Museums and citizen science are allied in many important ways. Museums were established to collect, preserve, interpret, and display artifacts for research and for the education, enjoyment, and betterment of the public. Citizen science involves the collection, preservation, interpretation, and display of public observations. When museums support citizen science, they become not only centers for learning about science, but also centers for doing science. In the process, they help make available to all the pursuit of science and knowledge, which — according to James Smithson, founding donor of the Smithsonian Institution — was the key to happiness and prosperity.

The Smithsonian and its affiliates have successfully engaged the public in pursuing science and knowledge. Some citizen scientists have walked through museum turnstiles, but thousands more have been part of geographically distributed networks of people across the world. How has museum-based citizen science helped further our scientific understanding? Here are some examples from the Smithsonian’s history, both past and present.

Joseph Henry, first secretary of the Smithsonian, created a program in 1849 for the systematic collection and aggregation of weather observations. The Smithsonian Meteorological Project began with 150 volunteers, but grew in a decade to a network of more than 600 volunteer observers in Canada, Mexico, Latin America, the Caribbean, and United States. These citizen scientists received instructions, standardized forms, and weather instruments. At first, they gave monthly weather reports that included daily temperatures, barometric pressure, humidity, wind conditions, cloud conditions, and amounts of precipitations. But by 1857, thanks to the telegraph, the Washington Star used this data to publish a daily national round-up of weather reports. The Smithsonian Meteorological Project was transferred in 1870 to the U.S. Army and in 1891 to the newly formed National Weather Service (originally called the Weather Bureau) with
“Citizen science,” known by other names in other eras, has always been an essential part of the Smithsonian’s DNA. In her 2013 paper “Citizen Science in Democracy,” Smithsonian senior archivist Pam Henson, notes that “after the Institution was founded in 1846, the scientists who directed its programs made a conscious effort to involve a broad array of citizens across the United States and abroad in its scientific programs.” These included “farmers, medical doctors, soldiers, teachers and telegraph operators [who] recorded daily weather observations and sent them to the Smithsonian to be compiled and analyzed for patterns.” In the 1950s, Operation Moonwatch, organized by the Smithsonian Astrophysical Observatory, relied on amateur astronomers to track the first artificial satellites, including Sputnik 1. The Smithsonian, like many of our Affiliates, continues to harness the energy and enthusiasm of dedicated volunteers of all ages and backgrounds to gather information on a wide variety of critical topics.

The importance of citizen science, as both an official government website designed to accelerate the use of citizen science and crowdsourcing throughout the federal government, mark the newest advances in this field.

We have noticed that a significant number of Smithsonian Affiliates are employing citizen science techniques on a regular basis. These programs provide invaluable data on the diversity and quality of life on our planet. Emlyn Koster, director of the North Carolina Museum of Natural Sciences (NCMNS), eloquently offers that citizen science is key to “illuminating the interdependence of nature and humanity.” It has been eye-opening to discover the range of citizen science projects that the Smithsonian and Smithsonian Affiliates are already leading and their ongoing contributions to the advancement of knowledge.

We are grateful to Emlyn and his colleagues at NCMNS for suggesting a special issue of The Affiliate for the discussion of this topic and for their guiding role in helping to shape this newsletter. Also, great thanks to James Deutsch, curator at the Smithsonian’s Center for Folklife and Cultural Heritage, for adding a critical perspective and serving as our guest editor.

This publication only scratches the surface of what we have learned to date; we know that there are many more citizen science efforts in the works and we look forward to hearing from many more Affiliates about the impact of citizen science in your communities.

Harold A. Closter
Director
Smithsonian Affiliations

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Citizen Science Association Annual Conference May 17–20, 2017

The 2017 Citizen Science Association annual conference, a welcome venue for new and experienced practitioners, will take place at the St. Paul RiverCentre in Minnesota. Presentations will focus on best practices in conceiving, developing, implementing, evaluating, and sustaining projects that facilitate public participation in scientific endeavors in any discipline. The 2015 CSA conference, attracted 700 attendees from 21 countries. For further information and registration, visit citizenscience.org/association/conferences/citsci2017.
volunteers placed in the Cooperative Weather Observer Network. To this day, Cooperative Weather Observers across the country maintain weather stations and record daily measurements. As the nation’s oldest source of ground-based weather observations, this data is essential to contemporary scientists studying climate change—an application that Secretary Henry in the 19th century could never have anticipated.

