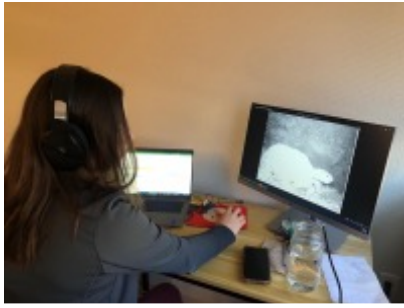
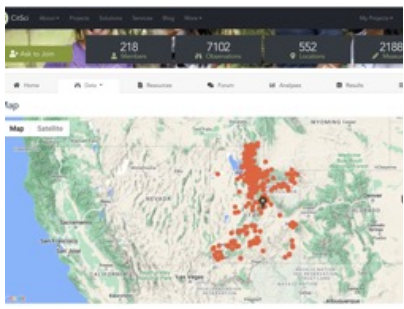
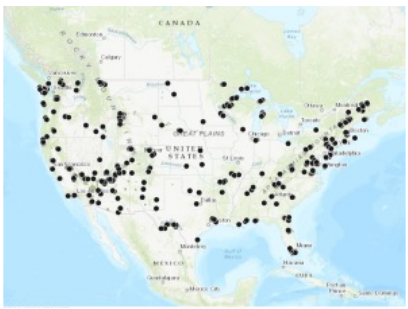




INTERAGENCY CITIZEN SCIENCE CASE STUDIES



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INTRODUCTION

This case study book is a companion to the Interagency Citizen Science Toolkit and training modules. When we started working on the toolkit and training modules, we set out to uncover and learn as much as we could about all of the citizen science projects that take place on federal lands or that are managed by federal land-based agencies. Through the citizen science coordinators for each agency, all of whom are partners in this endeavor, and through online searches, we identified projects that already embraced the teachings we hoped to impart. You will find these projects throughout the toolkit and training modules.

As we gathered project information—reading all available materials and interviewing project leaders for first-hand accounts of project intricacies—several projects stood out to us. These projects not only exemplify specific methods and best practices for citizen science, but are well-rounded examples of larger themes conveyed in the toolkit. This casebook is a compilation of 10 citizen science projects that offer highly applicable learnings and deserve more attention than we could give in the training modules or pages of the toolkit. Each case study comprises a summary of the project, a graphic highlighting the best practices exemplified by the project, and further reading. In the toolkit and training modules, you'll have the opportunity to learn about each in the context of our step-by-step guidance to building your own successful citizen science project.

We hope that you enjoy learning more about these projects as much as we did.

Sofia Corley
Project Researcher and Case Book Author

TRIBAL NATIONS BOTANICAL RESEARCH COLLABORATIVE

Tribal Nations Botanical Research Collaborative (TNBRC), an example of a community-based project, is a partnership among the US Forest Service (USFS), several Arizona Tribes, and Northern Arizona University that collects information on traditionally used plants with cultural, medicinal, or economic values important to Tribal communities.

The project began with the participants—Arizona-based Indian Tribes—who asked the USFS to work with them to develop the management protocols necessary to conserve identified species through restoration treatments. The treatments are conducted on the Four Forest Restoration Initiative (4FRI) project area. Initially, the 4FRI included restoration plans that posed a threat to traditionally harvested plants in the area, and the USFS lacked data on the locations of these species. Through this project, they prioritized the need to consider traditionally used plants in their 4FRI work in the Apache-Sitgreaves, Coconino, Kaibab, and Tonto national forests. Tribal members trained federal land managers about the cultural importance and uses of native plants so that Forest Service staff would understand the needs of the community to use and protect them.

Federal Land Management Agency and Partner Organizations:

USFS, Northern Arizona University (NAU), and Arizona-based Indian Tribes: Western Apache, Tonto Apache, Yavapai Apache, San Carlos Apache, White Mountain Apache, Hopi, Zuni, Havasupai, and Hualapai.

Goals:

- Provide Tribal members with harvest locations.
- Gather information on species status for federal land managers.
- Promote stewardship outside of the Tribe.
- Support Tribal connection to USFS lands.

Objectives:

- Enhance Tribal access to traditionally used plants.
- Enable 4FRI managers to develop management protocols to ensure long-term sustainability and availability of plant resources for Tribes.
- Provide data to researchers to devise scientifically based management and restoration protocols for these species.

Audience:

Tribal members, grade-school students, and outdoor enthusiasts.

Data-Gathering Tool:

iNaturalist

Data

Volunteers record observations of plants on a specified list using their mobile phones, and they analyze the data to shape conservation and land management goals for increased sustainability of these important plants. The project started in late 2018. By the end of 2022, more than 1,200 observers had made more than 4,000 observations of 35 species.

USFS Tribal liaisons share with Tribal members data collected by participants on the locations of wild-harvested plants. Project information and data are also publicly available on iNaturalist, although exact locations of plants are blurred to protect them from harvest by individuals who are not Tribal members.

Project data are used to strengthen actions taken to protect species of conservation concern. For example, species location information was used to create a species distribution model of Emory oak to support the Emory oak restoration project. Data also were used to create an R-code, which allows a user to enter the name of a species to view up-to-date information on its occurrence within the 4FRI project area. This tool allows Tribes to map harvest locations and to depict trends through time and also can be employed by USFS staff to suggest locations of favorable habitat.

Project data contributed to recommendations in the policy brief, "Culturally Significant Plant Species on USFS Lands – Options to Address Fair Access, Harvesting Rights, and Sustainable Management" (Colombo et al. 2021). Additionally, project data and management recommendations are summarized in the USFS project StoryMap and in the journal article "Use of Citizen Science to Achieve Multivariate Management Goals on Public Lands" (Souther et al. 2021).

TNBRC participants collaborating. Photo credit: TNBRC Facebook page

Standout Practices

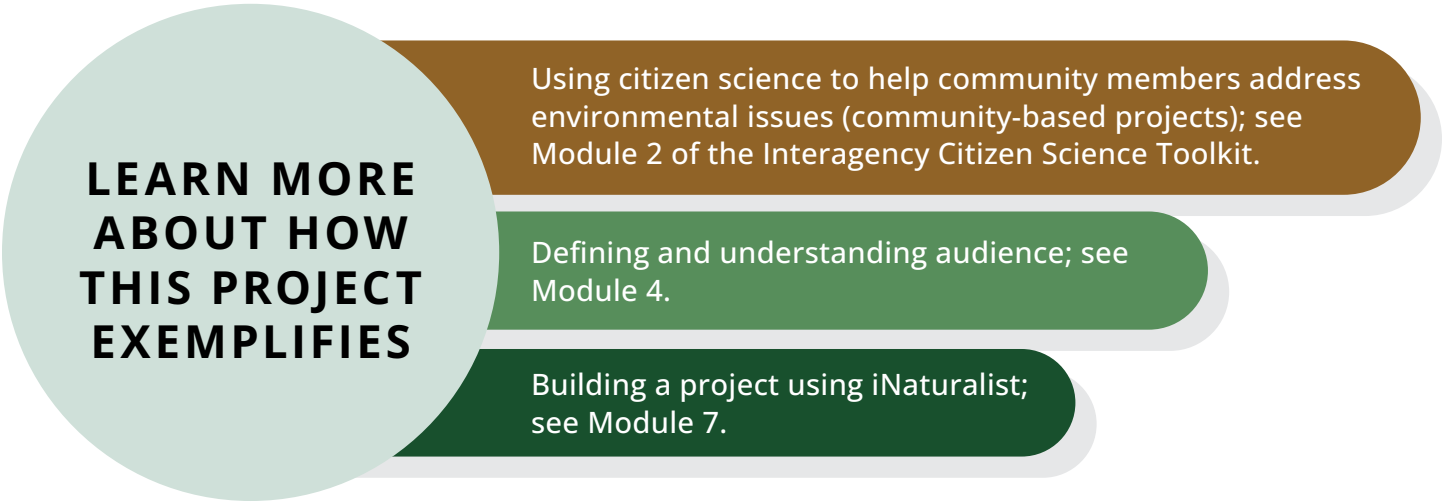
TNBRC did an exceptional job of obtaining and including feedback from participants during project design. In mapping the project structure, project leaders gathered the greatest concerns of the Tribes in 4FRI planning and used this as a base for deciding which data needed to be collected. Project planning meetings brought together project leaders (including researchers and USFS Tribal liaisons), Tribal leaders, and USFS staff members to make key decisions, such as a list of priority species. A final meeting was held to disseminate project findings to participants and to strategize research and management initiatives in partnership with 4FRI land stewards, NAU scholars, and members of the Tribes.

Takeaways

Throughout the project, leaders continually incorporated the values and perspectives of Tribal Nations by taking participant input into account. The project thus facilitated a productive exchange of information between Tribal leaders and land managers, which led to culturally informed management of the focal species and a deeper understanding of Federal Land Management Agencies' harvest rules among the Tribes. Tribal partners expressed their satisfaction with the results of the project, and project leaders deemed the project successful because of the enduring working relationship with their Tribal partners, which established replicable mechanisms for future collaboration.

