Citizen Science: Anyone can do it

CITIZENS AID IN SCIENTIFIC DISCOVERIES

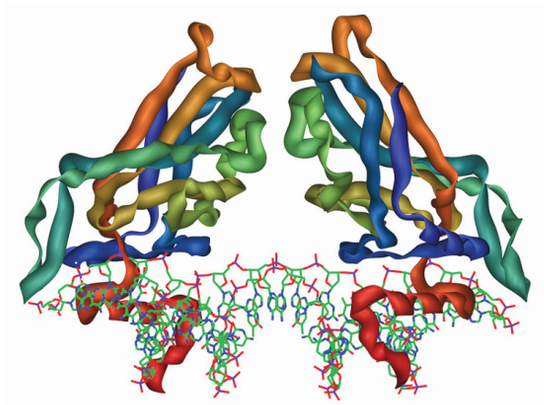
By Marta Shocket

Editor's note: Marta Shocket will give a talk about citizen science at the next Bloomington Science Café on July 17th at 6:30 p.m. at Finch's Brasserie (514 E. Kirkwood Ave.). Science Café brings scientists to talk about topics of general interest that are related to their research. As such it is an opportunity to bridge the growing gap between scientists and the public. Ample time is set aside for Q&A. More information at www.sciencecafebloomington.org/

What do bumble bees, stars, and protein-folding have in common? They're all the subject of citizen science projects – a growing movement to harness the power of ordinary citizens for scientific research. Many professional scientists are now turning to crowdsourcing to help them collect and analyze data on large scales that would not otherwise be possible. Ideally, these projects not only allow scientists to make new discoveries, but also promote scientific literacy and engagement among the general public while keeping the scientific community more connected to the population that their research serves.

From the Renaissance until the late 19th century, most scientific research was conducted by non-professional "gentlemen scientists" who operated independently from the university system and used their personal wealth to finance experiments that captured their attention.

Citizen science is particularly well-suited to answer scientific questions that require large amounts of data collected over a large geographic area. For example, *The Great Sunflower Project* has collected millions of observations of pollinator visits to sunflowers from over 100,000 participants across North America since 2008. That volume of data would be impossible to collect using a single team of researchers on a normal scientific funding grant.



A 3D model of the TBR1 protein (thick, ribbon-like lines) binding to DNA (thin, stick-like lines), similar to the models manipulated by participants of the citizen science project Foldit. TBR1 is important for brain development in humans and other vertebrates. Image by Robert Hevner.

By combining millions of reports onto a single map (an interactive version is available online), the researchers have been able to identify areas of the United States that have very few or no pollinators – what they call "pollinator deserts" – and show that urban environments in general have fewer pollinators. These findings compliment traditional studies that show specific bee populations are in trouble, and can give scientists a better idea of how bee population declines and urbanization are affecting pollinator service across the United States. The project has also helped draw public attention to the importance and vulnerability of pollinator populations, which provide over $200 billion worth of crop production globally each year.

Another extremely successful citizen science project has taken advantage of the natural human desire to play games and compete against each other. *Foldit* is a free program that allows users to manipulate 3-D models of proteins until they find the best configuration. Knowing the correct structure of a protein is extremely important for predicting how it will interact with drugs or other proteins that may cause disease. While solving protein-folding puzzles with computers alone is a lengthy and expensive process, the superior

Picture of a baby elephant from a Serengeti Snapshot camera trap in Serengeti National Park in Tanzania, taken from the project blog at http://blog.snapshotserengeti.org/.

spatial reasoning of human volunteers can find the answer much more quickly and cheaply. The *Foldit* game has made national headlines twice: in 2011 users helped determine the structure of an important protein from the Mason-Pfizer Monkey Virus, and in 2012 players helped modify the structure of a manufactured protein to make its catalysis of a chemical reaction eighteen times more efficient.

Of course, there are also downsides to the citizen science approach. In some cases, like *The Great Sunflower Project*, scientists are still figuring out how to effectively analyze and use the massive amounts of data that they collect. It is also more difficult to control the quality of data collected by thousands of people with varying backgrounds than by a few highly-trained experts. Some projects try to compensate for the extra error by having multiple volunteers perform the same task and checking to see if the results match.

For instance, *Snapshot Serengeti* lets internet users identify the type and number of animals in millions of pictures captured by 225 camera traps throughout Serengeti National Park in Tanzania. Each image is examined by at least 20 people and the computer algorithm that analyzes all of the volunteer responses arrives at the correct answer about 95.8% of the time. (The answer is partially correct or undetermined 3.1% of the time, and is incorrect only 1.1% of the time.) Scientists are using the information that the project collects to examine how different

Looking for a citizen science project to join?

Here are some great places to start looking.

