholders and solicit further input into citizen science and crowdsourcing work
* Including specific references to citizen science and crowdsourcing in thematic priority areas and strategic plans. For instance, the Department of Interior’s [Strategic Plan for FY2014 -2018](https://www.doi.gov/sites/doi.gov/files/migrated/pmb/ppp/upload/DOI-Strategic-Plan-for-FY-2014-2018-POSTED-ON-WEBSITE-4.pdf) outlines a mission area of “Ensuring healthy watersheds and sustainable, secure water supplies.” A sub-strategy that encourages the use of this method could read “To increase understanding of the state of watersheds, utilize citizen science and crowdsourcing for near real-time monitoring of water supplies on public lands.”[[1]](#footnote-1)

1. Sourced from [https://www.wilsoncenter.org/sites/default/files/strategic\_recommendations\_for\_Federal\_ccs\_0.pdf](https://www.wilsoncenter.org/sites/default/files/strategic_recommendations_for_federal_ccs_0.pdf) [↑](#footnote-ref-1)