Further Reading

- Colombo, S., Cruz, G., Stevenson, E.; Northern Arizona University Environmental Sciences & Policy Program. Culturally Significant Plant Species on USFS Lands – Options to Address Fair Access, Harvesting Rights, and Sustainable Management
- Souther, S., Randall, V., and Lyndon, N. 2021. The use of citizen science to achieve multivariate management goals on public lands. *Diversity*, 13(7), p.293. https://doi.org/10.3390/d13070293



DESERT AVICACHING

Desert Avicaching was created by the Sonoran Joint Venture (SJV) and the Bureau of Land Management (BLM). The project uses the concept of geocaching to engage birders in collecting data about migrant birds in the Mojave and Sonoran deserts from rarely visited locations where information about bird populations is typically not captured. Desert Avicaching is built on the eBird platform for ease of project delivery and to reach the large numbers of eBird users.

Federal Land Management Agency and Partner Organizations:

BLM, Point Blue Conservation Science, the Sonoran Joint Venture (SJV), eBird, Cooper Ecological Monitoring, Inc., and the Great Basin Bird Observatory.

Goal:

Fill gaps in species distribution data at infrequently visited and therefore under-birded locations in the Colorado and Mojave deserts of California to inform management and mitigation planning regarding alternative energy development in southern and eastern California.

Objectives:

- Determine spatial distribution and population status for Bendire's Thrasher and LeConte's Thrasher.
- Collect all-species avian migrant diversity and abundance data across Mojave and Sonoran desert habitats.

Audience:

Birders in California, local conservation groups, and local Audubon chapters.

Data-Gathering Tool:

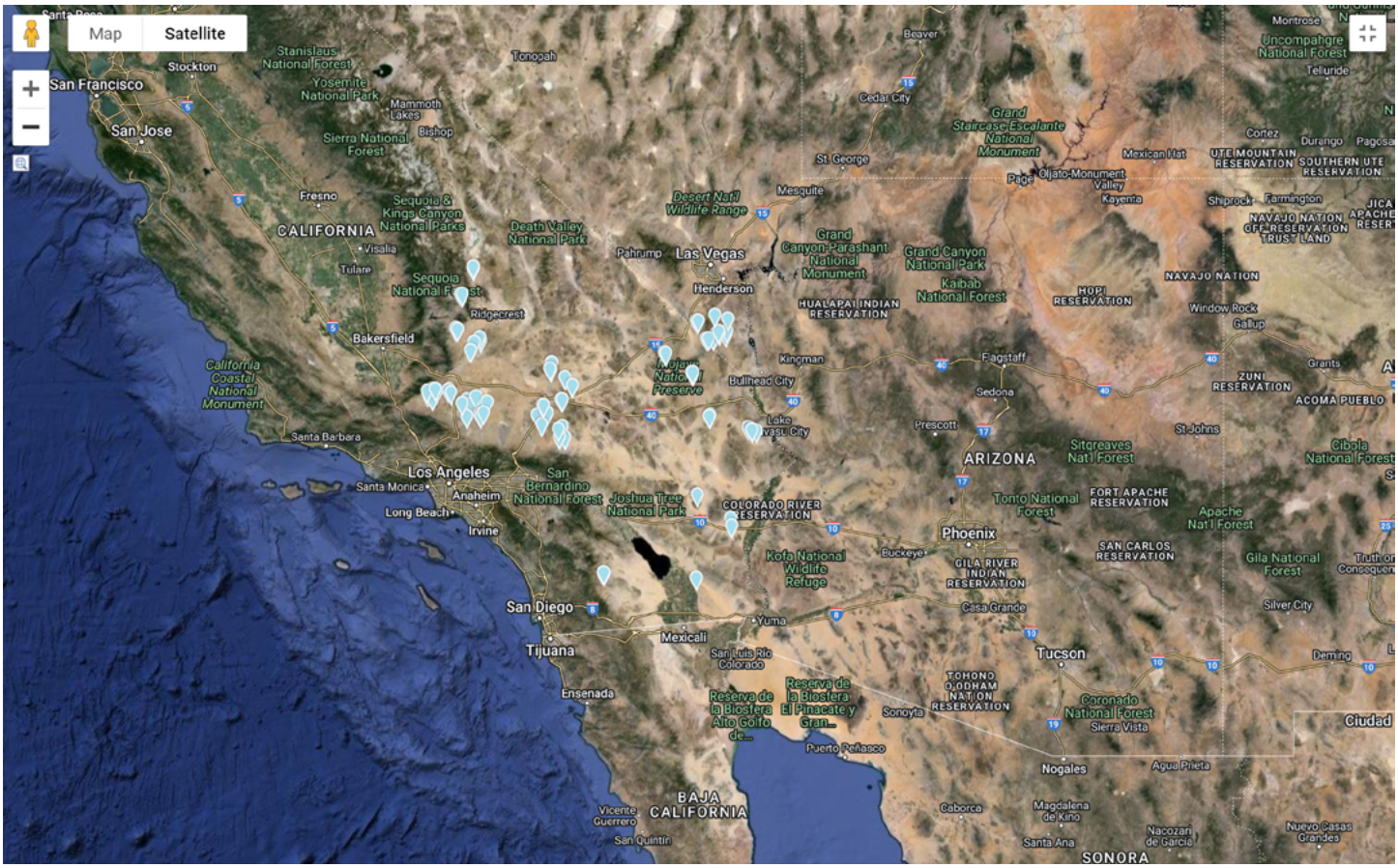
eBird

Data

Project data inform management and mitigation planning regarding alternative energy development in southern and eastern California. By encouraging volunteers to conduct eBird surveys at these remote locations, project leaders were able to improve species distribution models for evaluating threats to sensitive desert bird populations.

During the winter and spring of 2018, 72 observers submitted 409 checklists representing more than 500 cumulative survey hours. Observers reported more than 16,000 birds of 102 species in migration at 53 avicaching sites, which were chosen for their proximity to planned or operating solar facilities. Observers recorded up to 8 migrating individuals per minute at these sites. These data are being used in ongoing studies of migration and mortality around solar installations.

The data are shared publicly in a project report and in several articles posted to the SJV website.



Avicaching locations visualized via Google maps. Retrieved from: https://sonoranjv.org/desert-avicaching-coordinated-bird-monitoring/

Standout Practices

Desert Avicaching leaders were exceptionally effective in pinpointing gaps in their data, evaluating the factors contributing to their causation, and designing a project to fill those gaps. They identified a need for data on birds in remote areas, particularly migratory species, and realized that they could collect these data using eBird surveys from volunteer birders. However, project leaders recognized that recreational birders typically survey in accessible areas, such as near roadways, and would therefore need to be incentivised to do otherwise. To entice

volunteers into collecting the desired data on under-visited areas of the Mojave and Sonaran deserts, project leaders employed the unique approach of building a game on the eBird platform. With it, a publicly available leaderboard was set up to reflect the number of surveys submitted by each birder, granting a higher number of points for surveys submitted at priority survey (avicaching) locations.

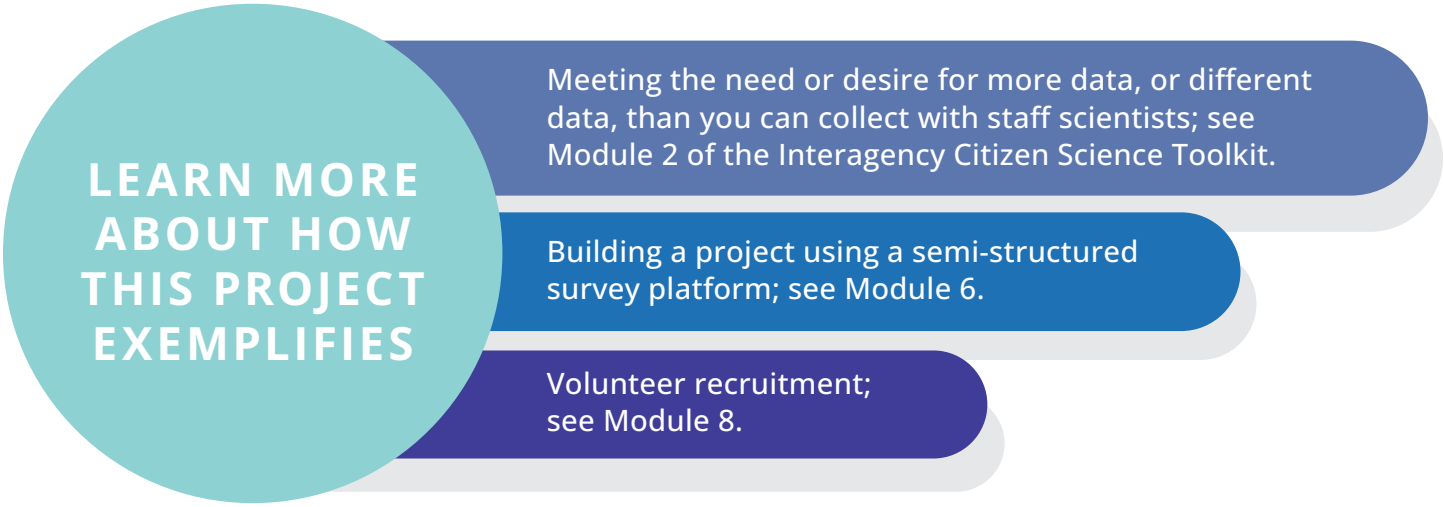
To recruit participants, the SJV started by creating a bilingual webpage hosted on the SJV website that provided background information on the game, objectives, rules, map of the Desert Avicaching locations, potential prizes, and a real-time leaderboard to keep track of volunteers' scores. The SJV published two articles, one hosted on its web page and promoted through its newsletter and one on the eBird website, and they developed a social media toolkit to share with their partners that offered guidelines for how to promote the game on social media outlets. The toolkit included a series of suggested posts and graphics for partners to use on their websites and in social media accounts. The SJV made sure to "tag" its major partners (Point Blue, Great Basin Bird Observatory, BLM) as well as the prize sponsors to reach a larger audience, and they developed a series of hashtags for maintaining wording consistency in tracking project use.