Old weather observations are so critical to climate science that citizen scientists are now transcribing the handwritten observations made by sailors and whalers centuries ago. The Mystic Seaport in Connecticut has a collection of logbooks from whaling ships, which volunteers are using to extract weather and sea-ice observations through an online portal called Old Weather: Whaling, a project hosted by the Zooniverse—said to be the world’s largest platform for people-powered research. Another Smithsonian affiliate, the Adler Planetarium in Chicago, was a founding partner in the Zooniverse, which hosts weather transcription projects, numerous astronomy projects, and more.

Citizen science methods of crowdsourcing have helped humanities research as well. Online volunteers in Ancient Lives—also part of the Zooniverse—have identified more than seven million Greek letters from some half million papyrus fragments excavated from the ancient Egyptian city of Oxyrhynchus. Professional papyrologists could never have processed the vast treasure trove by themselves. Similarly, more than 6,000 online volunteers with the Smithsonian Transcription Center help transcribe historic diaries, correspondence, and ledgers for a variety of purposes. Transcription turns handwritten and sometimes even typed documents into online searchable resources for future generations.

Similarly, citizen science has increased our knowledge of natural history in many ways. Spencer Fullerton Baird, the Smithsonian’s second secretary, created a large network of collectors, including Army officers in the West, while also persuading the Army to have naturalists join their exploring expeditions. Baird increased the Smithsonian’s holdings from 6,000 specimens in 1850 to more than 2 million in 1878. Donating specimens to museum collections, which is an early form of citizen science, still continues, not only with physical specimens but also with photo documentation, such as the Smithsonian Flickr Commons and the Encyclopedia of Life.

The pursuit of scientific knowledge through citizen science differs from more conventional scientific research in two significant ways. One is the unprecedented reach across both time and space. With so many people in so many different places contributing to citizen science projects, new discoveries are made that scientists working alone, or even in small groups, might never have achieved themselves. Citizen science therefore extends our collective capacity to reach into the unknown.

When museums offer citizen science, they afford people the opportunity not only to learn science through personal experiences, but also to help advance immediate scientific frontiers…

Secondly, there are often powerful social outcomes that result from the collective effort of scientists and the public. The benefits of citizen science may include not only a greater appreciation of science and increased scientific literacy among the participants, but also the empowerment of communities, an increased investment in conservation, and enhanced social networking.

Thanks to citizen science, museums are able to bring more people into contact with science. Even if these people never visit the Smithsonian or one of its Affiliates in person, they are engaged with the increase and diffusion of knowledge in new ways. Museums-based science enters their homes… and their lives.

Public trust in museums can have two effects. The typical interpretation is that museums are institutions that are highly trusted—seen as reliable and honest—by the public. Moreover, museums are also a public trust, serving as the guardians and custodians of our culture, science, and history. When museums offer citizen science, they afford people the opportunity not only to learn science through personal experiences, but also to help advance immediate scientific frontiers, to become part of long-term data legacies, and perhaps even (as James Smithson advocated) to find greater happiness and prosperity.
Smithsonian Affiliates Promote Citizen Science

A permanent exhibition at the San Diego Natural History Museum in California illustrates some of the ways in which amateur naturalists have helped shape science as we know it today. Extraordinary Ideas from Ordinary People: A History of Citizen Science showcases rare books, art, and photographs from the library’s 96,000-volume collection, many of which are on public display for the first time. The overarching theme of Extraordinary Ideas is simple: you do not need to be a scientist to participate in science.

Citizen science at the Denver Museum of Nature and Science in Colorado has deepened our understanding of taste sensations. The Genetics of Taste project involves two types of citizen scientists: those who learn lab techniques for analyzing DNA; and those who become research participants by being the subject of study. The research team found that humans can taste fat, a sixth taste in addition to sweet, sour, bitter, salty, and umami (savory). Together, scientists and citizen scientists debunked the notion that taste-bud density influenced sensitivity to bitterness.

The California Science Center in Los Angeles currently has two citizen science projects in progress. The Kelp Forest Census records the occurrence of giant kelp along the coast of California from Point Conception to the Mexican border, including all of the Channel Islands. Volunteers furnish images of live kelp attached to the reef, images of kelp that has broken loose from the bottom and is drifting freely, and images of kelp that has washed up on the beach. The L.A. Zone Flora and Fauna project encourages volunteers to photograph and post images of plants and animals found in the greater Los Angeles area.

Citizen science at the National Mississippi River Museum and Aquarium in Dubuque, Iowa, often involves the collection and reporting of data on animal life and environmental conditions along the river. Current projects include FrogWatch USA, where volunteers report data on the evening calls of local frogs and toads; Mudpuppy Sightings, where volunteers track the health of mudpuppies — aquatic salamanders found only in the eastern United States and Canada; MayFly Watch, which tracks the emergence of mayflies on the Upper Mississippi River; and Iowater, which trains volunteers to conduct chemical, physical, and biological measurements of valuable water resources.