GENERAL CATALOGUES

The magazine Scientific American lets you browse projects by topic areas like Heath, Technology, and Evolution.
www.scientificamerican.com/citizen-science/

The Citizen Science Alliance webpage is also portal to all of the internet-based projects that they help host.
www.citizensciencealliance.org/

SciStarter is a citizen science matchmaker that finds the right project for you based on your interests.
www.scistarter.com/

BIOLOGY

Your Wild Life is a collection of projects looking at the biology right under our noses: on us, in us, and around us, from the bacteria in your belly button to the ants in your backyard.
http://www.yourwildlife.org

BIRDS

eBird volunteers can submit observations of birds any time of year, and the website allows you to track your life list and compete with other birders.
www.ebird.org/

BRAINS

EyeWire volunteers compete for points by tracing retinal neurons through 3D composites of brain slices to research visual perception.
www.eyewire.org

GEOGRAPHY

Geo-Wiki Project volunteers improve the quality of global land cover maps by comparing what they see in Google Earth to their local knowledge.
www.geo-wiki.org/

CLIMATE CHANGE

Nature's Notebook volunteers track seasonal changes in plants and animals to see how climate change is affecting our planet.
www.usanpn.org/natures_notebook

SPACE

SETI@home was one of the first internet-based citizen science projects, initially released in 1999. Its software uses your computer's downtime to analyze radio telescope data and look for signs of extraterrestrial life.
http://setiathome.berkeley.edu

species of predators avoid each other over space and time, how different species of herbivores specialize on diverse habitat types, and if food quality or predation risk is a better predictor of where herbivores forage for food. This knowledge is essential for managing the park in a way that effectively conserves all of the species coexisting within its borders.

A honeybee pollinating a flower. The USDA estimates that bee pollination is worth about $200 billion in crop production each year, including foods like apples, citrus fruits, strawberries, broccoli, onions, almonds, soybeans, and even non-food crops like cotton. Scientists are unsure why bee populations are currently declining.
Photo by Jon Sullivan.

On the Origins on Citizen Science

Although the rising popularity of citizen science has coincided with – and arguably been fueled by – increasing internet access since the 1990's when the term was first coined, it is hardly a new concept. From the Renaissance until the late 19th century, most scientific research was conducted by non-professional "gentlemen scientists" who operated independently from the university system and used their personal wealth to finance whatever experiments or observations captured their attention. One of the first citizen science projects created in the modern sense of the phrase was started by the Smithsonian Institution in 1849. They took advantage of expanding telegraph technology to create a network of volunteer weather stations. Data from that project led to important discoveries about weather patterns and are still used today to provide historical comparisons for more recent weather.

Another pioneering citizen science project was the Christmas Bird Count, started by the National Audubon Society in 1900 as a conservation-friendly alternative to traditional Christmas "side hunts," in which teams of friends competed to see who could kill the most birds. Over the past 113 years, participation has steadily increased to over 63,227 participants spread out over 2,248 bird count locations in 2012. Many of the sites are strategically located along important migratory pathways and have decades' worth of continuous data, allowing scientists to track fluctuating bird populations over time in response to factors like habitat loss and climate change.

Astronomy also has a long and ongoing legacy of citizen scientist

participation. Many amateur astronomers have made significant contributions to the field, including the discovery of countless comets and supernovae, and the white spot on Saturn. Amateurs are particularly useful for monitoring variable stars, whose light intensity fluctuates systematically over time. Most professional astronomers are only able to reserve observation slots at major telescopes a few times a year, usually for a week or less at a time. This sporadic access is not conducive to studying phenomena that require detailed observations at frequent, regular intervals over long periods of time. To help solve this predicament, the American Association of Variable Star Observers has worked to coordinate the efforts of amateur and professional astronomers and collected over 21 million observations of variable stars since 1918. For space enthusiasts plagued by light pollution or without access to a telescope, the project *Galaxy Zoo* asks users to classify images of galaxies from the Sloan Digital Sky Survey and has produced at least twenty-five scientific publications.

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Moving Forward

Once limited to circles of only the most dedicated naturalists and nerds, the idea of citizen science has gained notoriety in mainstream society and a strong foothold in schools around the country. Nearly every notable scientific organization, from the National Wildlife Federation to NASA, has a citizen science section on their webpage with links to various projects that the public can get involved with. Looking at the impressive lists of scientific publications and reading testimonials from enthusiastic participants, it's easy to understand why.

However, citizen science is more than just a satisfying win-win scenario for professional scientists and their kindred spirits; the success and growth of citizen science is in the best long-term interests of the scientific establishment. As funding for basic science research becomes harder for scientists to acquire – and more controversial for some members of Congress to allocate – crowd-sourced science represents a way to do more with fewer resources while at same time demonstrating directly to the public that science itself is worth paying for. Meanwhile, we are increasingly faced with important policy decisions that depend on being able to understand and interpret complex scientific topics, like climate change and infectious disease biology. Professional scientists will not be able to solve these problems alone – they need your continued support, and perhaps some help collecting and analyzing data too.

A honeybee pollinating a sunflower. The Great Sunflower Project collects data on pollinator visits to sunflowers from thousands of people across North America each year. The data is used to study pollinator abundance and bee declines across the continent.
Photo by Matt Batchelor.