Takeaways

Project leaders analyzing data trends discovered that while a few volunteers submitted most of the checklists, the volunteers generally fell into two categories: those submitting surveys regularly and intensively, and those submitting fewer, sporadic surveys. Although every survey location in the Desert Avicaching game was allotted equal points and received equal levels of promotion, only 53 of 91 avicaching sites were surveyed. The distribution of submitted surveys, heavily concentrated in one county near population centers, suggested that future project participation is likely to be highest in areas close to where volunteers reside. This spatial pattern provides insights for planning future project iterations.

Further Reading

McCreedy, C. 2018. Desert Avicaching, Results and Discussion from the 2018 Season. Point Blue Conservation Science. https://sonoranjv.org/wp-content/uploads/2020/06/DESERT-AVICACHING-REPORT_2018.pdf



SAGUARO CENSUS

The Saguaro Census is led every ten years by Saguaro National Park to study the long-term health and vitality of the park's namesake cactus. Begun in 1990 and developed into a citizen science project in 2000, the census aims to understand the impact of environmental factors such as fire, drought, and climate change on saguaro health, distribution, and survival. It also aims to build greater awareness of long-term ecological processes through its citizen science approach.

Federal Land Management Agency and Partner Organizations:

National Park Service (NPS), Friends of Saguaro National Park.

Goal:

Study the long-term health and vitality of saguaro cactus throughout Saguaro National Park.

Objectives:

- Detect changes in cactus distribution that may be related to climate or other landscape-level processes.
- Study saguaros on randomly distributed study plots across a wide elevation gradient.
- Train volunteers to collect data: Search for, measure, and flag all saguaros encountered along belt transects within each plot.
- Analyze data and make them available on the park's website.

Audience:

Saguaro National Park visitors and local community members.

Data-Gathering Tool:

Bespoke

Data

Saguaro Cactus Census data are used to develop research grants and to share with other scientists, for example, at gatherings such as the 2023 saguaro research symposium. In addition, the accumulation of data over a long timescale allows ecosystem-wide understanding that can have implications from policy decisions to educational endeavors. For example, the results of the 2020 Census confirm the patterns that emerged from the 2010 Census. The large number of relatively young saguaros just beginning to reach reproductive age is a positive sign and reflects the survival of many saguaros that germinated throughout the park from roughly 1970 through 1990. This is offset, though, by a smaller establishment of saguaros since the 1990s, which appears to be strongly associated with drought that is probably driven by temperature extremes. Census data also are used on a daily basis for interpretive programs and to answer questions from the media—from local to international—about how the saguaros are doing and how they are responding to climate change.

Standout Practices

Saguaro Census project leaders harnessed their understanding of their audience, which consists of park visitors and local community members, to facilitate an effective citizen science project. This understanding guides their larger efforts to increase public excitement about science and to encourage project participants to establish a first-hand understanding of the scientific processes involved.

Saguaro Census participants in the field. Photo credit: NPS, Public domain

Specifically, staff used this knowledge to direct their recruitment and engagement efforts. Recruitment largely utilized social media posts and news articles as outlets to relay information about the project to the public. The Saguaro Census Project regularly provides updates through its social media pages, especially on Facebook and Instagram, and some of their Instagram posts have reached more than 50,000 people. They also developed a range of interpretive products ranging from brochures to refrigerator magnets to recruitment posters, and they've given a number of community talks, school pre-visits, and presentations to interpreters. As a result, the project received significant media attention, with two front-page articles in the *Arizona Daily Star* and an episode on local public television's *Arizona Illustrated*. The Census was also featured in an article on saguaros and climate change in the *Washington Post*.

Takeaways

One of the main goals of the project's volunteer engagement is to provide a hands-on learning experience for its participants. For Saguaro National Park biologist and Saguaro Census project leader Don Swann, this is an important focus of the project because it communicates a larger message that science is about process. According to Swann, citizen science projects like the Saguaro Census encourage participants to focus on understanding how data are collected and used, rather than whether they agree with the implications of the data—such as the causes of climate change.

To maximize Saguaro National Park's citizen science engagement, Swann works to better understand the different types of people who visit the park and what factors might encourage them to get involved in citizen science. In efforts to reach a wider audience, Swann searches for ways to connect with all park visitors in a meaningful way, rather than focusing on those who are already interested.

Further Reading

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- Winkler, D.E., Conver, J.L., Huxman, T.E., and Swann, D.E. 2018. The interaction of drought and habitat explain space–time patterns of establishment in saguaro (*Carnegiea gigantea*). *Ecology*, 99(3), 621–631. https://doi.org/10.1002/ecy.2124
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- O'Brien, K. and Swann D.E. 2021. Three Decades of Ecological Change: the 2020 Saguaro Census Part I: Changes in the Saguaro Population 1990–2020 Report to Western National Park Association, Part I of Projects #19–06 and #20–09. http://npshistory.com/publications/sagu/saguaro-census-2020.pdf
- Fule, E., Beckman, D., and Swann, D.E. 2021. Three Decades of Ecological Change: the 2020 Saguaro Census Part II: Changes in the Plant Community Report to Western National Park Association, Part II of Projects #19–06 and #20–09. https://wnpa.org/wp-content/uploads/2023/10/SAGU-Research-2020-09-Three-Decades-of-Ecological-Change.Part-2.the-2020-Saguaro-Census.pdf.pdf

LEARN MORE ABOUT HOW THIS PROJECT EXEMPLIFIES

Building projects around goals and objectives; see Module 3 of the Interagency Citizen Science Toolkit.

Sharing your results with the wider world; see Module 9.

ENGAGING ANGLER SCIENTISTS

Engaging Angler Scientists is run by Trout Unlimited (TU) in collaboration with the US Forest Service (USFS) to inform management of brook trout on national forest lands. Participants conduct spawning (redd) surveys and monitor the effectiveness of Aquatic Organism Passage (AOP) projects.

Federal Land Management Agency and Partner Organizations:

USFS and TU.

Goal:

Restore brook trout spawning habitat by managing aquatic connectivity throughout national forests.

Objectives:

- Develop a redd (spawning nest) survey protocol, database, and mobile data collection application and test their effectiveness in Michigan and Pennsylvania national forests.
- Train participants to use the protocol and app to conduct surveys and aquatic barrier assessments in Michigan and Pennsylvania national forests.
- Create a handbook for conducting redd surveys for other TU chapters and USFS staff to reference when developing and running their own redd surveys.

Audience:

Anglers, local fishing guides, and other local people who rely on the rivers for their livelihoods.

Data-Gathering Tool:

ArcGIS Survey123

Data

TU, USFS, and their partners use barrier assessment data to evaluate which stream reconnection projects to prioritize. For example, volunteers have assessed the impacts of road infrastructure on fish passage and sediment pollution in coldwater streams, and the data have been used to prioritize management actions, such as the development of culverts, to minimize these impacts.

To inform management of brook trout on national forests in Michigan and Pennsylvania, anglers have conducted redd surveys, identifying key habitats for reproduction of coldwater fish. Following completion of the redd surveys, TU staff emailed results to participants with some interpretations of what they saw. Results are also visualized using maps in the Redd Survey Handbook, which show redds displayed as points before and after barrier removal and redd observations displayed in density by stream section. These maps are frequently used in presentations and displayed on TU's website.

Standout Practices

Engaging Angler Scientists is an example of a project with strong training programs. To reduce observer errors owing to inexperience and the challenges of observing redds in turbid waters, project staff hold workshops for monitoring certification. In addition, many online training tools are available to volunteers, including videos, tutorials, publications, and a FAQ page.

Engaging Angler Scientist participant enters data into a mobile application. Photo credit: Jeff Yates

Engaging Angler Scientists is also a great example of a project that has successfully developed reusable data practices. This project created a mobile application and database for redd survey data as well as a redd survey protocol and handbook, which can be used by any groups wanting to set up redd surveys.

This project allowed TU to create tools to support other TU chapters and other organizations in conducting similar assessments with citizen scientists. These include:

- the Redd Survey Handbook, an instructional guide for brook trout spawning surveys; and
- a spawning survey database and Redd Survey Map Application developed using ArcGIS Survey123, which automatically collects the relevant GPS data when a redd observation is made.