By James Deutsch
Citizen science has found a welcome home in numerous Smithsonian Affiliates, a few highlighted here. As the number of citizen science programs and projects across the Affiliate community is quickly growing, we welcome receiving short descriptions of citizen science efforts for future publication.

Thanks to a worldwide network of volunteers, the Citizen Science Department at the Adler Planetarium in Chicago is able to analyze complex data in a matter of months or sometimes even weeks — data that might require a conventional science team more than 100 years to analyze. In programs such as Planet Hunters, part of the Adler’s Zooniverse program, citizen scientists discover planets outside our solar system by identifying light-curve changes observed by the Kepler Space Telescope. Over the past several decades, scientists in Chicago have been partnering with the public — using their human eyes and minds to crunch data, find trends, and make new discoveries.

Citizen science at the North Carolina Museum of Natural Sciences has revealed that tiny mites — arachnids that live in human hair follicles and in the pores of our face — have evolved alongside humans since the dawn of existence by eating our skin cells and body oils. A person’s ancestry may predict the type of mite found in their hair and on their face, suggesting that we pass them on to each generation like microscopic family heirlooms. At the museum, expert mite hunters inspect the faces of volunteers — in this case, the noted biologist E.O. Wilson — in search of tiny creatures inside our pores.

Old Weather: Whaling is a crowd-sourced research initiative that is helping scientists analyze historical data from whaling logbooks, in an effort to improve the collective understanding of long-term climate variability and weather patterns from the 19th century into the future. Mystic Seaport is contributing the content of some of the logbooks in its collections to support this citizen science initiative, in which members of the public extract historic weather measurements and other data from ship logs, including observations of sea ice, which many whaling ships sailed through and documented while navigating Arctic waters.

The Patricia and Phillip Frost Museum of Science in Miami, Florida, has enlisted an army of citizen scientists to tackle the sweaty work of removing invasive vegetation and planting native species on Virginia Key, a thousand-acre barrier island just seven miles from downtown Miami. One feature of the project’s innovative features is using social media, blogs, science exhibitions, and eco-art installations to empower conservation-minded residents to volunteer to help restore a variety of urban coastal habitats.
One of the earliest instances of citizen science at the Smithsonian was the weather map on display in the Castle, the Institution's original building and headquarters. Starting in 1856, the map displayed daily weather conditions (clear, cloudy, rain, or snow) based on reports received by telegraph from hundreds of volunteers across the country. This effort eventually led to the creation of the National Weather Service.

The Smithsonian Environmental Research Center (SERC) in Edgewater, Maryland, relies heavily on a dedicated crew of citizen scientists who assist with research projects in the field or in the lab. Citizen scientists work with researchers to investigate a wide range of topics including environmental-archaeology, forest biodiversity, invasive species distributions, and water quality issues. They become partners in discovery, finding answers to new questions and getting an inside look at science in the real world. In return, the scientists are able to gather information on a much larger scale than would be possible on their own. For instance, recent projects include environmental archaeology at the Sellman Plantation on the SERC campus, examining mud crabs for the presence of a parasitic barnacle known as Loxothylacus panopei, and collecting data from 48 nest boxes for Eastern Bluebirds, Carolina Chickadees, and Tree Swallows.

The Urban Ecology Engagement Initiative (UEEI) is a cooperative effort between the Smithsonian’s Anacostia Community Museum and the Smithsonian Environmental Research Center to engage middle and high school students and teachers throughout the Anacostia Watershed in studying and monitoring the environment that surrounds them. Students have been contributing to the ongoing research of scientists at the Anacostia Watershed Society and the Maryland Department of Natural Resources Stream Waders program. UEEI began in 2012 as part of the Anacostia Community Museum’s Reclaiming the Edge: Urban Waterways and Civic Engagement exhibition. UEEI aims to challenge the way students view and think about the environment they live in, by getting directly involved with streams in their communities and realizing that nature is found even in very urban ecosystems.