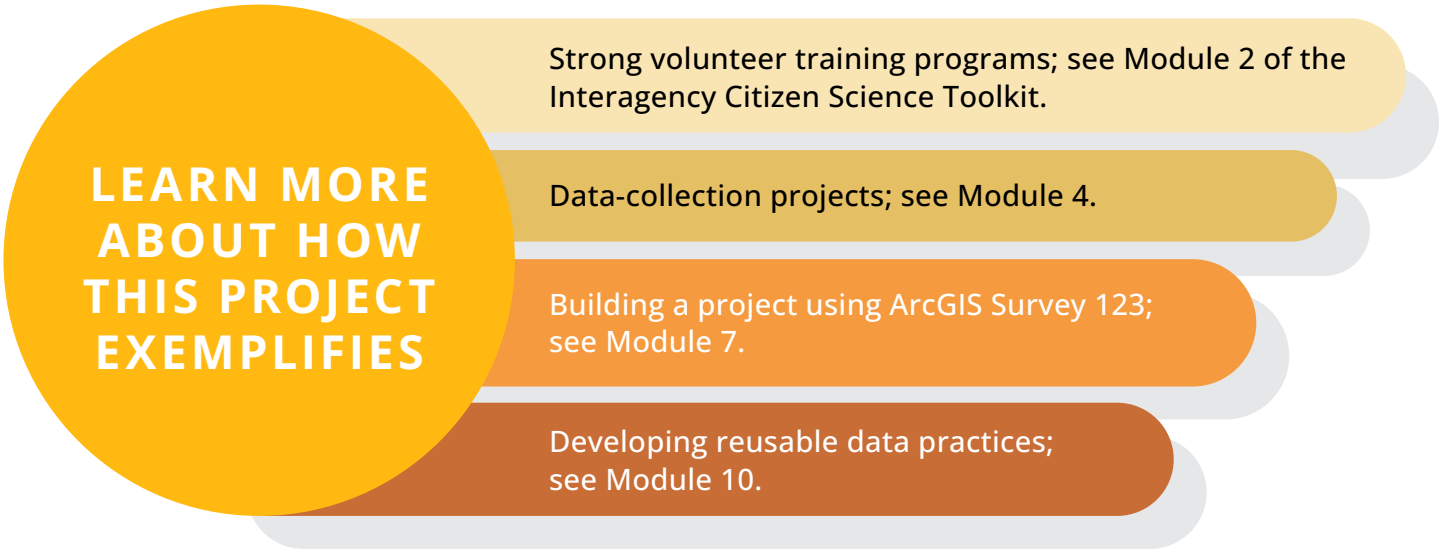
Takeaways

The project's effectiveness can be somewhat attributed to the dedication of the people involved.

In each forest, project designers consulted with local anglers, fishing guides, and other people who rely on the rivers for their livelihoods. These individuals helped to identify the types of anglers whom they felt would be interested in collecting data, and they even helped to design surveys so that their methods would be of interest to local anglers. They also identified focal areas for the surveys and promoted the program among their peers. Through this program development strategy, the project developers gained a deep understanding of the project audience and how to work with its members.

Further Reading

Lemon, J. and Rummel, S. Redd Survey Handbook. https://www.tu.org/wp-content/uploads/2020/01/Redd-Survey-Handbook-v1_w_appendices.pdf



ALABAMA WATER WATCH

Alabama Water Watch (AWW), a project of the Alabama Extension Service, operates a network of volunteer water quality monitors across Alabama. The US Forest Service (USFS) has established a partnership with AWW to monitor the health of watersheds across the four national forests in Alabama (NFAL). Participants gather data to inform the USFS Watershed Condition Framework.

Federal Land Management Agency and Partner Organizations:

USFS and AWW.

Goal:

Collect water quality data to establish a baseline of water quality in NFAL's future priority watersheds, which will be monitored to ensure that clean water is provided to the forests, their ecosystems, and the public.

Objectives:

- Identify stream locations in NFAL to sample water quality monitoring data to establish a baseline for restoring watershed resiliency.
- Train and support citizen scientists in collecting water quality data and storing data in the AWW database.
- Analyze citizen-collected data to assess and manage NFAL's watersheds.

Audience:

Urban and rural youth and adults, retired citizens, outreach specialists, educators, and community groups.

Data-Gathering Tool:

Bespoke

Data

Water monitoring observations are used to create a baseline of water quality in Alabama's current and future priority watersheds. This information helps the USFS ensure that it is providing clean water to the state's forests, ecosystems, and the public. USFS uses data to inform water management decisions in NFAL, such as watershed assessments and restoration plans.

To communicate its accomplishments, NFAL's soil scientist Estella Smith created a StoryMap using ESRI ArcGIS that summarizes the data collection process and the volunteer engagement aspect of the project. The tool was geared toward other USFS staff and the public with the intent to spark their interest in citizen science by conveying its usefulness. Data are publicly available through the Water Data section of the project website, which hosts a data interactive map, table, and additional data visualization tools. To directly relay the project's results, project leaders conducted a data interpretation session where they reviewed project goals and summarized the collected data.

Standout Practices

AWW is an example of a project with excellent volunteer training. Staff conduct in-person, multi-day workshops that provide an overview of the project and go over information related to the water environment, forest and watershed health, pollution, and water quality standards. During the second day of each workshop, participants conduct monitoring at a national forest. Forest Service district staff give presentations that highlight the ecological history, flora, and fauna of the particular forest. They also provide volunteers with additional safety guidelines and protocols for working in the forest and certify the volunteers as water chemistry and

AWW Program Director and Project Co-Leader Mona Dominguez teaches an AWW workshop. Photo credit: Sydney Zinner, AWW

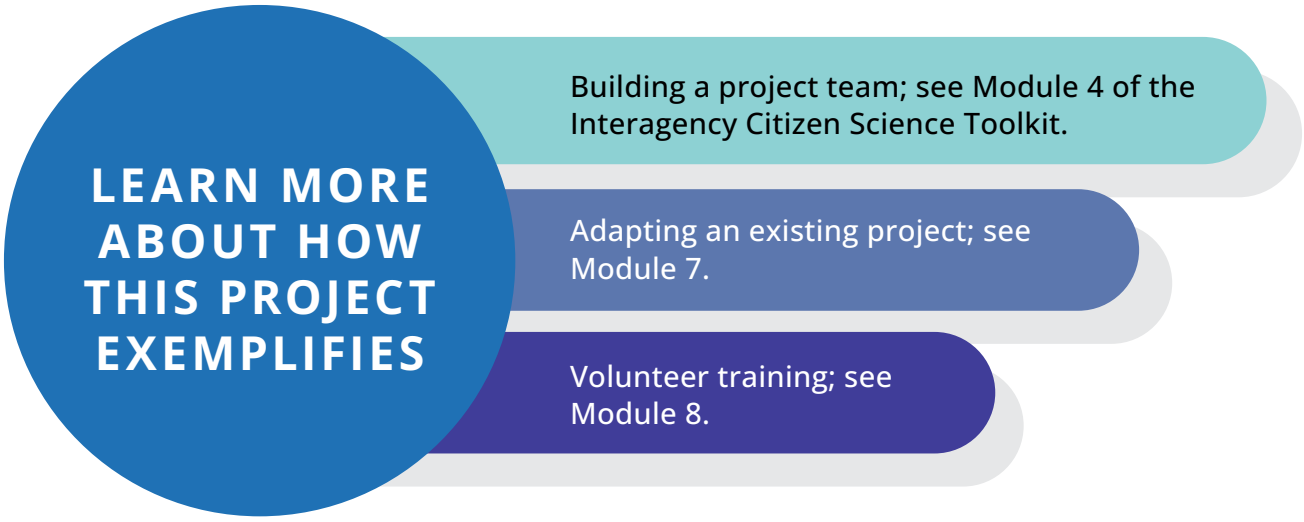
bacteriological monitors. Each workshop takes about 10 hours and includes a visit to the local US Department of Agriculture Forest Service Ranger District Office. Approximately one year after their initial certification, volunteer monitors must complete recertification requirements including a short training session or online test, depending on the monitoring type. After the initial recertification, volunteers are required to recertify every two years.

Takeaways

This mutually beneficial partnership harnessed the specialized roles within the partner organization which allowed USFS to establish a baseline of reliable and replicable monitoring data. Looking to compensate for their shortage of personnel and resources needed for monitoring, USFS staff approached AWW, an organization known for their strong capability to collect sound hydrological monitoring data. In exchange, the project provided AWW with an opportunity to grow their volunteer network and reach new audiences they might not otherwise engage. AWW leaders saw the project as a new way to ensure their volunteers felt their data collection efforts were of use, a challenge that AWW leaders believe can exist in many citizen science projects. Thanks to NFAL, this project had a predetermined use for the data, which AWW made clear to volunteers from the start.

Further Reading

Smith, E. and Alabama Water Watch Staff. 2022. National Forests in Alabama Citizen Science Project https://storymaps.arcgis.com/stories/cc3320c26279475194e12403b41337af



COLORADO BAT WATCH

Colorado Bat Watch (CBW) was started by Rocky Mountain Wild (RMW) to monitor Colorado bat populations in response to current and emerging threats, especially from white-nose syndrome (WNS), which has killed millions of bats in the eastern and midwestern US since 2006. Volunteers report bat roost site locations and help conduct emergence counts, especially at maternity roost sites, as a means of understanding impacts of WNS on local populations.

Federal Land Management Agency and Partner Organizations:

USFS, RMW, Colorado Parks and Wildlife, and Colorado Natural Heritage Program.

Goals:

- Provide reliable data to meet multi-agency bat monitoring needs across the state.
- Inform efforts to address current and emerging threats to bat populations.
- Build public support for bat conservation.
- Increase the capacity of partners to address pressing bat research and conservation needs in Colorado.

Objectives:

- Collect baseline data on roost site locations and characteristics, with emphasis on roost sites in anthropogenic structures, talus, trees, and snags.
- Make data on bat roost sites available to agency partners.
- Engage volunteers in monitoring at bat roost sites.
- Generate media around the project and hold trainings and educational events to recruit the public to participate and to teach the public about the value of bats and their conservation.

Audience:

Colorado public with a focus on underserved communities, outdoor enthusiasts, agriculture professionals, students and teachers, partner organizations' volunteers, wildlife and conservation organizations, and their supporters.

Data-Gathering Tool:

Data are stored online in Survey123, then integrated into the NABat database for sharing.

Data

CBW is adding essential capacity to bat research and monitoring efforts throughout the state by addressing research and management needs unmet by existing efforts. Data can be used by all stakeholders, informing research and management efforts for each agency. Furthermore, the project continues to identify opportunities for synergy with NABat.

Phase I of CBW was launched on International Bat Appreciation Day, April 17, 2023. Since then, nearly 50 observations have been submitted to the project's database, providing information on the location and characteristics of bat roost sites throughout Colorado. Phase II of CBW involves conducting emergence counts, that is, counts of the number of bats emerging from a roost in the evening at select roost sites. Data from Phase I informs Phase II of the project, in which volunteers conduct long-term monitoring to gauge the impact of WNS and other emerging threats on local bat populations in Colorado. One potential outcome of both datasets is the identification of sites to test WNS vaccines.

Utilizing the NABat framework as a foundation for monitoring protocol, CBW fosters a greater understanding of bat species' distributions and population trends, not only in Colorado, but across North America. The knowledge gained will help land managers and biologists create and implement bat conservation plans in Colorado, such as the US Forest Service (USFS) Region 2's 2013 White-Nose Syndrome Adaptive Management Strategy Environmental Assessment, the Colorado Parks and Wildlife White-Nose Syndrome response plan, and the 2018 Colorado Bat Conservation Plan prepared by the Colorado Bat Working Group and the Colorado Committee of the Western Bat Working Group.

Standout Practices

The project leads have prepared a robust and multifaceted plan for this project, which is well worth reading for anybody who is designing a citizen science project, as the plan covers in detail most of the topics covered in this toolkit (Singer et al. 2020).

In developing the plan, the project leads at RMW researched multiple stakeholders including the USFS, Colorado Parks and Wildlife, and the Colorado Natural Heritage Program. For example, information was obtained from the 2018 Colorado Bat Conservation Plan, the USFS Region 2's 2013 White-Nose Syndrome Adaptive Management Strategy Environmental Assessment, Colorado Parks and Wildlife's White-Nose Syndrome Response Plan,

Example of a bat roost, such as those that participants monitor. Photo credit: NPS, Shawn Thomas, Public domain

Colorado State Wildlife Action Plan, NABat, the Western Bat Working Group, and the Colorado Bat Working Group, and the needs and requirements of all stakeholders were incorporated into the program.

The project reached out directly to stakeholders during this process. Early in the project design process, the team organized a collaborative meeting with the USFS, Colorado Parks and Wildlife, and the Colorado Natural Heritage Program during which agency staff provided input to inform development of the Bat Watch implementation plan. The team also continually solicited input from agency partners via email and conference calls on various aspects of the project plan including data sensitivity.

Takeaways

CBW is built on a strong partnership with RMW agency partners at the USFS, Colorado Parks and Wildlife, and Colorado Natural Heritage Program. RMW has leveraged partner resources such as agency and partner staff time, biological and resource expertise, and interns from local universities such as Colorado State University and the University of Colorado. RMW staff has identified and collaborated with additional partners such as the U.S. Geological Survey (USGS) and NABat to inform development of protocols to facilitate nationwide bat colony monitoring by community scientists, and have identified additional funding sources for the project such as an Adopt a Bat program run by RMW. RMW has formed additional community partnerships, such as with Larimer County Open Space and Denver Public Library Montbello Branch, and continues to look for other potential partnerships to grow their volunteer base with an expressed focus on engaging diverse audiences throughout Colorado.

Equally important, as protocols were field tested and data collection began, staff realized that the project needed additional objectives. These new objectives (shared in Module 3 of the Interagency Citizen Science Toolkit) emphasize the need for a project to be flexible and to change over time as a project comes to life or as it encounters “real-world conditions,” and they are emblematic of the changing and adaptive nature of good citizen science.

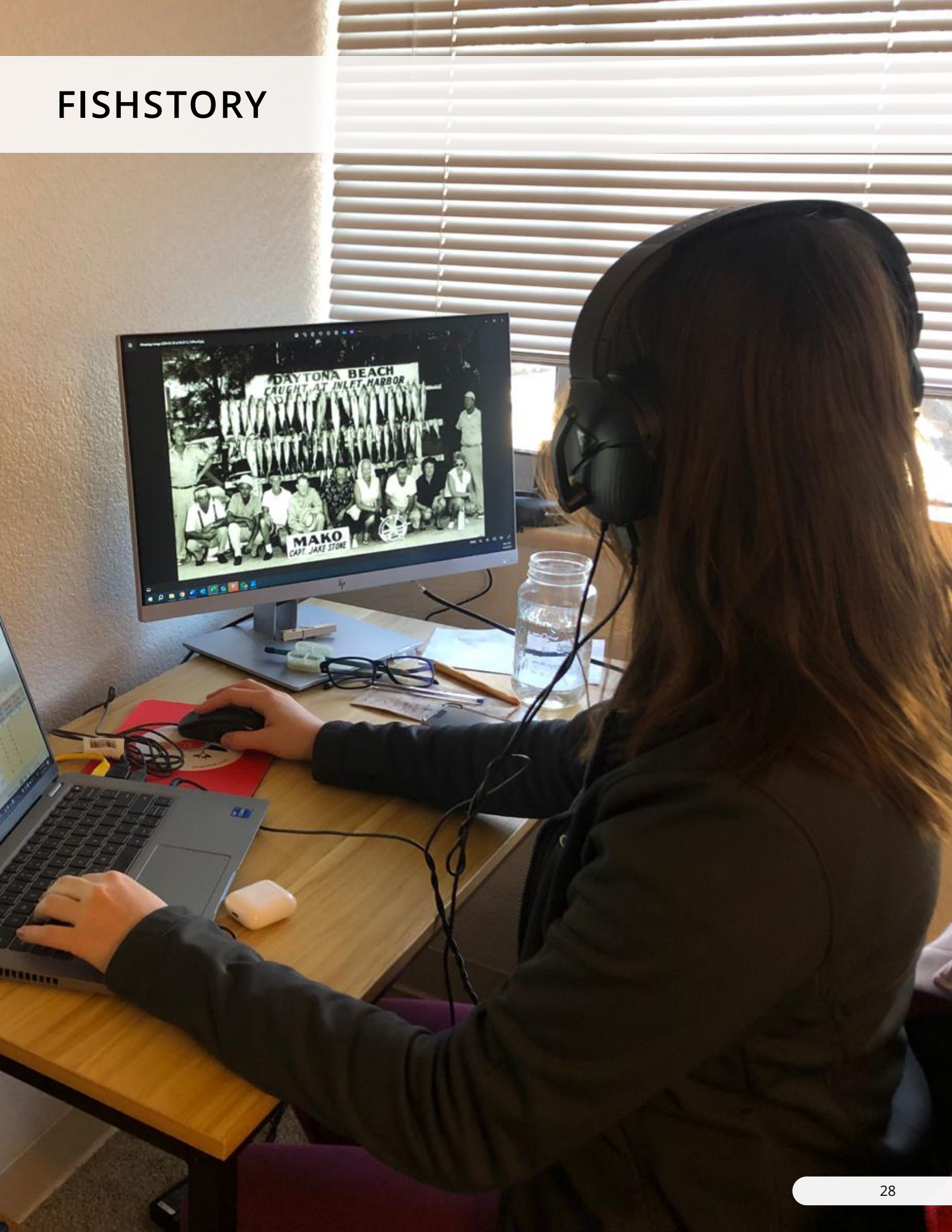
Further Reading

Singer, P., Dressen, M., Mueller, M., and Colbert, S. 2020. Citizen Science Project Plan for Colorado Bath Watch on the Routt and Pike National Forests. USDA Forest Service.

LEARN MORE ABOUT HOW THIS PROJECT EXEMPLIFIES

- Building projects around goals and objectives; see Module 3 of the Interagency Citizen Science Toolkit.
- Considering stakeholders early in the project design process; see Module 5.