Citizen scientists have examined the details of bird lives in residential areas, thanks to the Smithsonian’s Neighborhood Nestwatch, which focuses on American Robin, Mockingbird, Cardinal, Gray Catbird, and House Wren. One result is that they have found higher nesting success in urban areas, probably because of fewer predators, despite the presence of cats. Neighborhood Nestwatch also found that urban songbirds bioaccumulate lead in their tissues, which not only affects their health, but also indicates the persistence of this heavy metal in soils in urban and suburban areas. Neighborhood Nestwatch provides both an experiential educational experience for citizens and a unique platform for important scientific research. It is headquartered at the Smithsonian Migratory Bird Center in Washington, D.C., which is operated by the Smithsonian’s National Zoological Park and its Conservation Biology Institute.

cMammal is a system for collecting, storing, and sharing camera-trap data from around the globe. The system is designed for scientists and citizen scientists, and anyone who wants to join in the fun and discovery of camera trapping. Professional and volunteer camera trappers use eMammal software to look at pictures, identify animals, and upload them to the Smithsonian Data Repository for review and storage. These data are useful for addressing important scientific and conservation questions, and the pictures provide a unique view into the hidden world of wildlife. The eMammal project team includes staff from the Smithsonian Conservation Biology Institute, Smithsonian Tropical Research Institute, and National Museum of Natural History, working with researchers from the North Carolina Museum of Natural Sciences and University of Missouri.

The Smithsonian’s National Museum of Natural History, in conjunction with the University of Maryland and Columbia University, developed Leafsnap—a free mobile app that helps identify tree species from photographs of their leaves and contains beautiful high-resolution images of their flowers, fruits, petioles, seeds, and bark with visual recognition software to help identify species from photographs. By sharing images, species identifications, and geo-coded stamps of species locations with a community of scientists, Leafsnap turns users into citizen scientists. The resulting stream of data can map and monitor the ebb and flow of flora.

One cubic foot of Earth—measuring 12 inches by 12 inches by 12 inches—contains a lot of life. The Bisoah program at the Smithsonian’s National Museum of Natural History uses small, accessible samples of that size to understand the world’s biodiversity: organisms hidden in leaf litter, soil, and the nooks and crannies of environments. By focusing on just one cubic foot, students, like scientists, can characterize representative communities and begin to understand distributions, interactions, and relationships. The Bisoah program was inspired by a feature article in National Geographic that involved Smithsonian scientists and led to the book, A World in One Cubic Foot: Portraits of Biodiversity (2012) by photographer David Littschwager.
Whether you ease in with pre-existing projects or dive into the deep end with institutional change, citizen science is a great way to engage your visitors in authentic science.

For museums that already have researchers and web developers, consider starting a new project from scratch! This is the most complicated way to get involved in citizen science and generally requires staff, financial, web, and media resources. Creating your own project also allows your institution to customize every aspect of your project and to tailor it to your specific needs. However, just because your museum doesn’t have researchers doesn’t mean you can’t create your own project. Collaborations between museums and local universities can lead to wonderful projects that meet the needs of both.

If your institution wants to formally develop citizen science programs, you should outline your program goals within your greater institutional goals. This strategy will help your entire staff understand the importance of citizen science to your institution, encourage broad staff participation in your program, and provide dedicated support for your efforts.

Many online platforms allow you to create your own project relatively easily and without a web developer. For example, iNaturalist allows people worldwide to photograph plants, animals, and fungi, and to share their findings publicly. Building a project within iNaturalist is easy and provides your museum the opportunity to create biodiversity-focused projects with minimal resources. Zooniverse is another great platform that allows users to build computer-based citizen science projects. Current Zooniverse projects ask participants to help transcribe museum specimen/artifact labels and documents, identify and count animals captured on camera traps in the Serengeti, and classify galaxy shapes. Platforms such as iNaturalist and Zooniverse allow you to quickly and easily start your own projects without web developers, many dedicated staff, or researchers, while engaging your visitors in work that is meaningful to your institution.

Regardless of how you begin your citizen science journey, you should always consider the following:

- Even the easiest gateway, such as participating in a pre-existing project, incurs some cost. Consider the staff time, equipment, and other resources you will need before you begin and determine if the benefits balance the costs.
- Staff support is vital for success!
- Because citizen science is an inherently social enterprise, your participants will appreciate getting occasional updates, news about the projects they participate in, and other information. Plan to share these through your social media and other outlets for communication with your participants.

Whether you ease in with pre-existing projects or dive into the deep end with institutional change, citizen science is a great way to engage your visitors in authentic science.
Citizen Science: A Needed Movement for the Anthropocene

By Emlyn Koster

Although only a quarter-century old as a term, citizen science is centuries old as a practice in which those without formal training are able to engage in science and advance its frontiers. Here are a few illustrative historical examples:

- Shakespeare wrote in The Merry Wives of Windsor (1602), “She laments sir... her husband goes this morning a-birding.”