FISHSTORY



FISHstory is a data organization and analysis project run by the South Atlantic Fishery Management Council (SAFMC) and built on the Zooniverse platform. Project volunteers examine historic photos of dockside fish catches taken prior to the 1990s when regular monitoring of fisheries began. Participants classify and document the species and lengths of fish shown in the photos, which were provided by recreational fishermen, restaurants, libraries, marinas, state agencies, and other members of the public. The information provides insight into historic fishery conditions, which is useful for current fisheries management.

Federal Land Management Agency and Partner Organizations:

US Fish and Wildlife Service (USFWS) and SAFMC.

Goal:

Aid in setting fishery management regulations by filling gaps in historic catch data through comparing historic photos for seasonality and size of catches as well as individual fish sizes over decades.

Objectives:

- Digitize and archive historic fishing photos.
- Analyze historic photos to estimate catch composition and effort.
- Develop a method to estimate fish length in historic photos.

Audience:

Anglers in the South Atlantic region of the United States.

Data-Gathering Tool:

Zooniverse

Data

Project data show changes in overall catch composition and seasonality of catches over past decades, and reveal whether the sizes of fishes caught over time have changed. This information can be used to inform both historical and current fishery stock assessments.

FISHstory data are publicly available on both the SAFMC FISHstory webpage and the Zooniverse projects webpage. The SAFMC webpage directs people to view project results via a Zooniverse webpage link or via a link to an SAFMC presentation (recorded webinar). SAFMC also summarizes key findings from FISHstory (and their other projects) in their Citizen Science Program's 2022 Annual Report, which can be accessed from their website.

The Zooniverse Projects webpage has links to project results in various formats:

- a statistics page;
- a results page, which contains key findings with graphics; and
- a research page, which explains the background and significance of the project.

A FISHstory example photo. Photo credit: Russell Hudson

Standout Practices

FISHstory is a strong example of an agency-based data processing project. Data processing projects are less commonly developed by federal agencies but are a type of project well worth considering. Most agencies probably have considerable banks of data that could be processed through volunteer assistance. In addition, data processing projects can engage a very different type of participant than data collection projects—people who are less able to go into the field to collect data, for example, or people who would like to engage with a project at varied hours of the day or night. FISHstory capitalizes on both of these factors by allowing volunteers to analyze photos from whatever location and at whatever time they'd like, as long as they have a computer and an internet connection. The Zooniverse platform makes it easy for participants to contribute to the project, providing training tools like practice photos and instructional illustrations that ensure participants correctly identify species. Discussion boards also provide an opportunity for participants to communicate with staff about their challenges identifying species. Another benefit of the platform and the nature of a data processing project is having multiple volunteers identify each data sample, in this case historical photos. These measures improve the quality of data collected and ensure that volunteers receive the support needed to stick with the project.

Takeaways

During the development of the project on the Zooniverse platform, the project developers incorporated feedback from the FISHstory design team, Zooniverse staff, and Zooniverse beta test volunteers to refine data collection protocols, improve volunteer training resources, and provide mechanisms for data quality review. Listening to this feedback and adapting the project during the design stage proved critical to improving the data collected through the project.

Project leaders articulate their lessons learned in the publication, Designing the FISHstory Project to Support Fisheries Management:

- Time invested in preparation can give a project the best chance of success.
- Bring diverse experience into your team in the project development stage.
- Listen to experts and incorporate their feedback.
- Training was a key component in multiple facets of the FISHstory project.
- Include data end-users in project design.
- There are costs associated with citizen science projects.
- Leverage learning from other citizen science projects.

Further Reading

Byrd, J., Collier, W.C., and Iberle, A. 2022. Designing the FISHstory project to support fisheries management. *Fisheries Magazine* 47(11), pp.492–498. https://doi.org/10.1002/fsh.10809

MOUNTAIN BIRDWATCH

Mountain Birdwatch, a project of the Vermont Center for Ecostudies (VCE), enlists participants in conducting five-minute point counts on 10 species of high-elevation songbirds and one species of squirrel (the birds' primary nest predator) within the White Mountain National Forest (WMNF).

Federal Land Management Agency and Partner Organizations:

USFS and VCE.

Goal:

Gain a better understanding of montane bird population dynamics and the impact of factors negatively affecting their habitat, such as climate change and recreation.

Objectives:

- Increase volunteer participation within the WMNF for Mountain Birdwatch.
- Make interns available for supporting new volunteers with their surveys.
- Increase the use of the project dataset by designing tools for practitioners and USFS biologists, and creating fine-scale (< 1 hectare) predictive occurrence and abundance maps for each of the 10 bird species that the project monitors.

Audience:

Birders, WMNF visitors, bird conservation enthusiasts, college students, retirees, and state and federal agency biologists.

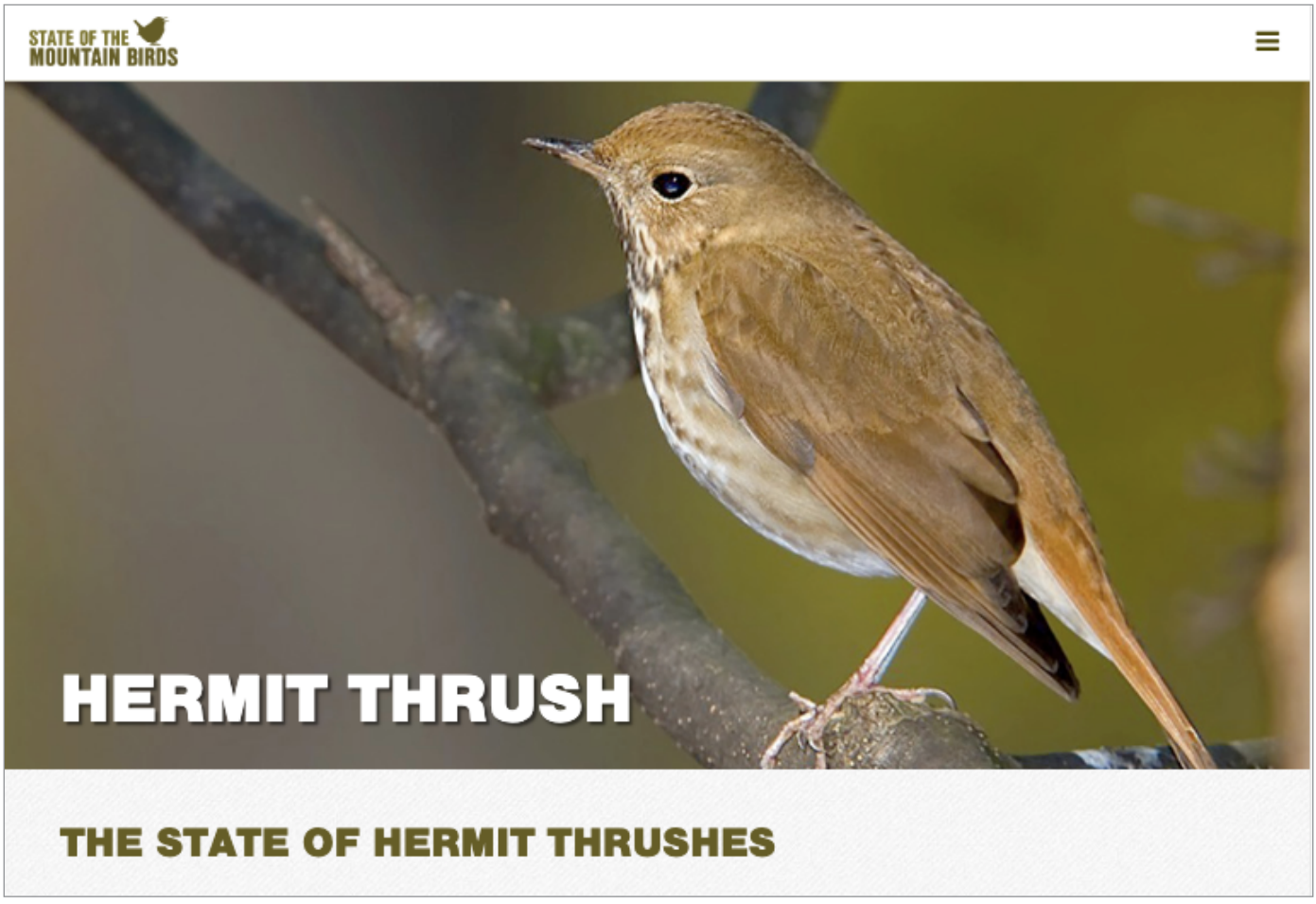
Data-Gathering Tool:

eBird is used as a tool for recruiting volunteers and storing data; data collection is bespoke.

Data

Mountain Birdwatch data are used to analyze population dynamics and relative abundance of high montane bird communities, which indicate how these species are responding to the effects of climate change and increased human activity on their habitat. VCE staff rely on occurrence data to create regional population trends and GIS layers that are shared with the WMNF. Data supports conservation plans for these species, such as the establishment of protective management zones throughout the WMNF. Land managers also utilize this information when making land-use decisions that impact these species.

Mountain Birdwatch is an example of a project that has successfully developed accessible data practices. Data are publicly available online through the *State of Mountain Birds Report*, where the information is offered in three different downloadable forms: raw data, full table of results for all 10 species and regions, and condensed data. Data are also organized into species-specific webpages with graphs and tables that communicate population change over time. The State of Mountain Birds homepage also links to the Knowledge Network for Biocomplexity (KNB) database, where raw data and metadata are publicly available and downloadable. Data targeted to a more specific audience of birders and researchers are also available for viewing and downloading on the eBird platform.



Webpage from State of the Mountain Birds. Retrieved from: https://mountainbirds.vtecostudies.org/birds/hermit-thrush/; © 2024 Vermont Center for Ecostudies

Standout Practices

By actively engaging with volunteers throughout the entire project, Mountain Birdwatch leaders strive to maximize enjoyment for project participants, while ensuring the desired data are successfully collected. From the beginning, VCE provides several different methods of training and allows participants to choose their own survey route, which helps participants feel independent and trusted. Throughout the survey process, VCE offers extra support for project participants by dedicating one employee entirely to the Mountain Birdwatch project. Citizen science grant funding has allowed VCE to host two summer interns who are available to go into the field with volunteers and guide them through the survey protocol, field questions from the office, and assist in data entry quality control. Providing extra guidance is believed to help retain new volunteers who may have trouble learning the procedure. Data are also readily available and communicated in an easily understandable format, which helps volunteers stay invested in the project.

Takeaways

Mountain Birdwatch leaders encourage continued participation in each year's survey by providing plenty of resources to provide volunteers with guidance on project protocol.

VCE tracks the volunteers who partake in the project more than once. The organization implements strategies that encourage repeat participation, such as allowing participants to sign up for the next season and choose their transects when participants submit the current year's survey data online.

Further Reading

Hill, J.M. 2023. The State of the Mountain Birds Report: 2023. Vermont Center for Ecostudies, White River Junction, VT. https://mountainbirds.vtecostudies.org/

LEARN MORE ABOUT HOW THIS PROJECT EXEMPLIFIES

Accessible data practices; see Module 10 of the Interagency Citizen Science Toolkit.

DRAGONFLY MERCURY PROJECT (DMP)

The Dragonfly Mercury Project (DMP) monitors mercury pollution in US national parks and other protected areas using dragonfly larvae as biosentinels, that is, organisms that measurably reflect environmental change. Dozens of national parks are implementing the project or have done so in the past. For this project, park staff and local volunteers collect dragonfly larvae from various park locations. Data are gathered about each specimen in the field. Then the collected larvae are preserved and shipped to a U.S. Geological Survey (USGS) lab where they are analyzed for mercury. Since 2009, more than 6,000 volunteers have helped to collect dragonfly larvae at more than 140 parks and other protected areas across the US. The DMP is now the nation's largest assessment of mercury contamination and environmental risk, and more parks and waterbodies are added each year.

Federal Land Management Agency and Partner Organizations:

NPS, USGS, USFWS, Appalachian Mountain Club, and the National Park Foundation.

Goal:

Collect dragonfly larvae for mercury analysis in national parks.

Objectives:

- Develop a quantitative model to forecast risk from mercury.
- Develop tools and options for assessing/mitigating risk from mercury.
- Test the efficacy of mercury emissions reductions on availability of mercury in aquatic food webs.
- Engage and educate project participants and the public.
- Communicate the importance and improve understanding of mercury issues across a variety of audiences.

Audience:

Youth, community members, park visitors and volunteers, local conservation groups, and university students and faculty.

Data-Gathering Tool:

Bespoke

Data

Data from this field study help scientists and managers better understand and address mercury contamination, which is responsible for more than three-quarters of US fish consumption advisories and threatens food webs in parks and protected lands. More specifically, the project shows where potential mercury risks are located; determines how well mercury emission reduction programs and policies are working; provides science to inform resource management and risk mitigation techniques; gets people involved in learning about mercury; and spreads the word about mercury issues. Each participating unit or national park provides staff from their resource management or interpretive division, or they link with other partners to work with, for example, a teacher from their community. These project liaisons coordinate, train, and lead participants in collecting samples, which are shipped to a centralized laboratory for analysis.

Land managers use the data to determine what parts of the unit or park might be at greatest risk of contamination, which can inform where and how to mitigate, manage, or remediate mercury risk with land management practices and control techniques such as managing dam releases, prescribing fire, and restoring wetlands. This knowledge also helps buffer against unintended consequences of applying a management action, only to have it backfire and exacerbate mercury cycling. Further, dragonfly mercury results are especially informative in the face of climate change, given that the risk of mercury exposure is intricately linked to water chemistry, ecosystem conditions, and environmental drivers that may be impacted by global changes like extreme precipitation events, wildfire, or glacial melt.

At a local scale, DMP data can be analyzed to indicate which areas within a park are at a greater risk of contamination; these areas may require a more in-depth assessment or further consideration before implementing land management actions. At a national level, data are utilized to evaluate spatial and temporal trends in mercury levels throughout the country. Spatially, data can highlight the differences in mercury concentrations within and between parks and can even suggest what factors may be contributing to mercury levels throughout a park. Temporally, data can be used to assess dragonfly mercury concentrations over time, and whether linkages exist between mercury exposure and availability (i.e., loading to the ecosystem via atmospheric deposition). Further, due to the program's robust and extensive spatiotemporal dataset on mercury in dragonflies, and as a continuous measure of mercury in the environment, the DMP can help track the effectiveness of mercury emission reductions in accordance with domestic and global policies. One such policy is the Minamata Convention on Mercury, a UN treaty ratified by more than 100 different countries that aims to reduce mercury emissions to the atmosphere and protect human and environmental health from mercury exposure.

Standout Practices

DMP is an example of a project whose early consideration of stakeholders has enabled large-scale growth. Leaders expanded the effort by reaching out to USGS scientists in the Ecosystems Mission Area and Environmental Health Program, implementing a national-scale demonstration study to test the efficacy of dragonflies as mercury biosentinels. Together these organizations developed the project plan and protocols and refined the training materials with assistance from the Schoodic Institute at Acadia National Park. Over the course of a decade, program leaders identified and reached

DMP participants collect dragonfly larvae. Photo credit: NPS, Public domain

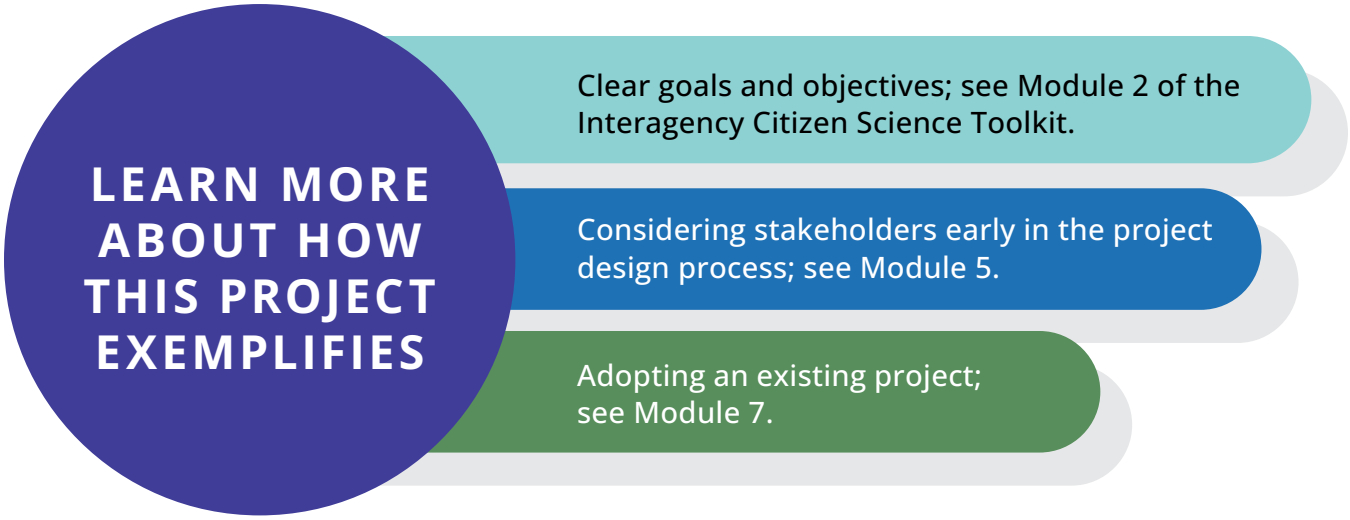
out to stakeholders to enhance engagement opportunities. Stakeholders included the National Park Foundation, other federal and state agencies, academic institutions, local municipalities, resource managers, and recreational and subsistence consumers of fish.

Takeaways

By offering numerous resources with detailed information, the Dragonfly Mercury Project organizers make it easy for citizen science practitioners to implement the project. One such tool they developed is a detailed protocol implementation plan. Materials include a field sampling guide, a dragonfly identification key, lessons on mercury and entering and retrieving data, additional materials for teachers to use with their students, and more. Accessible and useful resources like this have allowed more than 140 national parks, 20 national wildlife refuges, 2 national forests, and 2 Tribal lands to participate in the project so far. These numbers not only exemplify the degree of public participation in science that the project has incited, but also the magnitude of data it has established the capacity to collect.