- At Lyme Regis on the English Channel coast, tourists learn that Mary Anning (1799–1847) was the first person to collect ammonites and marine reptiles from cliff outcrops of Jurassic strata. According to Stephen Jay Gould, the distinguished evolutionary theorist and historian of science, Anning was “probably the most important unsung (or inadequately sung) collecting force in the history of palontology.”

- Two Boston socialites, Harriet Hemenway and Minna Hall, urged approximately 1,000 women in 1896 to end the fashion of adorning hats with bird feathers. A Massachusetts law one year later eventually led to the U.S. Migratory Bird Treaty Act of 1918.

- In 1977, after two decades of volunteers tagging thousands of Monarch butterflies, a tagged Monarch was found in the mountains, thus providing evidence of their long-distance migration.

- Annually since 1979, the Astronomical Society of the Pacific has given its prestigious Amateur Achievement Award.

- This year’s annual Christmas Bird Count began in 1900. Cornell University’s Lab of Ornithology reports that its eBird database now enables birders to track any of the Earth’s 8,600-plus bird species. Similarly, observations on 8,600-plus species worldwide help to document declines of some species, range expansions of others, and spread of avian diseases.

- Nevertheless, it was not until the early 1990s that the philosophy and practice of citizen science truly blossomed, especially after Rick Bonney at Cornell University’s Lab of Ornithology formalized the term. Around the same time, Robert Sullivan at the Smithsonian’s National Museum of Natural History questioned the prevailing Victorian paradigm of natural history museums and advocated for public engagement and ecosystem-level approaches. Physicist Ursula Franklin at the University of Toronto provided further philosophical underpinnings with her call “to build knowledge and understanding among and between citizens and scientists.” The goal, she opined, is to erase “the distinction between the two groups... so that both become citizen scientists, potentially able to solve our problems together.”

Today, citizen science is a surging global movement that provides a myriad of opportunities for the interested public—at all ages and stages of learning and from all backgrounds—to engage in research projects focused on understanding and improving the world around us. With the frontiers of citizen science now also including such topics as biodiversity, weather and climate, environmental quality, and medical research, the virtual ubiquity of Internet access and cameras has greatly advanced what is possible. Increasingly, concerned members of the public are the ones who spur the interests of researchers and policymakers. What began as pastimes detached from scientific professions has become a desirable nexus of mutual energy at the nature and science museum sector. Such actions would have affirmed the founding raison d’être of “the museum,” taken from Greek mythology as the place where The Muses were worshipped.

We now believe that our attachment to nature is instinctive and that within each of us exists an “inner scientist.” Accordingly, our nature and science museums need new and uplifting ways to engage their communities in topics that illuminate the Anthropocene from its multiple angles. The rising popularity of citizen science—which is stimulating lifelong public participation in scientific research—offers an especially promising pathway. Thanks to their comprehensive expertise, our nature and science museums have perhaps the greatest potential to enhance lifelong learning around the world. These museums must find ways to act holistically in response to the Anthropocene’s societal needs, which are becoming increasingly urgent.

Where I work, the North Carolina Museum of Natural Sciences, explicitly recognizes the imperative of the citizen science movement. Our mission is to illuminate the interdependence of nature and humanity, propelled by four vital questions: What do we know? How do we know? What is happening now? How can the public participate?

Top
Bird watching and bird counting are popular activities for citizen scientists.
Photo courtesy of U.S. Fish and Wildlife Service.

Bottom
This Monarch butterfly was tagged in Cape May Point State Park, New Jersey. Photo by and © Derek Ramsey.

Today, citizen science is a surging global movement that provides a myriad of opportunities for the interested public—this particular moment in human history, known as the Anthropocene.

Admittedly, it took some time for museums—particularly nature and science museums—to broaden their thinking with research insights from other fields, such as social biology and psychology. In hindsight, the first attempts at space exploration in the 1950s and 1960s, which may well coincide with the formalized start of the Anthropocene, should have sparked a period of profound introspection, reflection and inspiration across the nature and science museum sector. Such actions would have affirmed the founding raison d’être of “the museum,” taken from Greek mythology as the place where The Muses were worshipped.

Opportunities for citizen science are rapidly expanding throughout the country, with new resources appearing in print and online every day. See, for instance, the Smithsonian’s page for citizen science, with links to opportunities for getting involved: www.si.edu/volunteer/citizenscience.

Additional Resources

The Citizen Science Association offers more opportunities at www.citizen-science.org, and Caren Cooper, the author of this newsletter’s cover story, has recently published Citizen Science: How Ordinary People Are Changing the Face of Discovery (Overlook Press, 2016), which provides both a historical overview and thoughts about future directions for citizen science.