Further Reading

- Flanagan Pritz, C.M., Eagles-Smith, C.A., VanderMeulen, D.D., Nelson, S.J., and Willacker, J.J. 2022. Protocol Implementation Plan for Dragonfly Larvae Sampling and Mercury Analysis: A Contribution of the Dragonfly Mercury Project. Natural Resource Report NPS/NRSS/ARD/NRR— 2022/2386. National Park Service, Fort Collins, Colorado. https://doi.org/10.36967/nrr-2291783
- Flanagan Pritz, C.M., C.A. Eagles-Smith, D.D. VanderMeulen, and K. Ko. 2022. Standard Operating Procedure #1, Pre-Season Preparation: Protocol Implementation Plan for Dragonfly Larvae Sampling and Mercury Analysis. Version 1.0. Air Resources Division, National Park Service, Denver, Colorado. https://irma.nps.gov/DataStore/DownloadFile/674022
- Eagles-Smith, C.A., Willacker, J.J., Nelson, S.J., Flanagan Pritz, C.M., Krabbenhoft, D.P., Chen, C.Y., Ackerman, J.T., Campbell Grant, E.H., and Pilliod, D.S. 2020. A national-scale assessment of mercury bioaccumulation in United States national parks using dragonfly larvae as biosentinels through a citizen-science framework. *Environmental Science and Technology*, 54(14), pp.8779–8790. https://doi.org/10.1021/acs.est.0c01255



HOVENWEEP DEBRIS FIELD

The Hovenweep Debris Field Citizen Science Project was initiated by the Bureau of Land Management (BLM) to remove an abundance of waste debris on the Hovenweep field, a small area on the BLM's Canyons of the Ancients National Monument (CANM), thus making it fit for recreation and visitors. Since the waste appeared to be mixed with some historic debris, the removal procedure needed to comply with the National Historic Preservation Act. This would require documenting the trash deposits to ensure nothing of historical significance was removed. Because this task would be too time consuming for the monument's sole archaeologist to accomplish independently, the BLM brought in citizen scientists from the Cultural Site Stewardship Program (CSSP)—managed by the Southwest Colorado Canyons Alliance (SCCA)—to document the debris, allowing CANM Archaeologist Vince MacMillan to assess the archaeological significance of the debris.

Federal Land Management Agency and Partner Organizations:

BLM and SCCA.

Goal:

Document the debris on the Hovenweep field to determine its archaeological significance and allow for its removal, opening up the site for visitors and recreation.

Objectives:

- Identify distinct concentrations of debris (loci) within the area.
- Number each locus and record its dimensions.
- Tally the artifacts in all loci on the site.

Audience:

Amateur archaeologists and historians.

Data-Gathering Tool:

Avenza

Data

Site stewards conducted intensive surveys to monitor 120 cultural resources in the CANM in Colorado. Working under the supervision of the Site Steward Program Manager, Diane McBride, and the Monument Archaeologist, Vince MacMillan, the participants followed surveyed transects while documenting historic artifacts in place, with photos, drawings, and precise GPS coordinates.

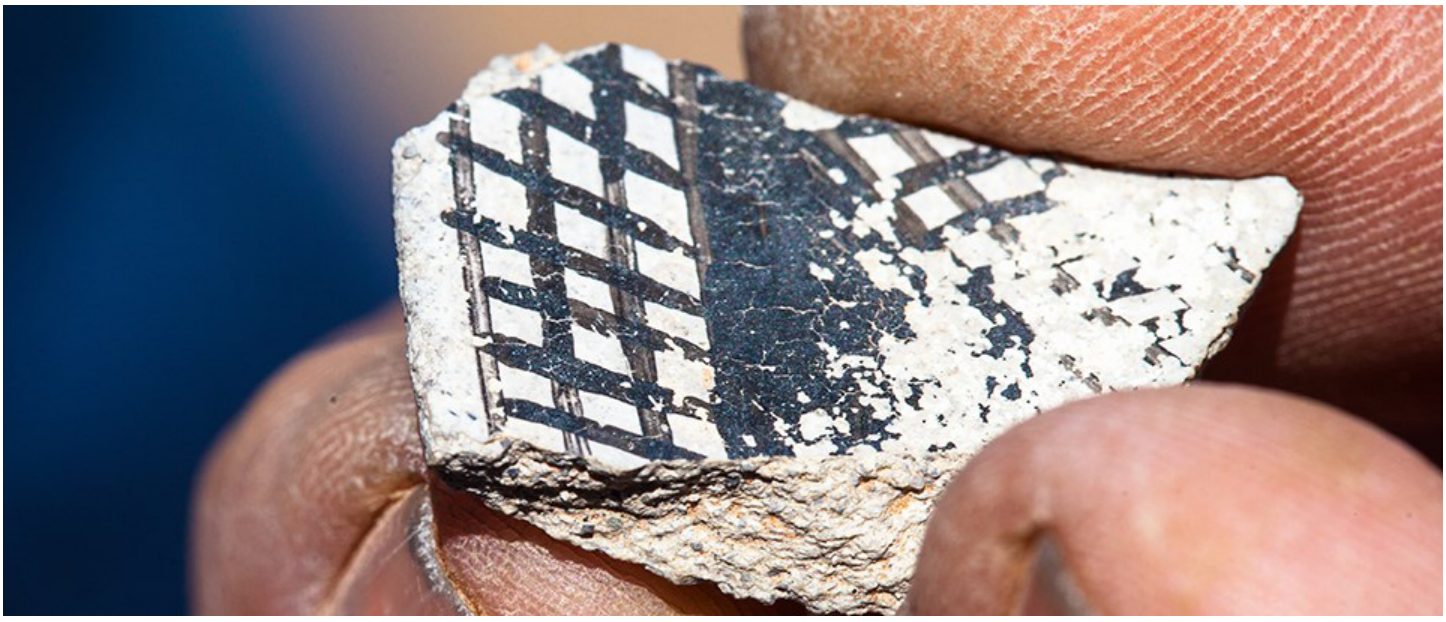
Data collected by site stewards is used by MacMillan to analyze the archaeological significance of the artifacts and therefore assess the historical significance of the site. MacMillan compiled project findings into a written report, which he references when consulting with the state historical preservation office about the proposed site clean-up.

Data were maintained in the electronic databases managed by the BLM and the Colorado State Historic Preservation Officer. MacMillan updated site stewards on project developments and invited them to return to help with the site clean-up upon completion of the documentation required for the National Historic Preservation Act compliance. Most of the communication with the site stewards was via email and during various in-person trainings, which were coordinated through the CSSP program manager.

Standardized data collection forms developed by the Colorado State Historic Preservation Office (SHPO) were completed by MacMillan with direct input from volunteer surveyors. In-field artifact analysis was conducted using established protocols developed to meet standards set forth by the Secretary of the Interior for cultural preservation.

Standout Practices

The Hovenweep Debris Field Project was successful in part owing to the longevity of the Cultural Site Stewardship Program, which has been ongoing since the early 2000s. Additionally, these volunteers have many opportunities to gain experience and knowledge of archeological methods and theory, including classroom training and field



An example of the debris documented by participants on the Hovenweep field. Photo credit: Jacob W. Frank, NPS

work with experienced professionals. As a part of the Site Stewardship Program, CANM offers archaeological and cultural trainings at the Monument itself and within the collections at the Monument museum. Site stewards receive credit in the program for pursuing additional external archaeological trainings. Engaging volunteers in this way helps retain volunteers and allows experienced site stewards to train new volunteers as well as to assist in conducting professionally led archaeological projects such as this one.

Takeaways

This project both benefited from and built onto the niche expertise of its volunteers. MacMillan received informal feedback from volunteers before, during, and after completion of the project to incorporate into the results and future project planning efforts. Though the material documented within the Hovenweep debris field was atypical from most volunteers' experiences with prehistoric archaeological resources, the volunteers gained valuable field experience and a greater understanding of the breadth of cultural resources of interest to anthropologists, archaeologists, and land managers. The dynamic nature of the existing volunteer program, on which this project relied, was critical to the project's success.

When evaluating the impact of this work, MacMillan believed that the greatest factor to consider was the influence of volunteers on the local community. CANM had 65 active members of the community helping to disseminate information about the importance of the archaeological sites protected within its boundary. These volunteers could share their experience and understanding with families and colleagues, helping advance the goals and objectives of the BLM's cultural resources program.

Further Reading

- Bureau of Land Management. 2023. BLM Crowdsourcing and Citizen Science Action Plan: Public Science for Public Lands. US Department of the Interior, Bureau of Land Management, Division of Education, Cultural, and Paleontological Resources, Washington, DC. https://www.blm.gov/noc/blm-library/report/blm-crowdsourcing-and-citizen-science-action-plan-public-science

LEARN MORE ABOUT HOW THIS PROJECT EXEMPLIFIES

Establishing straightforward protocols that are enjoyable for participants to undertake; see Module 2 of the Interagency Citizen Science Toolkit.